Aerobic Exercise and Short Term Memory

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Abstract

This paper will explain background research and observe answers to the question: Does aerobic exercise improve short term memory (STM) functioning in humans? Aerobic exercise has been found to correlate with improved short term memory functioning in gerbils and rats, but has not conclusively correlated with improved STM in humans. This study observes how 14 participants answer questions about age, education, weekly aerobic, anaerobic, and total exercise, and their performance in a measure of short term memory functioning, the Corsi Task. We found that only the negative correlation between education and STM was statistically significant. There was no relationship between weekly aerobic exercise and STM in our participants. This indicates and supports other published studies that although exercise has been associated with improving executive function in humans, it is not specifically associated with STM functioning. This study could be improved in the future by expanding the sample size to increase external validity and measuring aerobic exercise more directly in an within-subjects design experiment.

Introduction

Exercise has been shown to improve overall well-being for humans and other animals in many previous studies (Warburton et al., 2006, Kim et al., 2014, Tomporowski & Ganio, 2006). Specifically, aerobic exercise has been associated with short-term memory improvement in rats and gerbils (Kim et al., 2014, Sim et al., 2004). In humans, aerobic exercise resulted in improved executive processing, but not short term memory tasks (Tomporowski & Ganio, 2006). Other studies have observed improved memory functioning after aerobic exercise tasks, but have not clarified what kind of memory is targeted and how this relationship is mediated and moderated (Roig et al., 2016, Stroth et al., 2009). This study will further contribute to this literature by analyzing potential associations between aerobic exercise and short term memory functioning.

Physical activity can help facilitate cell survival and neurogenesis, especially in the hippocampus, which is connected to human memory functioning (Kim et al., 2014, Sim et al., 2004). Sim et al. (2004) claim that neuroprotective effects resulting from physical exercise can relieve injury in the hippocampus. This study also noted that exercise via treadmill can improve short term memory functioning in gerbils (Sim et al., 2004). In humans, aerobic exercise improved executive functions but not short term memory. This may demonstrate that the effects of aerobic exercise are domain specific (Tomporowski & Ganio, 2006). Other studies in humans have been also somewhat inconclusive about effects of aerobic exercise on short term memory. Roig et al. (2016) and Stroth et al. (2009) emphasize that more research is needed to understand how aerobic exercise may be related to specific memory functions. This project intends to contribute to the research needed to observe associations between aerobic exercise and short term memory.

We will be asking if short-term memory functioning is associated with aerobic exercise levels in human participants. We hypothesize that increased aerobic exercise will have a positive correlation with short-term memory functioning.

Our independent variable of interest is the amount of aerobic exercise (in minutes) on a weekly basis. This IV will not be manipulated, but differences in self-report responses to levels of physical activity will be measured. This means that we are partaking in a quasi-experiment since variables will be measured, but not manipulated or controlled in a lab setting. This is a between-subjects design. We will analyze the data through regression analysis correlating aerobic exercise with short-term memory functioning. Our dependent variable is short-term memory function, which will be measured through completion of levels of the Corsi task. The dependent variable is interval, ranked on a scale from 0-9.

This builds on past research finding that exercise can improve neurogenesis, increase neurotrophic factors, and increases dendritic length of neurons in the hippocampus of rats and gerbils, all of which are associated with increased memory exercise (Sim et al., 2004, Kim et al., 2014). We hope to confirm or deny that aerobic exercise is associated with short term memory functioning in humans.

Methods

Design

This is a quasi-experiment between-subjects study design that measured differences in weekly aerobic, anaerobic, and total exercise times and performance on the Corsi Task, a measure of short term memory. These data were analyzed through correlational tests on R studio (version number 1.2.5001) (www.r-studio.com).

Participants

Participants were recruited through various media platforms, including Instagram, Facebook, LinkedIn, and Reddit. Thirty-eight participants started the study, but 24 were excluded due to missing responses on the survey, or not beginning the Corsi task. There were 14 total participants that completed the survey and experiment components of our study and we could include in data analysis. This sample was comprised of 2 males, 12 females, and 0 nonbinary persons. Participants ranged in age from 21 to 30 years of age (M= 23.5, SD=2.93). Two participants had highschool diplomas, 8 participants had undergraduate college degrees, 3 participants had postgraduate college degrees, and 1 participant had the highest education of a doctoral degree. Participants included 4 White and 9 Asian individuals, and 1 who preferred not to disclose.

Measures

We used a self-report questionnaire to measure all of our variables. These include participant demographics, age and education, weekly exercise levels, measured by a 3-item scale asking about aerobic, anaerobic, and total exercise minutes weekly, and completion of the Corsi Task. The Corsi Task measured short-term memory functioning by lighting up squares and asking the participant to recall which squares lit up in the correct sequence. It goes through different levels, from 0-9, with more squares lighting up at each higher level. The highest level a participant could reach indicated short term memory functioning. This is a positive relationship between level of Corsi Task and short term memory functioning (cite).

Procedures

Participants took a 10-15 minute survey that included demographic questions, weekly exercise questions, and the Corsi Task. This survey could be taken from whatever electronic platform was available to participants. Participants were not compensated, but given further

information on our topic of study and potential benefits of participation. Online data was collected through the software PsyToolkit (Stoet, 2010, 2017). We used the R Studio (version number 1.2.5001) (www.r-studio.com) statistical software to analyze the data. Correlations with a p-value of .05 were considered statistically significant, and a p-value of less than .20 was considered a potential trend.

Results

Pearson's correlation tests were used to determine if age, education, aerobic exercise, anaerobic exercise, and total exercise are associated with short term memory as measured through completion of the corsi task. Age (M=23.5, SD=2.93) and short term (M=5.52, SD=0.99) memory were not statistically significantly associated in our sample (df(11)=-0.07, p=0.81). Education (M= 3.21, SD=0.8) and short term memory had statistically significant negative correlation, meaning that as reported education level of participants increased, short term memory measured by the corsi task decreased (df(12)=-.61, p=.02)(*Figure 1*). There is no significant association between aerobic exercise (M=81.09, SD=64.22) and the performance in short term memory tasks (t(10)=-0.14, p=0.66). Total exercise (M=108.92, SD=92.03) was not significantly associated with short term memory (df(11)=0.23, p=0.45), and anaerobic exercise had an almost statistically significant positive trend with short term memory (df(12)=0.39, p=0.17) (*Figure 2*).

Figure 1: Pearson's Correlation between Education and Short Term Memory

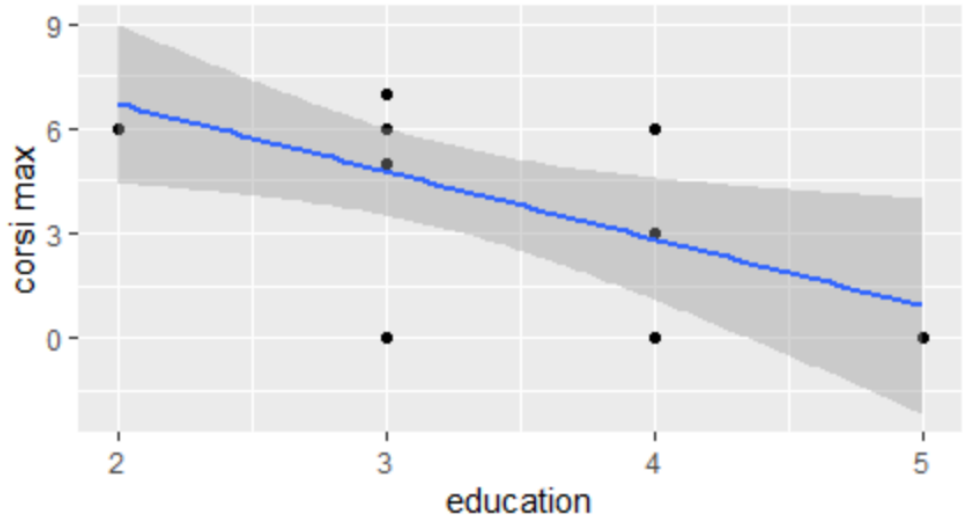
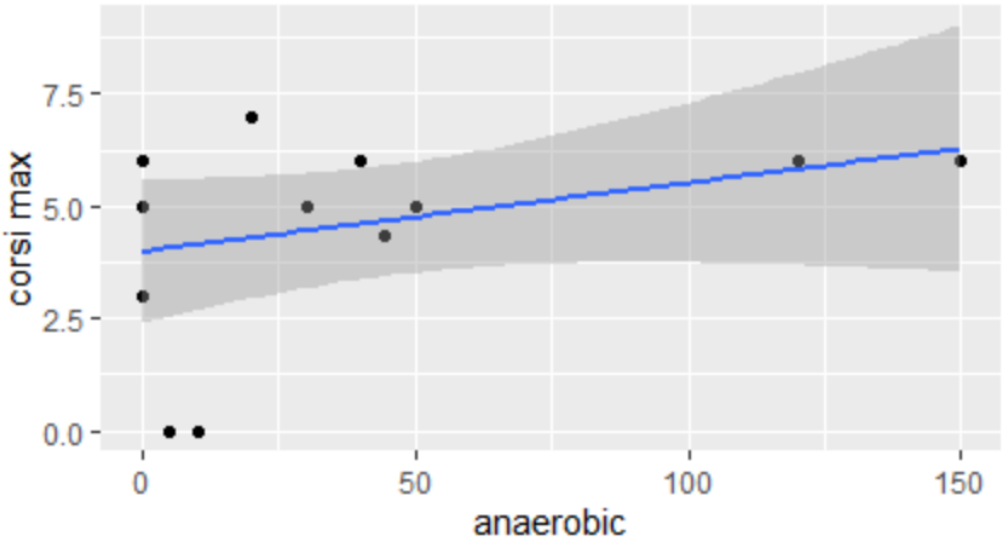


Figure 2: Pearson's Correlation between Anaerobic Weekly Exercise and Short Term Memory



Discussion

Interpretation

Our hypothesis that weekly aerobic exercise would have a positive correlation with short term memory functioning was not supported. Rather, we found that anaerobic exercise may be more associated with short term memory, and education was significantly correlated with short term memory functioning, surprisingly, in a negative direction. This supports Tomporowski & Ganio's (2006) conclusions that aerobic exercise does not improve short term memory tasks. Interestingly, we found a statistically significant negative correlation between education and short term memory tasks in our sample. This result suggests that further research is needed to observe how different factors, including socioeconomic, can influence a person's short term memory.

Limitations and Future Directions

This study and the concluded results are limited due to a small sample size of participants for whom we could analyze data for. This makes it difficult to generalize the results of this study to a broader American population, especially considering there were only two ethnoracial groups represented in our sample. This decreases this study's external validity. This could be improved through future directions to increase sample sizes by increasing the amount of time the survey is available to participants, and potentially including participant compensation to increase motivation to complete the Corsi Task, which is where we saw most of our participants excluded from the study.

This study has good construct validity because the constructs of weekly exercise and short term memory were operationalized accurately. We would continue to use the measures to expand sample sizes. It was especially helpful to separate weekly exercise into aerobic,

anaerobic, and total divisions to analyze what could potentially mediate differences in exercise and short term memory. Construct validity could be improved in an experimental within-subjects setting by measuring short term memory, having the participant engage in aerobic or anaerobic exercise, and then measuring short term memory again. This would also improve the internal validity of this study, but potentially identifying causal relationships between exercise and short term memory.

This study also suggests the importance of further research into how short term memory changes based on environmental factors, like education. This could illuminate disparities in groups that could potentially be effective in targeting for intervention to improve executive functioning, specifically short term memory functioning.

Conclusion

The conclusions of this experiment is that cardiovascular workouts do not have an effect on short term memory tasks, while other workouts (non cardiovascular or anaerobic) might have some benefit for short term memory tasks. This would not be a quality solution for people with inhibited short term memory, but improved performance on short-term memory tasks could be another benefit to leading a healthy lifestyle. The implication of education being negatively correlated to short-term memory tasks definitely requires more attention. Potentially there could be a benefit to forgetting unimportant tasks to better recall more important tasks in the future, but this would require another experiment to further understand this finding. Overall, the best takeaway is that leading a healthy lifestyle that is not dependent on aerobic exercise, but instead is balanced with anaerobic exercise might be good for short-term memory tasks. This is a great way to lead a healthy lifestyle for the body and the brain.

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