The Effects of Physical Activity On Subjective Cognitive Function And Academic Ability

Stephen Hogan

X17302086

B.A. (Hons) in Psychology

Michelle Kelly

National College of Ireland March 2020

Submission of Thesis and Dissertation

National College of Ireland

Research Students Declaration Form

(Thesis/Author Declaration Form)

Name: Stephen Hogan

Student Number: X17302086

Degree for which thesis is submitted: Bachelor of Arts Psychology

Material submitted for award

(a) I declare that the work has been composed by myself.

(b) I declare that all verbatim extracts contained in the thesis have been distinguished by quotation marks and the sources of information specifically acknowledged.

(c) My thesis will be included in electronic format in the College Institutional Repository TRAP (thesis reports and projects)

(d) ***Either*** *I declare that no material contained in the thesis has been used in any other submission for an academic award.

Or *I declare that the following material contained in the thesis formed part of a submission for the award of

_____

(State the award and the awarding body and list the material below)

Signature of research student: Stephen Hogan

Date: 1st March 2020

Submission of Thesis to Norma Smurfit Library, National College of Ireland

Student name: Stephen Hogan Student number: X17302086

School: National College of Ireland Course: Bachelor of Arts (Honours) Psychology

Degree to be awarded: Level 8 Bachelor of arts (Honours) Psychology

Title of Thesis: The Effects of Physical Activity On Subjective Cognitive Function And Academic Ability

One hard bound copy of your thesis will be lodged in the Norma Smurfit Library and will be available for consultation. The electronic copy will be accessible in TRAP (http://trap.ncirl.ie/), the National College of Ireland's Institutional Repository. In accordance with normal academic library practice all theses lodged in the National College of Ireland Institutional Repository (TRAP) are made available on open access.

I agree to a hard bound copy of my thesis being available for consultation in the library. I also agree to an electronic copy of my thesis being made publicly available on the National College of Ireland's Institutional Repository TRAP.

Signature of Candidate: Stephen Hogan

For completion by the School:
The aforementioned thesis was received by_____
Date:_____

This signed form must be appended to all hard bound and electronic copies of your thesis submitted to your school

Acknowledgements

I would like to take this opportunity to thank firstly, my family and friends who have continually supported and taken a keen interest in my well-being. Secondly, I wish to express my gratitude of thanks to my supervisor Michelle Kelly, who has encouraged and has given me continuous guidance throughout this entire process. Finally, I would like to thank the National College of Ireland for facilitating the opportunity to complete this dissertation.

Abstract

Previous studies have examined the effect physical activity can have on cognitive function and academic achievement objectively using acute measures for the younger adult population and longitudinal interventions for older adult population. However, little research has been conducted investigating the effect of subjective physical engagement on subjective cognitive function and academic achievement. The purpose of this study is to examine these associations. Participants N = 41, were recruited using social media platforms and their data was collected through a google forms survey, incorporating questionnaires on memory, attention, executive function and academic achievement. Participants data was then configured using a Spearman's rank order correlation and four individual linear regressions. There was no correlation between any of the assessed variables and physical activity. Linear regression analysis found no indication that physical activity predicts better subjective cognitive function and academic achievement. In conclusion, the study's findings suggest no relationship between physical activity and any of the criterion variables, Attention, Memory, Executive function and academic ability. The association between all the variables and physical activity is very complex as different measures used to assess each variables have their own strengths and weaknesses. The following paper will discuss this matter in detail.

Contents Page

Literature Review

According to the National Health Service (NHS) 150 mins of moderate aerobic exercise and 1 hour of strength exercises i.e. weightlifting is recommended in maintaining a healthy lifestyle (‘Exercise’, 2019). Physical exercise is fundamental component of increasing an individual’s lifespan which has a large number of physical health benefits including a reduction in chronic pain, cancer, diabetes, obesity, osteoporosis as well as the reduction in cardiovascular morbidity and mortality (Ambrose & Golightly, 2015; Oberman,1985; Warburton, Nicol, & Bredin, 2006). Also, there have been studies shown that physical exercise promotes improvements in psychological health including mental health (e.g., reduces depression and anxiety; Biddle & Asare, 2011) and cognition (Robinson & Lachman, 2018).

The effects of exercise has been an important aspect of research for some time and will continue to do so. In Ireland, just over 32% of the population are considered to be sufficiently active (HSE, 2015). This unnerving statistic amplifies the reason to research the area surrounding exercise in order to gain more of an insight into the benefits stated above. This review will cover the effects of exercise engagement across two population types, older adults and younger adults assessing the reported benefits of acute exercise, interventions and longitudinal studies on their cognitive abilities. The review will then cover the studies primary focus that is subjective cognitive function and its relevance to cognition.

Exercise and Older Adults’ Cognitive Function

The research under this heading will look to identify the benefits that physical exercise can have on an older adults cognitive function by addressing such studies that have reported significant findings relating to improvements in cognitive performance. The correlation

between the effects of exercise on older adults cognitive function has been heavily researched by addressing aspects such as acute exercise, intervention strategies and the longitudinal effects of exercise. Results from a number of reviews show that there was an improved or maintenance of cognition related to self-reports of physical activity or activity interventions (Kramer& Erickson, 2007; Rockwood & Middleton, 2007). Much research has demonstrated that engaging in acute bouts of exercise whether that be aerobic exercise or resistance training can provide significant improvements to various aspects of cognition such as memory and executive functioning (Chang, Labban, Gapin, & Etnier, 2012; Chang, Tsai, Huang, Wang, & Chu, 2014; Harveson et al., 2016; Hsieh, Chang, Hung, & Fang, 2016; Kashihara, Maruyama, Murota & Nakahara, 2009; McMorris & Hale, 2012; Weinberg, Hasni, Shinohara, & Duarte, 2014). Other studies have found that continuous moderate intensity aerobic exercise can have a beneficial effect on speed processing, selective attention and aspects of inhibitory control (Yanagisawa, et al., 2010; Alves, Gualano, Takao, Avakian, Fernandes, Morine, et al., 2012. Most studies in this area have examined either the immediate effects of exercise on cognition in both younger adults and older adults simultaneously (Hogan, Mata, & Cartensen, 2013); or the longitudinal effects that exercise has on the older adult population's cognitive abilities (Allerhand, Gale, & Deary, 2014). The increasing age of individuals has been shown to be a major risk factor in cognitive impairments and cognitive associated diseases such as dementia (Yaffe et al., 2009). A comparison study conducted by (Lautenshlager & Almeida, 2006) found that healthy physically active older adults show significant better cognitive functioning and less cognitive decline then older adults who don't. Similar findings were found in a meta-analytic review, (Smith et al., 2010) reported that significant improvements were found in healthy older adults executive functioning, attention, speed processing and memory after aerobic training compared to control groups with nonaerobic exercise. All avenues of research

suggest that there are positive links between physical activity and the maintenance or improvement of cognition in older adults.

Cognitive decline effects many different areas of persons being such as language, memory, thinking and judgement making and attention. It has been well documented in recent years that cognitive decline is associated heavily with age (Craik & Salthouse, 2000, 2008) and that aerobic exercise training has been shown to produce a multitude of benefits in nontrained tasks such as memory and cognitive control (Erikson et al., 2011; Kramer, Larish, Weber & Bardell,1999). However, there have been mixed reviews on whether aerobic exercise interventions have a sustained improvement on cognitive function (Angervaren, Aufdemkampe, Aleman, & Vanhees, 2008; Colcombe & Kramer, 2003). Additionally, in a recent expert-panel review (Snowden et al., 2011) reported that there is insufficient research to conclude that exercise interventions improve cognitive function. In a study conducted by (McDaniel et al.,2014) their study examined the role of aerobic exercise on complex real-world cognitive tasks. Their findings suggested that aerobic exercise was not significantly associated with the outcome- task performances although they did suggest that aerobic fitness is correlated with performance on selective cognitive tasks. The age at which cognitive decline starts has not been fully made certain but is has been suggested to start declining in healthy educated adults relatively early in adulthood and certainly before 60 years of age (Salthouse, 2009). It is also important to note that the association between cognitive decline and age is not inevitable as other factors that may influence the decline in cognitive functioning are diseases such as Dementia and Alzheimer’s.

Exercise and Younger Adults' Cognitive Function

The research pertained in this subsection will look to assess the benefits of acute and prolonged physical activity also considering the effects that physical exercise may have on the academic abilities and brain structure of the younger adult population.

In a recent meta-analysis by Chang et al., (2012), reviewed 79 studies of which participants engaged in acute exercises and were assessed on their cognitive performance after. The study groups identified in this analysis were younger adults aged between 20-30 being found in 42 of the studies and only 6 six studies found participants over the age of 60. The results show that there was a small positive effect regardless of when the cognitive task was performed. This result indicates that physical activity can have an immediate impact as well as a prolonged one. In contrasting findings, the period of administration of a cognitive task is important as Lambourne and Tomporowski (2010) found that exercise had a detrimental effect on cognitive performance during exercise but did have positive effects when the cognitive task was administered after the exercising session. They found that these detrimental results may be affected by the attention needed to perform the exercise. However, in a study conducted by (Stern et al., 2019) younger adults aged between (20-67) were subjected to a 6-month trial, under 4-times-weekly conditions including aerobic exercise and stretching/toning. Results indicated that the effect of aerobic exercise on executive function was more pronounced as age increased suggesting that it may mitigate age-related declines. This is valuable information as it suggests that younger adults who are more likely to continue exercising into older adulthood may experience less decline than their non-exercising counterparts.

Recent societal trends have minimized opportunities for physical exercise whether that be in school in regard to physical education (Thomas, 2004) or at home because of the

increase in screen time as well as the reduction in active transportation (Owen, Sparling, Healy, Dunstan & Mathews, 2010). Previous research has looked at preadolescent children in regard to their fitness and response variability in performing cognitive control tasks (Wu et al.,2011) which suggest that higher levels of aerobic fitness was related to more accurate and less variable cognitive performance. The results in this paper suggest that further research needs to be investigated to show individual differences in cognition in relation to physical exercise.

Another important note to consider is the effect that physical exercise can have on the younger adults academic performance. Structural changes in the brain following physical exercise have been related to academic achievement in comparison to sedentary individuals (Lees & Hopkins, 2013; Donnelly et al., 2016). These structural changes correspond to brain volume, measures of white matter integrity or modulation in neurotrophins levels. Physical exercise encourages the release of neurotrophic factors such as peripheral BDNF (Hötting et al., 2016) increases blood flow, improves cerebrovascular health and determines benefits on glucose and lipid metabolism carrying “food” to the brain (Mandolesi et al., 2017). Vigorous physical activity has been shown to be heavily associated with better grades in children (Coe, Pivarnik, Womack, Reeves & Malina, 2006). Positive associations were also found within children who have a higher level of physical fitness in regards to academic achievement (Catelli, Hillman, Buck, & Erwin, 2007; Wittberg, Northrup, Cotrell, & Davis, 2010) and children who were classed as overweight were associated with poorer achievement (Castelli et al., 2007; Datar, Strum & Magnabosco, 2004). It is important to understand and examine the effects of regular engagement in physical activity on the younger adults body and how regular engagement can help to mitigate age related diseases and impairments in later life. The findings in a study conducted by Hillman et al., (2006) suggest physical activity may be

beneficial to cognition during early and middle periods of the human life span and may continue to protect against age-related loss of cognitive function during older adulthood.

Subjective Cognition

Subjective cognitive function is related to confidence in one's own cognitive and academic abilities which in turn is found to be associated with actual performance. Subjective cognitive function has been found to decline with age (Geiger et al., 2019). However in a longitudinal study conducted by Fondell et al., (2018), they examined whether physical activity during early adulthood or mid-to-late life is associated with subjective cognitive function. With a strong cohort of 28,481 males, they found that being physically active in early adulthood lowers the odds of subjective cognitive decline by 23% and being physically active in both stages of adulthood is associated with 48% lower odds of poor subjective cognitive function. Objective measures of cognitive function can be more accurate than self-report, however self-report is related to actual performance and cognitive self-efficacy. Subjective cognitive function testing can be useful in understanding an individuals reported functional outcomes and perceived effectiveness in daily life and seeing if they correlate with objective measures in neuropsychological tests.

Conclusion

The gap in the literature seems to be that there has not been enough research done on the effects of long-term associations with exercise can have on self- reported cognitive performance in younger adults and whether or not people who are exercising regularly per week perform better than those who don't. The reason that we may expect an effect in regard to those who exercise regularly compared to those who don't is that in the young adult population there have been links involving habitual engagement in physical activity and better

cognitive functioning (Guiney & Machado, 2013). A reason for this could be cerebrovascular factors. In studies conducted by (Davenport, Hogan, Eskes, Longman, & Poulin, 2012; Schmidt, Endres, Dimeo, & Jungehulsing, 2013) they found that adequate cerebral oxygenation helps to maintain the brain in an optimal physiological state and exercise- related improvements in the regulation of cerebral blood flow could potentially improve cognitive functioning. Despite the overwhelming range of literature that mainly focuses on the younger adult population in regard to acute bouts of exercise, longer term interventions have focused mainly on the older populations (Colcombe et al., 2006).

Also, much research into the area of subjective cognitive functioning has been dominated by the factors in which it declines and becomes impaired. This study tries to gain an insight into the use of subjective cognitive measures on the younger adult population.

The Current Study

The aim of the current study is to assess whether self-reported levels of physical activity uniquely predict different factors of better subjective cognitive performance (i.e. Memory, Attention and Executive function) as well as actual academic abilities (Leaving certificate points). Specifically the research questions are, ‘Does higher levels of exercise engagement predict higher scores on subjective cognitive function’ and ‘Does higher levels of exercise engagement predict better scoring on an individual’s academic performance. Based on the current literature, the hypotheses are that self-reported levels of exercise engagement will predict higher scores on subjective cognitive functions such as memory, attention and executive function as well as higher score on academic performance.

Methods

Participants

The overall accessible population of this study was 500 hundred participants however only 41 adults completed the questionnaires. The 41 participants were made up of 63.4% male and 36.6% female. Participants ages were (M = 25.59, SD = 8.6 and the ages ranged from 20-58). Recruitment was conducted via convenience sampling. All participants were recruited by way of social media (Facebook, Instagram and Twitter) and were all well-educated, with all the participants successfully completing their leaving certificate or better. As the sample was recruited by means of social media much of the participants were friends of the researcher. This study was completely voluntary, and no participant received any reward for their involvement. In order for the participants to be included in the study they were required to provide informal consent and be over the age of 18. Ethics was approved by the National College of Ireland and all manners of this study were in accordance with the National College of Ireland's guidelines. The data provided by the participants was stored and managed by the researcher under the National college of Ireland data protection policy and data protection act.

Design

This current study looks to incorporate a cross-sectional correlational design. The two main purposes of this design are to understand the direction and strength of relationships between the variables within the group and gauge an estimation of how much a change in one variable will account for the change in another variable. The within-groups criterion variables (CV) were firstly, subjective cognitive function involving three factors (Executive function, Memory and Attention) and secondly, academic abilities (Leaving certificate points). The predicator variable was self-reported levels of Physical Activity.

Apparatus

The research was conducted online using google forms to facilitate the questionnaire. Participants could access the survey using a phone, computer or tablet. There were five questionnaires administered.

Attentional control scale (Derryberry & Reed, 2002) is a self-report 20 item questionnaire rated on a 4-point Likert scale (1 = almost never to 4 = always) which measures individual differences in attentional control (see appendix A). The internal consistency is reported to be as $\alpha = 0.88$ and test-retest reliability of the ACS items varies from 0.45 to 0.73 and it is 0.61 for the total score (Fajkowska & Derryberry, 2010). Higher scores indicate better attentional control.

Amsterdam Executive Function Inventory (AEFI), (Van der elst et al., 2012) is self-report 10 item questionnaire rated on a 3-point Likert scale (1 = not true, 2 = partly true and 3 = true) (see appendix B). Earlier studies using the (AEFI) reported that the internal consistency of these studies was sufficient with results revealing Cronbach's alphas to range from 0.4 to 0.7 (Van Tetering, De Groot & Jolles, 2018; Van Tetering & Jolles, 2017). Higher scores result in better self-regulation.

Memory functioning scale self-report (MARS-R) (Clare et al., 2002) is a self-report 10 item questionnaire rated on a 5-point Likert scale (0 = never to 4 = always), (see appendix C). Internal consistency is reported to be $\alpha = .94$ and test-retest reliability was .97. Higher score indicate a more positive perception of memory functioning. Academic performance was assessed by asking the participants to disclose their leaving certificate point and college grades.

Concise Physical Activity Questionnaire (CPAQ) (Sliter & Sliter, 2014) (see appendix D) is a 4 part questionnaire assessing levels of physical activity per week, (Light aerobic

activity, Moderate aerobic activity, Vigorous aerobic activity and Muscle strengthening activity) with items ranging from 0(physically unable/choose not to do this), 1 (1 day per week or less), 2 (2-3 days per week, 3 (4-5 days per week) and 4 (6-7 days per week), (see appendix 4). The internal consistency of the CPAQ is reported to be $\alpha = .88$. Each individual score on vigorous aerobic exercise must be multiplied by 2.5 and then summed to the remaining three parts to get a total score.

Procedure

Participants were tested individually online via google forms. Participants were asked to click on the link provided to them and complete the consent form (see appendix E) along with the associated questionnaires. Participants were asked to provide the researcher with certain demographics such as age, gender, occupation and highest academic reward. An information sheet (see appendix F)was provided before the commencement of said questionnaires explaining what will be asked the participants and how their identity will remain anonymous along with their data being managed and stored accordingly. Participants were given a brief paragraph of information before every questionnaire detailing which number attributed to which answer, for example (1 = not true, 2 = partly true and 3 = true). Participants were instructed to take their time in answering the questions and select the appropriate answers. The five areas of questioning the participants were instructed to answer were attention, memory, executive functioning, academic performance and levels of physical activity. After the questionnaires had been completely filled out the participants were issued a debriefing sheet (see appendix G) explaining to them the nature of the study as well as any relevant details needed should any of them want to learn more or need any additional services.

Results

A descriptive analysis was conducted to help identify any associations among the variables, to assess normality and to check for any outliers in this study. Table 1 shows the characteristics for the established measures of Physical exercise (Concise physical exercise questionnaire), Memory (Memory function scale report), Attention (Attentional control scale), Executive Function (Amsterdam Executive Function Inventory) and Academic abilities (Leaving certificate points). Over the week that the participants completed the survey, participants reported on average score of M = 11.35, SD = 3.65 on the Concise physical exercise questionnaire. The mean score in the Memory function scale report was 35.56 with an SD = 8.26. The reported descriptive statistics for attentional control scale were (M = 49.707, SD = 7.55. The reported statistics for Amsterdam Executive Function Inventory were (M = 19.95, SD = 2.97). The reported statistics for leaving certificate points were (M = 392.8, SD = 112.2).

Table 1. **Descriptive statistics of all continuous variables**

	Mean	Median	SD	Range
Physical Activity	11.35	11	3.65	6.5-19
Attention	49.707	50	7.55	32- 67
Executive Function	19.95	20	2.97	14-27
Memory	35.56	11	2.86	18-51
Leaving Certificate	392.8	390	112.20	0-580

Correlation analysis

A Spearman's rank order correlation was run to determine the relationship between 41 participants total scores on levels of self-reported physical activity, memory, attention, executive function and academic abilities. Table 2 shows the nonparametric correlation characteristics for the expressed variables. There was a moderate, negative correlation between attention scores and executive function scores, which was statistically significant r_s (1,39) = -.321, p = .041. The concise physical activity questionnaire score yielded a non-significant very weak correlation across the four variables memory (r_s (1,39) = -.080, p = .618), attention (r_s (1,39) = .022, p = .893), executive function (r_s (1,39) = .053, p = .743) and academic ability (r_s (1,39) = .036, p = .821).

Table 2 **(Spearman's Rank Order Correlation For Scores On Physical Activity (CPAQ), Memory (MFS-S), Attention(ACL), Executive Function(AEFI) And Leaving Certificate Points (LCP))**

Variables	1	2	3	4	5
1. CPAQ Scores	1				
2. MFS-S Scores	-.080	1			
3. ACL Scores	.022	.221	1		
4. AEFI Scores	.053	-.095	-.321*	1	
5. LCP Scores	.036	.105	.208	-.295	1

Note. Statistical significance: *p < .05; CPAQ = Concise Physical Activity Questionnaire; MFS-S = Memory functional Scale Self-Report; ACL = Attentional Control Scale; AEFI = Amsterdam Executive Function Inventory; LCP = Leaving Certificate Points

Linear Regression Analysis

A simple linear regression was performed to assess whether engagement in physical activity predicted better outcomes of self-reported cognitive functions (i.e. Memory, Attention and Executive Function) and academic scores (i.e. Leaving certificate points). Individual linear regressions were constructed using the IBM SPPS statistical software. Preliminary analysis was performed to ensure there was no violations of the assumptions of normality and linearity and homoscedasticity.

Attention and Physical activity

A non-significant regression equation was found (F (1, 39) = .001, p = .976), with an R^2 = .000. This means that Physical activity predicted 0% of the variance in attention, leaving 100% of the variance unaccounted for. Participants predicted attention is equal to 49.59 + .010 (physical activity) total score when physical activity is measured in total scores of Light aerobic activity, Moderate aerobic activity, Vigorous aerobic activity and Muscle strengthening activity. Participants attention increased .010 for every total score of physical activity.

Table 3 **(Table for displaying simple linear regression results)**

Simple linear regression model predicting Attention scores

	R^2	β	*B*	*SE*	CI 95% (B)
Constant	.000	49.59		3.945	41.61/57.5
Total score for PA		.010	.005	.331	-.660 / .680

Note. N = 41; Dependant variable = Attention scores, PA = Physical Activity

Memory and Physical activity

A non-significant regression equation was found (F (1, 39) = .393, p = .534), with an R^2 = .010. This means that Physical activity predicted 1% of the variance in memory, leaving 99% of the variance unaccounted for. Participants predicted memory is equal to 38.125 + -.226 (physical activity) total score when physical activity is measured in total scores of Light aerobic activity, Moderate aerobic activity, Vigorous aerobic activity and Muscle strengthening activity. Participants memory decreased -.226 for every total score of physical activity.

Table 4 **(Table for displaying simple linear regression results)**

Simple linear regression model predicting Memory scores

	R^2	β	*B*	*SE*	CI 95% (B)
Constant	.010	38.125		4.29	29.442/46.809
Total score for PA		-.226	-.100	.360	-.955 / .503

Note. N = 41; Dependant variable = Memory scores, PA = Physical Activity

Executive Function and physical activity

A non-significant regression equation was found (F (1, 39) = .084, p = .773), with an R^2 = .002. This means that Physical activity predicted .02% of the variance in executive function, leaving 99.8% of the variance unaccounted for. Participants predicted executive function is equal to 19.522 + .038 (physical activity) total score when physical activity is measured in total scores of Light aerobic activity, Moderate aerobic activity, Vigorous aerobic activity and Muscle strengthening activity. Participants executive function increased .038 for every total score of physical activity.

Table 5 **(Table for displaying simple linear regression results)**

Simple linear regression model predicting Executive Function scores

	R^2	β	*B*	*SE*	CI 95% (B)
Constant	.002	19.52		1.55	16.38/22.6
Total score for PA		.038	.046	.130	-.226 / .30

Note. N = 41; Dependant variable = Executive Function scores, PA = Physical Activity

Academic abilities and physical activity

A non-significant regression equation was found (F (1, 39) = .045, p = .833), with an R^2 = .001. This means that Physical activity predicted .01% of the variance in academic abilities, leaving 99.9% of the variance unaccounted for. Participants predicted academic abilities is equal to 404.648 + -1.043 (physical activity) leaving certificate points when physical activity is measured in total scores of Light aerobic activity, Moderate aerobic activity, Vigorous aerobic activity and Muscle strengthening activity. Participants academic abilities decreased -1.043 for every total score of physical activity.

Table 6 **(Table for displaying simple linear regression results)**

Simple linear regression model predicting leaving certificate scores

	R^2	β	*B*	*SE*	CI 95% (B)
Constant	.001	404.64		58.54	286.232/523.06
Total score for PA		-1.043	-.034	4.914	-10.98 / 8.89

Note. N = 41; Dependant variable = Leaving Certificate points, PA = Physical Activity

Discussion

The current study aimed to assess whether there was an association between self-reported levels of physical activity uniquely predicting different factors of participants subjective cognitive performance (i.e. Attention, Memory and Executive function) as well as actual academic abilities (Leaving certificate points). Findings of the current study suggest that there was no association between the predictor variable and the criterion variables. The was no correlation between physical activity and any of the criterion variables, Attention, Memory, Executive function and academic ability. Participants self-reported levels of physical activity failed to predict better subjective cognitive function scores (attention, memory, executive function) and academic ability.

Attention and Physical Activity

In order to measure attention, the attentional control scale (Derryberry & Reed, 2002) was used which assess the subjective cognitive function of the participants. The ACS looks to assess attention using 3 factors, focus attention, shift attention towards task and flexibly control thoughts. The findings surrounding attention and physical exercise in this study were found to be non-significant which is in direct contrast to the majority of studies investigating this relationship. Contrasting studies show that continuous moderate intensity aerobic exercise can have a beneficial effect on speed processing, selective attention and aspects of inhibitory control (Yanagisawa, et al., 2010; Alves, Gualano, Takao, Avakian, Fernandes, Morine, et al., 2012). As this study utilizes only a subjective approach to cognitive function the findings can't be related to previous research as most research in the present field incorporates objective measures to assess cognitive function and physical exercise. To the researchers understanding no research has been conducted investigating the relationship between physical exercise on perceived attention in healthy young adults. The researcher expected to find a

positive correlation between the two investigated variables as much of the research conducted prior found that different arrays of physical activity have beneficial effects on attention. However, if the results are a true finding then they would imply that physical activity has little to no impact on attention scores in relation the attentional control scale. Also, there was zero indication that there was any shared variance between the two variables. Contributing factors to these findings are found in the limitation section of this paper.

Memory and Physical Activity

Subjective memory ability was measured using Memory functioning scale self-report (MFS-S) (Clare et al., 2002). Similar to the findings relating to attention, the relationship between physical activity and memory functioning were found to be non-significant which indicates that regardless of how often you engage in physical activity, it will not indicate or suggest that there is a significant relationship between the two variables. These findings are in complete contrast with the existing literature which suggests that engaging in physical activity results to improvement in memory ability (Smith et al., 2010). However, in one study similar findings were observed (Hayes et al., 2015). This study looked to investigate the effects of objective measures on a younger adult sample in regards to physical activity and memory. They found that there was no relationship between the variables in the younger adult sample but there was in the older adult sample. This study is the only one to the researchers knowledge to have similar findings. However, as the study mentioned above only measured cognitive performance and physical activity objectively, the results cannot be one hundred per cent comparable. Their justifications for not using self-reported measure of physical activity were that it has been heavily criticized because the data generated ay be inaccurate because it is subject to omissions and bias (Prince et al., 2008; Shepard, 2003). Based on the current literature and the reasons behind investigating the relationship between the two variables, the

researcher expected to identify a significant relationship. Possible reasons for these conflicting findings are found in the limitation section of this paper.

Executive Function and Physical Activity

Executive function was measured using Amsterdam Executive Function Inventory (AEFI), (Van der elst et al., 2012). The questionnaire assess three important components, attention, self-control and self-monitoring. The current study's findings suggest that there was a non-significant relationship between physical activity and executive function. These findings are in complete contrast to the pre-existing literature which suggests that physical exercise can be beneficial to the improvement of executive function and memory (Chang, Labban, Gapin, & Etnier, 2012; Chang, Tsai, Huang, Wang, & Chu, 2014; Harveson et al., 2016; Hsieh, Chang, Hung, & Fang, 2016; Kashihara, Maruyama, Murota & Nakahara, 2009; McMorris & Hale, 2012; Weinberg, Hasni, Shinohara, & Duarte, 2014). The findings in the current study are particularly shocking as studies have indicated that executive function in particular may be more sensitive to physical activity than basic perceptual and motor functions (Colcombe & Kramer, 2003; Guiney & Machado, 2013; Tomporowski, Lambourne & Okumura, 2011). Executive function was only found to be significantly correlated with attention. This comes as no surprise because one of the main components of the executive function questionnaire assessed attention. Again, similar to the findings relating to attention and memory, much of the research conducted in the area of executive function and physical activity utilized objective measures which has proven to be a more accurate measurement of cognitive function. This key factor has proven to be crucial in being able to not support the findings in this paper as this study only uses subjective measures to gather its data

Academic Ability and Physical Activity

Academic ability was measured by asking participants to disclose their leaving certificate points. The findings in this study indicate that there is no relationship between academic performance and physical activity. Recent literature has either focused on the detrimental effects of a negative lifestyle in younger adults or investigating the role of regular physical activity in enhancing cognitive performance and academic achievement in elementary school children (Burkhalter & Hillman, 2011; Donnelly & Lambourne, 2011).In a study conducted by Keating et al., (2012), they investigated the role of strength training on academic performance which was one of the factors in the CPAQ. They found that there was a relationship between the two variables. Considering this study only investigated one aspect of physical activity on a small sample, further research is still needed involving other aspects of physical activity to get a clearer indication of the results. In a study conducted by Wald et al., (2014), they found contrasting findings to the one of this study as they added further confirmation of a relationship between physical activity and academic achievement. However, this life stage needs to be investigated further in relation to physical activity and academic achievement. Considering the measurements used to generate the results of this study, it is clear that the results cannot be reliable because for some of the participants they would have completed their leaving certificate a few years prior to this study and with no understanding of their physical activity back then, their results become void. Ideally this research should have examined the current effects of physical activity on academic performance or ask what their rate of physical activity was back then. However, this would lead to omission bias and rely on the participants ability to recall such events.

Limitations

In this study there are a few limitations that merit a discussion. One major limitation of this study is that it had a very low sample size. The problem with having a low sample size is that the study then operates on a low statistical power, which then reduces the chances of

detecting a true effect as well as finding a significant effect which in the case of this study may have proved crucial. This low sample size also prevented the study from modelling its results on the intended population as the results cannot be generalised to the greater population. One of the main reasons for this low sample size was that the study was under tight time constraints. These time constraints impacted the study severely as data had to be collected quickly and as efficient as possible. Also, as the studies data was collected through social media means the targeted population may not have felt the necessary need to participate in the study immediately. The participants may have intended to take part in the study but with everyday life still to contend with, they may have forgotten.

Another limitation of this study is that it doesn't induce causal effect but may instead hint at a relationship between the investigated variables. In the case of this study, there was no statistically significant relationship found between all of the criterion variables and the predictor variable. However, that doesn't necessarily mean that physical activity doesn't cause higher scores on subjective cognitive function and academic ability but that cannot be concluded from this study as the design doesn't investigate that question.

As the studies data was collected via a survey the responses to the questionnaires may have been falsified for a number of reasons. Participants may have wanted to express the best version of themselves, therefore manipulating the answers to fit this need. As this survey relied upon recalling the levels of physical activity you engage with and situations in which you have to answer about, the participants memory recall may be mistaken and therefore leading to inaccurate data.

In order to assess the participants levels of physical activity the study utilized the concise physical activity questionnaire. This questionnaire only establishes the participants current engagement with physical activity over a month period. No questions were asked in

relation to how long the participants had been engaging in exercise which upon reflection could have added a more in depth longitudinal understanding of the participants physical activity levels, subjective cognitive function and academic ability as some of the participants may have only recently started to engage in more physical activity or some may have always engaged in a routine amount.

Future Research

Over the period of conducting this research and reviewing all the necessary literature, several elements were noted. Firstly, the research has a proclivity to under look the importance of physical activity on subjective cognitive performance alone in the younger adults life stage in regards to longitudinal interventions. This life stage is of particular significance because despite the overwhelming range of literature that mainly focuses on the younger adult population in regard to acute bouts of exercise, longer term interventions have focused mainly on the older populations (Colcombe et al., 2006). Longer term interventions would enable researchers to understand the benefits of physical activity to its full extent. Future research should be using subjective and objective measures to assess cognitive performance as well as physical activity to cover all aspects of understanding. The participants subjective input is very important because higher self-confidence in ones ability reflects better on objective performance. Filling the gap between these two measures would be very beneficial for future research. Future research should also look to eliminate all the limitations mentioned above in order to gain a clearer understanding of this particular aspect of cognitive psychology. As this study was conducted using a cross-sectional, future research should look to utilize a mixed methods approach encapsulating both an experimental design to infer causality and qualitatively assess the participants subjective cognitive function.

Conclusion

In conclusion, the study's findings suggest no relationship between physical activity and any of the criterion variables, Attention, Memory, Executive function and academic ability. The association between all the variables and physical activity is very complex as different measures used to assess each variables have their own strengths and weaknesses. If the findings are true for this study then they provide an important insight for future research to assess why this may be the case and whether other aspects of sustaining a healthy lifestyle may be more beneficial in the maintenance of improvement of cognitive function and academic achievement. Future research should also look to incorporate other descriptive lifestyle choices such as diet, carcinogens and inadequate or adequate relief of stress etc.

References

Allerhand, M., Gale, C.R., & Deary, I.J. (2014). The dynamic relationship between cognitive function and positive well-being in older people: A prospective study using the English Longitudinal Study of Aging. Psychology and Aging, *29*, 306–318. doi 10.1037/a0036551

Alves, C. R. R., Gualano, B., Takao, P. P., Avakian, P., Fernandes, R. M., Morine, D., & Takito, M. Y. (2012) Effects of acute physical exercise on executive functions: a comparison between aerobic and strength exercise. *Journal of Sport and Exercise Psychology*, 34, 539-549.

Ambrose, K. R., & Golightly, Y. M. (2015). Physical exercise as non-pharmacological treatment of chronic pain: why and when. *Best practice & research Clinical rheumatology*, *29*(1), 120-130.

Biddle, S. J., & Asare, M. (2011). Physical activity and mental health in children and adolescents: A review of reviews. *British Journal of Sports Medicine, 45,* 886 – 895. http://dx.doi.org/10.1136/bjsports-2011- 090185

Burkhalter TM, Hillman CH. A narrative review of physical activity, nutrition, and obesity to cognition and scholastic performance across the human lifespan. Adv Nutr. 2011;2:201S–206S.

Castelli, D. M., Hillman, C. H., Buck, S. M., & Erwin, H. E. (2007). Physical fitness and academic achievement in third- and fifth-grade students. *Journal of Sport and Exercise Psychology, 29,* 239–252.

Chang, Y. K., Labban, J. D., Gapin, J. I., & Etnier, J. L. (2012). The effects of acute exercise on cognitive performance: A meta-analysis. *Brain Re- search, 1453,* 87–101. http://dx.doi.org/10.1016/j .brainres.2012.02.068

Chang, Y. K., Tsai, C. L., Huang, C. C., Wang, C. C., & Chu, I. H. (2014). Effects of acute resistance exercise on cognition in late middle-aged adults: General or specific cognitive improvement? *Journal of Science and Medicine in Sport, 17,* 51–55. http://dx.doi.org/10.1016/j.jsams.2013.02.007

Chu, C.-H., Chen, A.-G., Hung, T.-M., Wang, C.-C., & Chang, Y.-K. (2015). Exercise and fitness modulate cognitive function in older adults. Psychology and Aging, *30*(4), 842–848. https://doi.org/10.1037/pag0000047

Clare, L., Wilson, B.A., Carter, G., Roth, I., & Hodges, J.R. (2002). Assessing awareness in early-stage Alzheimer's disease: development and piloting of the Memory Awareness Rating Scale. *Neuropsychological Rehabilitation, 12,* 341-362. doi: 10.1080/09602010244000129

Coe, D. P., Pivarnik, J. M., Womack, C. J., Reeves, M. J., & Malina, R. M. (2006). Effect of physical education and activity levels on academic achievement in children. *Medicine and Science in Sports and Exercise, 38,* 1515–1519.

Colcombe, S. J., Erickson, K. I., Scalf, P. E., Kim, J. S., Prakash, R., McAuley, E., . . . Kramer, A. F. (2006). Aerobic exercise training increases brain volume in aging humans. *The Journals of Gerontology: Series A. Biological Sciences and Medical Sciences, 61,* 1166–1170. doi:10.1093/gerona/58.2.M176

Craik, F. I. M., & Salthouse, T. A. (Eds.). (2000). The handbook of aging and cognition (2nd ed.). Mahwah, NJ: Erlbaum.

Craik, F. I. M., & Salthouse, T. A. (Eds.). (2008). Handbook of aging and cognition (3rd ed.). New York, NY: Psychology Press.

Datar, A., Sturm, R., & Magnabosco, J. L. (2004). Childhood overweight and academic performance: National study of kindergartners and first- graders. *Obesity Research, 12,* 58–68.

Davenport, M. H., Hogan, D. B., Eskes, G. A., Longman, R. S., & Poulin, M. J. (2012). Cerebrovascular reserve: The link between fitness and cognitive function? *Exercise and Sport Sciences Reviews, 40,* 153–158. doi:10.1097/JES.0b013e3182553430

Derryberry D, Reed MA. Anxiety-related attentional biases and their regulation by attentional control. J Abnormal Psychology. 2002;111:225–36.

Donnelly J. E., Hillman C. H., Castelli D., Etnier J. L., Lee S., Tomporowski P., et al. (2016). Physical activity, fitness, cognitive function, and academic achievement in children. Med. Sci. Sport. Exerc. 48, 1197–1222. 10.1249/MSS.0000000000000901

Donnelly JE, Lambourne K. Classroom- based physical activity, cognition, and academic achievement. Prev Med. 2011; 52(suppl 1):S36–S42.

Erickson, K. I., Voss, M. W., Prakash, R. S., Basak, C., Szabo, A., Chaddock, L.,Kramer, A. F. (2011). Exercise training increases size of hippocampus and improves memory. PNAS Proceedings of the National Academy of Sciences of the United States of America, *108,* 3017–3022. doi:10.1073/pnas.1015950108

Exercise. (2019). Retrieved from https://www.nhs.uk/live-well/exercise/

Fajkowska M, Derryberry D. Psychometric properties of Attentional Control Scale: The preliminary study on a Polish sample. Polish Psychological Bulletin. 2010;41:1–7.

Fondell, E., Townsend, M.K., Unger, L.D. *et al.* Physical activity across adulthood and subjective cognitive function in older men. *Eur J Epidemiol* **33,** 79–87 (2018). https://doi.org/10.1007/s10654-017-0331-2

Guiney, H., & Machado, L. (2013). Benefits of regular aerobic exercise for executive functioning in healthy populations. *Psychonomic Bulletin & Review, 20,* 73–86. doi:10.3758/s13423-012-0345-4

Harveson, A. T., Hannon, J. C., Brusseau, T. A., Podlog, L., Papadopoulos, C., Durrant, L. H., . . . Kang, K. D. (2016). Acute effects of 30 minutes resistance and aerobic exercise on

cognition in a high school sample. *Research Quarterly for Exercise and Sport, 87,* 214 –220. http://dx.doi.org/10 .1080/02701367.2016.1146943

Hayes, S. M., Alosco, M. L., Hayes, J. P., Cadden, M., Peterson, K. M., Allsup, K., ... & Verfaellie, M. (2015). Physical activity is positively associated with episodic memory in aging. *Journal of the International Neuropsychological Society*, *21*(10), 780-790.
Health, r. (2019). Recommended population levels of physical activity for health. Retrieved 11 November 2019, from https://www.ncbi.nlm.nih.gov/books/NBK305058/

Hillman, C. H., Motl, R. W., Pontifex, M. B., Posthuma, D., Stubbe, J. H., Boomsma, D. I., & de Geus, E. J. C. (2006). Physical activity and cognitive function in a cross-section of younger and older community-dwelling individuals. *Health Psychology*, *25*(6), 678–687. https://doi.org/10.1037/0278-6133.25.6.678

Hogan, C. L., Mata, J., & Carstensen, L. L. (2013). Exercise holds immediate benefits for affect and cognition in younger and older adults. *Psychology and Aging, 28,* 587–594. http:// dx.doi.org/10.1037/a0032634

Hötting K., Schickert N., Kaiser J., Röder B., Schmidt-Kassow M. (2016). The effects of acute physical exercise on memory, peripheral bdnf, and cortisol in young adults. Neural Plast. 2016, 1–12. 10.1155/2016/6860573

Hsieh, S. S., Chang, Y. K., Hung, T. M., & Fang, C. L. (2016). The effects of acute resistance exercise on young and older males' working memory. *Psychology of Sport and Exercise, 22,* 286–293. http://dx.doi.org/10.1016/j.psychsport.2015.09 .004

Kashihara, K., Maruyama, T., Murota, M., & Naka- hara, Y. (2009). Positive effects of acute and moderate physical exercise on cognitive function. *Journal of Physiological Anthropology, 28,* 155–164. http://dx.doi.org/10.2114/jpa2.28.155

Keating XD, Castelli C, Ayers SF. Strength exercise frequency, body mass index, and academic performance among university students [published online ahead of print October 2012]. J Strength Cond Res. doi:10.1519/JSC.b0b013e318276bb4c.

Kramer, A. F., & Erickson, K. I. (2007). Capitalizing on cortical plasticity: Influence of physical activity on cognition and brain function. *Trends in Cognitive Sciences, 11,* 342–348. doi:10.1016/j.tics.2007.06.009

Lambourne, K., & Tomporowski, P. (2010). The effect of exercise-induced arousal on cognitive task performance: a meta-regression analysis. Brain Research, 1341, 12–24.

Lautenschlager, N.T., & Almeida, O. P. (2006). Physical activity and cognition in old age. Current Opinion in Psychiatry, 19, 190–193. doi: 10.1097/01.yco.0000214347.38787.37

Lees C., Hopkins J. (2013). Effect of aerobic exercise on cognition, academic achievement, and psychosocial function in children: a systematic review of randomized control trials. Prev. Chronic Dis. 10:130010. 10.5888/pcd10.130010

Llorens, F., Sanabria, D., & Huertas, F. (2015). The influence of acute intense exercise on exogenous spatial attention depends on physical fitness level. Experimental Psychology, 62(1), 20–29. https://doi.org/10.1027/1618-3169/a000270

Mandolesi L., Gelfo F., Serra L., Montuori S., Polverino A., Curcio G., et al. . (2017). Environmental factors promoting neural plasticity: insights from animal and human studies. Neural Plast. 2017, 1–10. 10.1155/2017/7219461

McDaniel, M. A., Binder, E. F., Bugg, J. M., Waldum, E. R., Dufault, C., Meyer, A., … Kudelka, C. (2014). Effects of cognitive training with and without aerobic exercise on cognitively demanding everyday activities. *Psychology and Aging*, *29*(3), 717–730. https://doi.org/10.1037/a0037363

McMorris, T., & Hale, B. J. (2012). Differential effects of differing intensities of acute exercise on speed and accuracy of cognition: A meta- analytical investigation. *Brain and Cognition, 80,* 338 –351. http://dx.doi.org/10.1016/j.bandc.2012 .09.001 Medicine, 72, 239–252. doi: 10.1097/PSY.0b013e3181d14633

Oberman, A. (1985). Exercise and the primary prevention of cardiovascular disease. American Journal of Cardiology, *55,*10D-20D

Owen, N., Sparling, P. B., Healy, G. N., Dunstan, D. W., & Matthews, C. E. (2010). Sedentary behavior: Emerging evidence for a new health risk. *Mayo Clinic Proceedings*, *85,* 1138–1141. http://dx.doi.org/10 .4065/mcp.2010.0444

Prince SA, Adamo KB, Hamel ME, Hardt J, Connor Gorber S, Tremblay M. A comparison of direct versus self-report measures for assessing physical activity in adults: A systematic review. The International Journal of Behavioral Nutrition and Physical Activity. 2008;5:56. doi: 1479-5868-5-56 [pii] 10.1186/1479-5868-5-56.

Robinson, S. A., & Lachman, M. E. (2018). Perceived control and cognition in adulthood: The mediating role of physical activity. *Psychology and Aging*, *33*(5), 769–781. https://doi.org/10.1037/pag0000273

Rockwood, K., & Middleton, L. (2007). Physical activity and the maintenance of cognitive function. *Alzheimer's and Dementia, 3,* S38–S44: doi:10.1016/j.jalz.2007.01.003

Salthouse TA. When does age-related cognitive decline begin? Neurobiol Aging. 2009;30:507–14. doi: 10.1016/j.neurobiolaging.2008.09.023.

Schmidt, W., Endres, M., Dimeo, F., & Jungehulsing, G. J. (2013). Train the vessel, gain the brain: Physical activity and vessel function and the impact on stroke prevention and outcome in cerebrovascular disease. *Cerebrovascular Diseases*, *35,* 303–312. doi:10.1159/000347061

Shepard RJ. Limits to the measurement of habitual physical activity by questionnaires. British Journal of Sports Medicine. 2003;37:197–206.

Sliter, K. A., & Sliter, M. T. (2014). The Concise Physical Activity Questionnaire (CPAQ): Its development, validation, and application to firefighter occupational health. International Journal of Stress Management, *21*, 283–305. doi:10.1037/a0035638 CPAQ

Smith, P. J., Blumenthal, J. A., Hoffman, B. M., Cooper, H., Strauman, T. A., Welsh-Bohmer, K., ... & Sherwood, A. (2010). Aerobic exercise and neurocognitive performance: a meta-analytic review of randomized controlled trials. *Psychosomatic medicine*, *72*(3), 239.

Snowden, M., Steinman, L., Mochan, K., Grodstein, F., Prohaska, T., Thurman, D., . . . Anderson, L. A. (2011). Effect of exercise on cognitive performance in community-dwelling older adults: Review of intervention trials and recommendations for public health practice and research. *Journal of the American Geriatrics Society, 59,* 704–716. doi:10.1111/ j.1532-5415.2011.03323.x

Stern, Y., MacKay-Brandt, A., Lee, S., McKinley, P., McIntyre, K., Razlighi, Q., … Sloan, R. P. (2019). Effect of aerobic exercise on cognition in younger adults: A randomized clinical trial. *Neurology*, *92*(9), e905–e916. Retrieved from http://search.ebscohost.com/login.aspx?direct=true&db=psyh&AN=2019-47213-019&site=ehost-live

Thomas, K. T. (2004). Riding to the rescue while holding on by a thread: Physical activity in the schools. *Quest, 56,* 150–170.

Tomporowski, P. D., Lambourne, K., & Okumura, M. S. (2011). Physical activity interventions and children's mental function: An introduction and overview. *Preventive Medicine, 52*(Suppl 1), S3–S9.
Van der Elst, W., Ouwehand, C., van der Werf, G., Kuyper, H., Lee, N., and Jolles, J. (2012). The Amsterdam Executive Function Inventory (AEFI): psychometric properties and demographically corrected normative data for adolescents aged between 15 and 18 years. *J. Clin. Exp. Neuropsychology.* 34, 160–171. doi: 10.1080/13803395.2011.625353

Van Tetering MAJ, De Groot RH, Jolles J. Teacher-Evaluated Self-Regulation Is Related to School Achievement and Influenced by Parental Education in Schoolchildren Aged 8–12: A Case–Control Study. Frontiers in psychology. 2018;9: 438 10.3389/fpsyg.2018.00438
Van Tetering MAJ, Jolles J. Teacher evaluations of executive functioning in schoolchildren aged 9–12 and the influence of age, sex, level of parental education. Frontiers in psychology. 2017;8: 481 10.3389/fpsyg.2017.00481

Wald A., Muennig P. A., O'Connell K. A., Garber C. E. Associations Between Healthy Lifestyle Behaviors and Academic Performance in U.S. Undergraduates: A Secondary Analysis of the American College Health Association's National College Health Assessment II. Am J Health Promot. 2014;28(5):298–305.

Warburton, D. E. R., Nicol, C. W., & Bredin, S. S. D. (2006). Health benefits of physical activity: The evidence. *Canadian Medical Association Journal, 174,* 801– 809. http://dx.doi.org/10.1503/cmaj .051351

Weinberg, L., Hasni, A., Shinohara, M., & Duarte, A. (2014). A single bout of resistance exercise can enhance episodic memory performance. *Acta Psychologica, 153,* 13–19. http://dx.doi.org/10.1016/j .actpsy.2014.06.011

Wittberg, R., Northrup, K., Cottrell, L. A., & Davis, C. L. (2010). Aerobic fitness thresholds associated with fifth grade academic achievement. *American Journal of Health Education, 41,* 284–291.

Wu, C.-T., Pontifex, M. B., Raine, L. B., Chaddock, L., Voss, M. W., Kramer, A. F., & Hillman, C. H. (2011). Aerobic fitness and response variability in preadolescent children performing a cognitive control task. *Neuropsychology*, *25*(3), 333–341. https://doi.org/10.1037/a0022167

Yaffe, K., Fiocco, A. J., Lindquist, K., Vittinghoff, E., Simonsick,E. M., Newman, A. B., . . . Harris, T. B. (2009). Predictors of maintaining cognitive function in older adults: The Health ABC study. Neurology, 72, 2029–2035. doi: 72/23/2029 [pii]10.1212/WNL. 0b013e3181a92c36

Yanagisawa, H., Dan, I., Tsuziki, D., Kato, M., Okamoto, M., Kyutoku, Y., & Soya, H. (2010) Acute moderate exercise elicits increased dorsolateral prefrontal activation and improves cognitive performance with Stroop test. *Neuroimage*, 50, 1702-1710. DOI: 1.1016/j.neuroimage.2009.12.023

Appendices

Appendix A

Items of the Attentional Control Scale

Items are scored on a 4-point scale (1 □ *almost never*; 2 □ *sometimes*; 3 □ *often*; 4 □ *always*). R □ reverse-scored item.

It's very hard for me to concentrate on a difficult task when there are noises around. (R)
When I need to concentrate and solve a problem, I have trouble focusing my attention. (R)
When I am working hard on something, I still get distracted by events around me. (R) My concentration is good even if there is music in the room around me. When concentrating, I can focus my attention so that I become unaware of what's going on in the room around me.
When I am reading or studying, I am easily distracted if there are people talking in the same room. (R)
When trying to focus my attention on something, I have difficulty blocking out distracting thoughts. (R)
I have a hard time concentrating when I'm excited about something. (R) When concentrating I ignore feelings of hunger or thirst.
I can quickly switch from one task to another. It takes me a while to get really involved in a new task. (R)
It is difficult for me to coordinate my attention between the listening and writing required when taking notes during lectures. (R)
I can become interested in a new topic very quickly when I need to.
It is easy for me to read or write while I'm also talking on the phone.
I have trouble carrying on two conversations at once. (R)
I have a hard time coming up with new ideas quickly. (R)
After being interrupted or distracted, I can easily shift my attention back to what I was doing before.
When a distracting thought comes to mind, it is easy for me to shift my attention away from it.
It is easy for me to alternate between two different tasks.
It is hard for me to break from one way of thinking about something and look at it from another point of view. (R)

Appendix B

Original	Adapted
Attention	**Attention**
I am not able to focus on the same topic for a long period of time	I am not able to focus on the same topic for a long period of time
I am easily distracted	I am easily distracted
My thoughts easily wander	My thoughts easily wander
Planning and initiative	**Planning**
I can make fast decisions (e.g., in lessons)	I am well organized. For example, I am good at planning what I need to do during a day
I am well organized. For example, I am good at planning what I need to do during a day	I am chaotic or disorganized
It is easy for me to come up with a different solution if I get stuck when solving a problem	My work is very tidy
I am full of new ideas	
I am curious, I want to know how things work	
Self-control and self-monitoring	**Self-control and self-monitoring**
I often react too fast. I've done or said something before it is my turn	I often react too fast. I've done or said something before it is my turn
It is difficult for me to sit still	Compared to others, I talk a lot
It takes a lot of effort for me to remember things	I do not consider the consequences before I act
I often forget what I have done yesterday	I am a blabbermouth
I often lose things	

Appendix C

Memory Functioning Scale Self-Report (MFS-S)

Name/Code:

Date:

I'm going to give you some examples of everyday situations where you might need to use your memory. I want you to think about your own memory, as it is now, and tell me how you think you would manage in that situation. I want you to choose the answer which best describes how you would do. The answers are on the card here. These are the situations.

SITUATION:	FREQUENCY 0 = Never 1 = Rarely 2 = Sometimes 3 = Often 4 = Always				
1. You meet someone and are told their name. Later on you meet them again, and you need to remember their name.	0	1	2	3	4
2. You have made an appointment and need to remember to go along.	0	1	2	3	4
3. You have promised to do something later in the day and need to remember to do it at the right time.	0	1	2	3	4
4. You have got a set of items to sort out, some of which you have seen before and some of which are new to you. You need to pick out the ones you have seen before.	0	1	2	3	4

5. You hear a news item on the radio.	0	1	2	3	4
a. One of your family comes in at the end and asks you what was said.	0	1	2	3	4
b. Later on – say half an hour later – someone else asks you what you heard.	0	1	2	3	4
6. You meet up with a group of people. Some of them you've met before, others you haven't. You need to recognise which ones you've met before.	0	1	2	3	4
7. You go to a new building and you are learning to find the way around. Someone shows you a short route which you will need to remember.	0	1	2	3	4
a. You need to retrace the route immediately.	0	1	2	3	4
b. You need to retrace the route again later on – say half an hour later.	0	1	2	3	4
8. You have been given a message to deliver to someone. You need to remember to give that person the message when you see them.	0	1	2	3	4
a. You see them right away.	0	1	2	3	4
b. You see them later on.	0	1	2	3	4
9. You are being asked to give some information about yourself, such as age, address, date of birth, and so on, and to answer a few basic general knowledge questions.	0	1	2	3	4
10. Someone asks you for today's date.	0	1	2	3	4

Appendix D

CPAQ Directions, Items, and Scoring

Directions

Please think about the **past month**. During that time, approximately how many days per week did you engage in each of the following types of physical activity for **at least 20 consecutive minutes**?

Example 1. If you walk to work and it takes you 10 minutes each way, that would NOT count because the minutes were not consecutive.

Example 2. If you walk to work and it takes you 20 minutes each way, then that would count as performing light physical activity that day. You walked for at least 20 *consecutive* minutes that day.

Items

1. Light aerobic activity (Ex: Shopping, housework, leisurely walking) 2. Moderate aerobic activity (Ex: Brisk walking, bicycling, tennis)
3. Vigorous aerobic activity (Ex: Jogging/running, swimming laps,

jumping rope)
4. Muscle-strengthening activity (Ex: Lifting weights, pilates, yoga)

CPAQ Development and Validation 305 Response Scale (coding in parentheses)

Physically unable/not medically allowed to do this (0) Chose not to do this (0)
1 day per week or less (1)
2–3 days per week (2)

4–5 days per week (3)

6–7 days per week (4)

Scoring Multiply each individual's responses to item 3 (vigorous aerobic activity) by 2.5. Sum the unweighted responses to items 1, 2, and 4, and the weighted response to item 3.

Appendix E

Consent Form

- I voluntarily agree to participate in this research study.

- I am 18 years or older

- I understand that even if I agree to participate now, I can withdraw at any time or refuse to answer any question without any consequences of any kind.

- I have had the purpose and nature of the study explained to me and I have had the opportunity to ask questions about the study.

- I understand that participation involves performing an online questionnaire and once my data is submitted I will not be able to withdraw

- I understand that I will not benefit directly from participating in this research.

- I agree to my data being used.

- I understand that all information I provide for this study will be treated confidentially.

- I understand that in any report on the results of this research my identity will remain anonymous.

- I understand that under freedom of information legalisation I am entitled to access the information I have provided at any time while it is in storage as specified above.

- I understand that I am free to contact any of the people involved in the research to seek further clarification and information.

- I understand that all information collected will be stored and protected for a period of 5 years before being destroyed.

- I understand that all information put forward will be subjected to a grade for a final year project and the resulting information may be publishable.

Name

Date

Appendix F

Information Sheet

My name is Stephen Hogan and I am a third-year psychology student attending the National College of Ireland. I would like to invite you to take part in this study that I am conducting for my final-year dissertation. The aim of this study is to examine if higher levels of exercise engagement are associated with higher levels of cognitive and academic performance.

Your participation in this study is completely voluntary; you can choose to withdraw during the study without penalty. Data will be fully anonymised, which means that after the point of submission, you will not be able to retract your data (as it will not be identifiable).

You will be asked to complete a 5-part questionnaire that should take around 10-15 minutes.

The questions will measure (1) Attention; (2) Memory Ability; (3) Executive Function (or planning and organising skills); (4) Academic Performance; and (5) Levels of Physical Activity.

You are under no time restraint and may complete the questionnaire in your own time.

There are no associated physical risks or benefits of participation in this study. There is no risk to loss of privacy as all data is GDPR compliant. Completed questionnaires will be sent to google forms and transferred to SPSS files. All data will remain non-identifiable and files will be password protected. After participation, you will be presented with a debriefing sheet which will provide you with support numbers and information if you have any queries relating to the study.

If you have any queries regarding the study or the security of your data you may contact either Stephen Hogan at x17302086@student.ncirl.ie or the supervisor of the study Michelle Kelly at Michelle.Kelly@ncirl.ie

Appendix G

Debriefing Sheet

Thank you for agreeing to participate in this study! The general purpose of this research is to gain an understanding as to whether people who exercise more compared to those who don't score better in their perceived cognitive abilities.The results from this study will provide an insight into the importance of exercise and how it can help benefit your cognition greatly in your everyday life. When all the data is submitted everyones identity and information will remain anonymous and confidential.

If you feel especially concerned about the nature of the study and the stress that may be involved with it then, please feel free to email Stephen Hogan X17302086@student.ncirl.ie about any queries. Below are a few outlets you may use if you feel any sort of distress or discomfort after the study.

Thank you for your participation in this study. In addition, if you have any concerns about any aspect of the study, you may contact my supervisor Michelle Kelly at Michelle.Kelly@ncirl.ie

https://www2.hse.ie/conditions/mental-health/anxiety.html

https://www2.hse.ie/conditions/mental-health/post-traumatic-stress-disorder/post-traumatic-stress-disorder-ptsd-causes

htmlhttps://niteline.ie/