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Exercise and the Brain: What Can FIT-U do For You?

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NORTHERN ILLINOIS UNIVERSITY

Exercise and the Brain: What Can FIT-U do For You?

A Capstone Submitted to the

University Honors Program

In Partial Fulfillment of the

Requirements of the Baccalaureate Degree

With Honors

Department Of

Allied Health and Communicative Disorders

By

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DeKalb, Illinois

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Capstone Faculty Approval Page

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HONORS CAPSTONE ABSTRACT

This project was a pilot study exploring the effects of an aerobic program, FIT-U, and factors influencing cognitive outcomes for healthy aging individuals and those with neurogenic cognitive-communicative disorders. While aerobic exercise has been shown to improve cognition in both cases, this study looked into the factors that influence this phenomenon. Three regular attendees of FIT-U were given a letter fluency test before and after FIT-U, using different letters each time, but balanced in terms of difficulty. By using single subject methodology, the data were consistent with a trend towards improved VF scores following each FIT-U session for two participants. However, the individual with a lower baseline cognitive function did not appear to be getting the same cognitive benefits as healthy aging individuals. This emphasizes the importance of measuring baseline cognitive functioning and perhaps altering program parameters so everyone can get an equal cognitive benefit.

Introduction

Purpose

The purpose of the study was to look at whether and how regular participation in FIT-U, a fitness class at Oak Crest Senior Living facility, affected thinking and talking. In order to determine this, cognitive functioning was looked at. The type of cognitive functioning that was looked at was letter verbal fluency. While some projects have begun to show a relationship between aerobic exercise and improvements in cognitive functioning, there is still some uncertainty due to studies containing too many variables. This project will aid in the discovery of whether aerobic exercise does improve cognitive functioning, how much it may improve functioning, and what specific variables influence this. Further, this project serves as a pilot to a much larger study, which will look further into the components that affect cognitive outcomes, as discussed later.

Personally, the biggest purpose to this project was to understand how I could best treat older adults. Based on the effect that FIT-U has on thinking and talking, I may try to incorporate this into physical therapy regimens to improve quality of life in my patients. I was also given practice with person-centered care, where I learned to adapt based on what works best for the participant.

Aerobic exercise on cognition

Verbal fluency is a short test of verbal functioning, or how easily someone can produce words. Aerobic exercise has been shown to increase verbal fluency (Nocera et al., 2015). In this 12-week study that exercised three times per week, participants began with 20 minutes of spin aerobic exercise; this duration was increased by one to two minutes per session to a maximum of 45 minutes (Nocera et al., 2015). It was shown that aerobic exercise increased verbal fluency by 15%, as compared to a 2% increase in the control group (Nocera et al., 2015).

This is significant because several cognitive functions are necessary for a verbal fluency task. These functions include “clustering,” which is the automatic activation of similar words, and “switching,” which is a deliberate change from one sub-category to another (Clark et al., 2015). A verbal fluency task also requires a “need to focus on the task” and “need to retrieve words of their language” (Shao et al., 2014). All of this means that a poor score on a verbal fluency test may be a result of a deficit in either verbal ability or executive control

(Shao et al., 2014). A deficit in verbal ability or executive control will ultimately affect how an individual can think and talk.

The use of verbal fluency tests and understanding their importance is necessary, as verbal fluency tests are a very inexpensive and efficient way to test cognitive functioning (Clark et al., 2015). Further, it can also be used to support diagnoses of Alzheimer's, Parkinson's, and dementia. (Clark et al., 2015).

Letter fluency

While both category and letter fluency decline with age, it is suggested that letter fluency declines more (Bizzozero et al., 2013). Letter fluency was used for this study because it puts more focus on attention, which requires the frontal lobe (Bizzozero et al., 2013). This was what we expected to see an improvement in with exercise. Letter fluency also requires words to be retrieved in a phonemic category, which is not commonly done on a daily basis (Shao et al., 2014). This required participants to suppress semantically associated words (Shao et al., 2014). Further, category letter fluency has been shown to be more impaired in Alzheimer and dementia (AD) patients than letter fluency (Bizzozero et al., 2013), making letter fluency easier to get data from in older adults who may be affected by AD.

Hypothesis

Based on the research, the hypothesis was that the intervention of FIT-U would improve verbal fluency, thus improving thinking and talking, in all participants.

Methodology

Participants

The participants of this study were attendees of the FIT-U class. This class had about 10-15 people in attendance during each session, but three were selected for this study. These participants were in the independent or assisted living sections, meaning that they had mild to no known cognitive impairments. Participant age ranged from 81-90 years old. The participants were all female.

Intervention

The FIT-U class involved stretching, resistance training, cardiovascular exercise, and asymmetrical body movement. The stretching was all done while seated and targeted all muscle groups, which lasted about 10

minutes. Resistance training with exercise bands was also done while seated. A band of varying resistance was given based on the participants' estimated strength. Exercises such as pulling the band apart, toward the body, or away from the body with either legs or arms was done. This component lasted about 10 minutes. The cardiovascular exercise portion included typical cardiovascular exercises and sports, but all done seated. This included exercises like stomping, swimming, punching, and running. This part lasted about 15 minutes. The asymmetrical body movement portion required residents to move one half of their body in a different way as the other half. For example, the residents were asked to move one arm up and the other arm down, all while stomping their feet. This part lasted about 5 minutes. The class lasted about 45 minutes each session. There was also a major social aspect in this group, as it was the main way for residents to interact with each other.

Data Collection

Letter verbal fluency tests

This study was IRB-approved, and the participants gave informed consent prior to the first data collection point. Verbal fluency tests were given before the start of the FIT-U class. Participants were pulled aside before entering the class, directions were explained, and their responses were written down individually. Residents attended the FIT-U class like normal. At the end of the class, another verbal fluency test was given in the same manner as the first. The letter fluency tests given were all comparable difficulties so the data could be compared fairly. All letters, excluding X and Z, letters can be split into three difficulty levels (Tombaugh et al., 1999). As long as the letters for pre-testing and post-testing are in the same difficulty level, they can be considered a fair comparison (Tombaugh et al., 1999). The following norms for letter verbal fluency were used:

Hard: Q, J, V, Y, K, U

Moderate: I, O, N, E, G, L, R

Easy: H, D, M, W, A, B, F, P, T, C, S

Each unique word that started with the correct letter was given one point. Proper nouns, contractions, similar words with different endings (-ed, -ing, etc.), words that do not exist, and words less than three letters were not counted as a point. Participants' scores from before versus after the class were used for comparison. This was conducted for 5 weeks.

Qualitative interviews

At the end of the study, a qualitative interview was done to get feedback and place an emphasis on person-centered care. These questions were concerning the class and how the residents felt about it. These were conducted at the conclusion of the study. All participants were asked the following questions:

1. Tell me a little bit about the program. What do you do during Fit-U?
2. Can you tell me why you choose to attend?
3. What is your favorite part of the program?
4. Is there anything you would change about Fit-U, if you could?
5. Do you feel like attending Fit-U helps you physically – like moving, walking, reaching for things? Can you describe for me?
6. Do you feel like attending Fit-U helps you mentally – like how you think, feel, or talk? Can you describe for me?

This feedback may be used in the future to improve parts of the class if necessary and understand how participants feel about the class.

Statistical analyses

Due to the small number of subjects and explanatory design, single-subject data were analyzed using visual inspection only. Average letter fluency before versus after the FIT-U intervention was looked at, as well as average improvement before versus after the FIT-U intervention. Finally, the long-term, generalized effect of FIT-U was looked at by comparing baseline scores to post 5-week intervention of FIT-U.

Results

Immediate effects

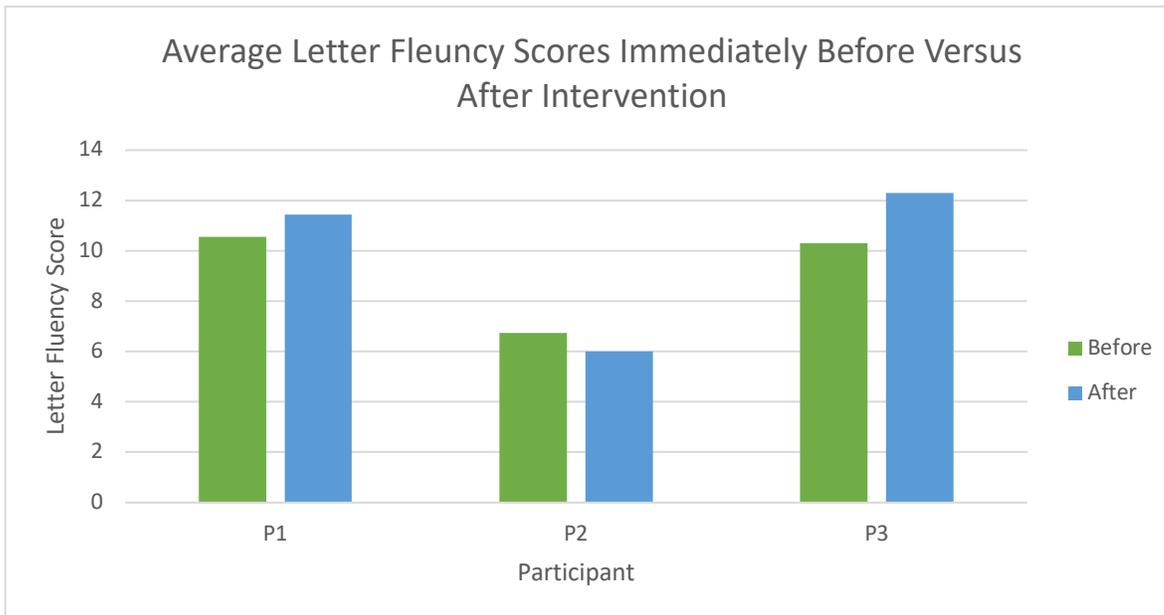


Figure 1. This graph represents the average letter fluency scores for each participant immediately before and after the FIT-U intervention. P1 and P3 showed improvement, while P2 showed a slight decrease in letter fluency scores.

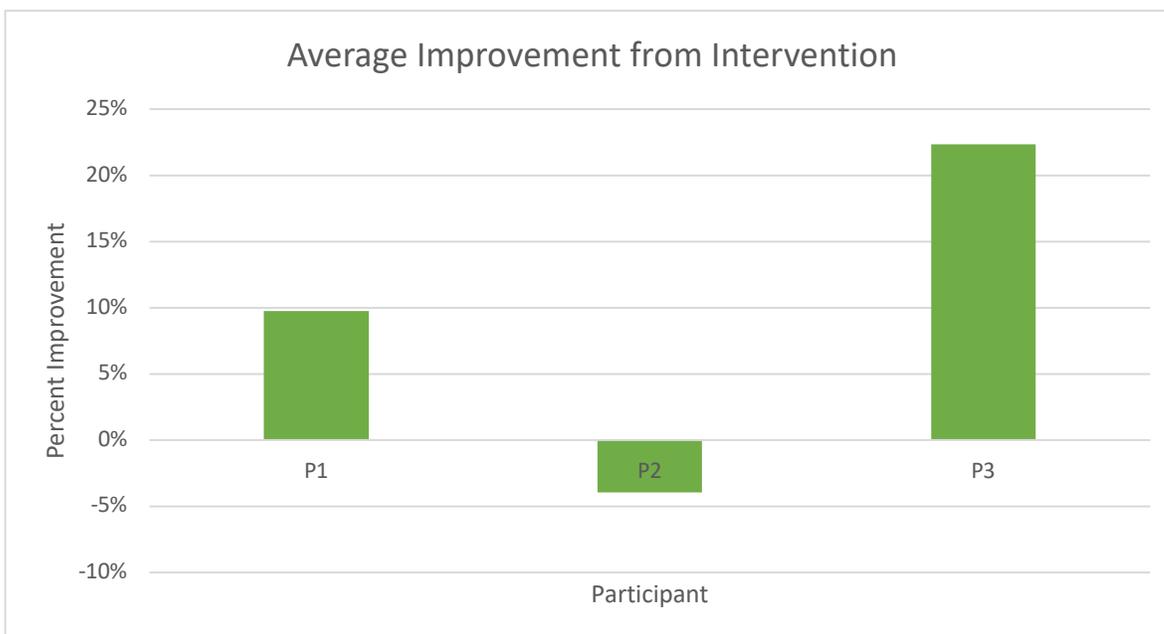


Figure 2. This graph represents the average letter fluency improvement for each participant immediately before and after the FIT-U intervention. P1 and P3 showed positive improvement, while P2 showed negative improvement.

Long-term effects

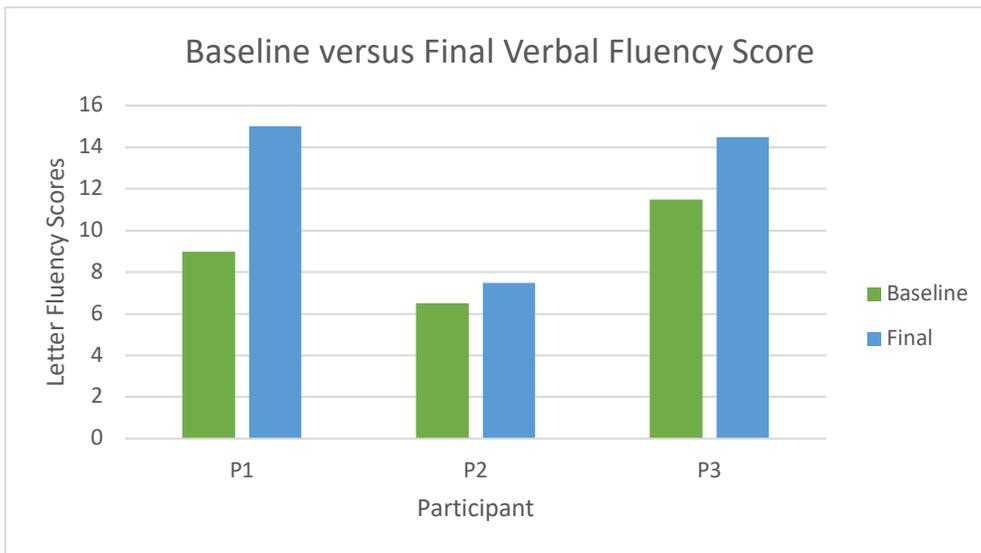


Figure 3. This graph represents the improvement from the first day of verbal fluency testing to the last day. Both days had “easy” letter categories. All participants improved from the first day to the last.

Qualitative interview

The qualitative interview provided very strong feedback on the FIT-U program. The first question showed that each participant very clearly understood the program, nearly down to each individual exercise that is done. The biggest reason that the participants chose to attend was because they felt like they got a lot out of it and was a good way for them to remain active, whether that be intrinsic motivation or their children telling them they should. It was hard for the participants to pick a favorite part of the program, but according to P1 and P2, they most enjoy the exercises that were “fun” and seemed to involve some rhythm, such as clapping and marching. None of the participants were able to pick anything that they would like to change about FIT-U. The participants said that FIT-U helped them physically with things that require more advanced movement, not something as simple as walking. P3 said she felt comfortable reaching high places and bending down likely because of the fitness class. However, the participants did not seem to get much cognitive benefit out of it; the asymmetric cognitive movement does appear to stand out, but not enough to make them feel as if they are getting a “brain workout” from it.

Discussion

The data were consistent with a trend towards improved VF scores following each FIT-U session for P1 and P2. This was likely due to activation of the frontal lobe while exercising, which is what letter fluency requires (Bizzozero et al., 2013). P2 showed lower VF scores in general, as well as a decrease after FIT-U. The participants' average score was 6.7, which is well below the expected range of 14-17. This may be evident of onset of mild cognitive impairment (Clark et al., 2015). When looking at the long-term effects of FIT-U, VF scores tended to increase, despite the baseline score.

The following sections provide other variables that may have affected the results and have potential to be further analyzed in the FIT-U class.

Monotonous versus stimulating exercise

One variable to look at in this study is the excitement of completing multiple exercises, rather than one monotonous one. In exercise sessions where there is only a single type of exercise included, such as cycling, there is a smaller effect on cognitive functioning (Angeveran et al., 2007), as compared to sessions that are more stimulating, such as yoga or weight training. Variation in activities is positively associated with higher cognitive functioning (Angeveran et al., 2007). There is very little research on this component of exercise, but it is potentially a big benefit of the FIT-U program, which is anything but monotonous.

Duration of exercise on cognitive functioning

Another variable is that there are varying durations of each type of exercise - stretching, resistance training, aerobic, and asymmetrical cognitive engagement. It has been shown that the most beneficial programs include over 30 minutes of exercising (O'Dwyer et al., 2007). Overall, a decrease in duration of aerobic exercise is associated with a decline in cognitive functioning (Van Gelder et al., 2004). Another study suggests that cognition improves more with exercise that lasts 20 minutes, not 10 minutes or 45 minutes (Chang et al., 2014). One explanation of this is that after this duration of exercise, the brain works more efficiently and more attention can be brought to the task (Chang et al., 2014). The FIT-U class in this project exceeds the overall suggested amount, but each component takes only 10-15 minutes apiece.

Intensity of exercise on cognitive functioning

Another variable to be looked at is the intensity of exercise, which has also been shown to have an important relationship with cognitive functioning. Knowing and using a participants' average weighted intensity of activities has been associated with a higher enhancement of cognitive capacities (Angeveran et al., 2007). And at least a medium-low intensity may postpone cognitive decline (Van Gelder et al., 2004). Further, a decrease in intensity is correlated with a stronger cognitive decline with age, as compared to maintaining the same intensity (Van Gelder et al., 2004). Intense physical exercise is related to better oxygen transport to the brain (Brown et al., 2012), thus improving cognitive functioning. However, in older adults and especially the elderly, a "high intensity" is not the same as it is for younger adults.

Reaction time

Finally, analyzing reaction time can show important relationships between word retrieval and cognition. If a large proportion of responses are produced early in the test, this points to a fast-declining rate of retrieval (Shao et al., 2014). A declining rate of retrieval indicates deficits in executive function, which is related to being able to come up with and form words in regular conversation (Baciu et al., 2015).

Conclusion

This study looked at the effects of aerobic exercise on cognition in three individuals, two of whom would be considered "healthy aging" and one of whom may have been experiencing very early cognitive decline. The data in this study were consistent with prior research that shows aerobic exercise does improve cognition (Nocera et al., 2014) This study also suggests that it is possible that overall decreased verbal fluency is indicative of cognitive impairment and that this predicts response to the fitness intervention. This suggests the importance of measuring and correlating baseline cognitive performance with change scores following aerobic exercise. For example, it may be that individuals with different cognitive profiles respond better to different program parameters, such as requiring a shorter class due to physical and mental fatigue.

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