### [Reading Fluency: Implications for the Assessment of Children with Reading Disabilities](https://link.springer.com/article/10.1007/s11881-009-0031-z)

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**May 2019**

**CERTIFICATE**

This is to certify that this dissertation entitled “**Reading fluency: implications for the assessment of children with reading disabilities**” is a bonafide work submitted as a part for the fulfillment for the degree of Master of Science (Audiology) of the student Registration Number: 17AUD001. This has been carried out under the guidance of the faculty of this institute and has not been submitted earlier to any other University for the award of any other Diploma or Degree.

Mysore May 2019

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### CERTIFICATE

This is to certify that this dissertation entitled “**Reading fluency: implications for the assessment of children with reading disabilities”** has been prepared under my supervision and guidance. It is also being certified that this dissertation has not been submitted earlier to any other University for the award of any other Diploma or Degree and the results of this work have not been previously submitted for any other degree and it is plagiarism free in accordance with Promotion of Academic Integrity and Prevention of Plagiarism in Higher Educational Institutions Regulations, 2018 of UGC.

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### DECLARATION

This is to certify that this dissertation entitled **“Reading fluency: implications for the assessment of children with reading disabilities”** is the result of my own study under the guidance of Dr. Vimala Jain, Reader in Audiology, Department of Audiology, All India Institute of Speech and Hearing, Mysore and has not been submitted earlier to any other University for the award of any other Diploma or Degree. I further declare that it is plagiarism free in accordance with Promotion of Academic Integrity and Prevention of Plagiarism in Higher Educational Institutions Regulations, 2018 of UGC.

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May, 2019

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***ABSTRACT***

Physical activity has shown to have a positive effect on the cardiovascular system, cognition, and auditory system. The aim of the present study was to assess the effect of physical activity on auditory P300 and working memory. To fulfill the aim of study 43 normal healthy individuals were recruited. Participants of the present study were divided into four groups based on their physical activity. They were divided into physically active, moderately active, moderately inactive and inactive groups based on The General Practice Physical Activity Questionnaire (GPPAQ) validated screening tool. The auditory P300 was recorded binaurally, and working memory was also assessed binaurally from all the participants. The P300 was recorded with infrequent stimulus as /da/ and frequent stimulus as /ba/. The P300 responses were analysed in terms of onset latency, offset latency, peak latency and amplitude. Working memory was assessed using digit span and digit sequencing tests. The results of the study showed a significant difference in amplitude of P300 among different physically active groups and no significant difference was noted for the latency measure of P300. The results also showed no significant differences in scores of working memory task across different physical active groups.

***Keywords:*** *GPPAQ, P300, digit span test, digit sequencing test*

**Chapter 1 Introduction**

Regular physical activity has shown to have a positive impact on mental, emotional (Kirk-Sanchez & McGough, 2014), as well as on auditory system performance (Yagi, Coburn, & Estess, 1999). Physical exercise can be in many forms for example aerobics (Yagi et a1., 1999), different forms of dance training (Zhang et al., 2014), strength training (Ozkaya et al., 2005), swimming (Zhang et al. 2014), etc. The benefits of physical exercises are well documented in the literature (Ozkaya et al., 2005; Yagi et a1., 1999; Zhang et al., 2014). Several studies have shown that physical exercise attenuates the age-related declination in cognitive performances (Bashore, 1989; Dustman, Emmerson, Ruhlinig, Shearer, Steinhaus, Johnson, 1990; Dustman, Emmerson

& Shearer, 1994; Hawkins, Kramer & Capaldi, 1992; Spirduso, 1980), increases the alpha activity in the brain (Boutcher & landers, 1988; Farmer et al; 1978; Hatfield et al., 1984; Kamp & Troost, 1978). The effect of physical activity on the functioning of the brain can be assessed by using event-related potentials reflecting cortical activities related to cognition (Pedroso et al., 2017).

Event-related potentials are non-invasive techniques to assess the functions of the central nervous system (CNS). P300 is an endogenous or event-related potential which is highly dependent on the attention of the subjects for the auditory stimuli. Davis (1964) described the P300 as the third positive wave since it has a latency of around 300 ms and P3 label is also used because it is the third positive wave in the late response time. The P300 potential is recorded using odd ball paradigm. In an odd-ball paradigm, a series of frequent (standard) stimulus is presented along with different types of non- frequent

## Chapter 2 Review of Literature

**C**hronic and acute exercises have a positive effect on cognitive function and improve the speed of information processing in older individuals (Mandolesi, Polverino, Montuori, Foti, Ferraioli, Sorrentinoet al., 2018). Studies have shown that physical exercise attenuates the age-related declination in cognitive function (Bashore & Goddard, 1993; Dustman, Emmerson & Shearer, 1994). Tomporowski and Ellis, (1986) also reported that physical exercise gives multiple benefits such as reduction in anxiety (Roth, 1989), feeling of increased energy, well-being, clarity of thought (Tuson & Sinyor, 1993) and increase in the speed of information processing (Hogervorst, Riedel, Jeukendrup & Jolles, 1996). To understand the effect of physical exercises on cognitive functions, physiological studies have been done. These studies have shown that physical training change the P300 components mainly because P300 is a valuable tool for measuring cognitive function which reflects the neural activity underlying the basic aspects of cognition (Donchin, 1981).

### Effect of Physical Activity on the Auditory System

Studies have shown that different types of physical activity have an effect on hearing as well as in cognition, memory (Laurin, Verreault, Lindsay, Macpherson & Rockwood 2001; Middleton, Barnes, Luims & Yaffe 2010; Yaffe, Barnes, Nevitt, Lui & Covinsky, 2001), and brain health markers in the brain (Hawkins, Kramer, & Capaldi, 1992).

## Chapter 3 Methods

The aim of the present study was to assess P300 and working memory in participants with different levels of physical activity.

### Participants

Forty three adults in the age range of 40 to 60 years (mean age: 49.72 years) participated in the study. They were divided into four groups, i.e., active (A), moderately active (MA), moderately inactive (MI) and inactive (I) based on the General Practice Physical Activity Questionnaire (GPPAQ) (Health, 2006). This questionnaire was developed by the London School of Hygiene and Tropical Medicine as a validated short measure of physical activity which is a validated tool to assess the physical activity of individuals.

### Inclusion Criteria

* + - * All the Participants with hearing sensitivity within normal limits (≤ 15 dB HL) for octave frequencies from 250 Hz to 8000 Hz [ANSI S3.1 (1991)].
			* Normal middle ear functioning as indicated by immittance evaluation.
			* A fair agreement between speech recognition threshold (SRT) and pure tone threshold (PTA) (+/- 12dB).
			* Speech identification scores greater than 90 % scores



*Fig 3.1.*The time domain waveform (upper panel) and spectral representation (lower panel) of /da/ stimulus

|  |
| --- |
| Table 3.1.*Stimulus and acquisition parameters used to record P 300* |
| **STIMULUS PARAMETERS** |
| Transducer | Insert ER- 3A |
| Stimulus paradigm | Oddball paradigm |
| Stimulus type | Speech soundsFrequent: /da/and Infrequent: /ba/ |
| Intensity | 70dB nHL |
| Duration of the stimulus | 200ms |
| Repetition rate | 1.1/s |
| Stimulus probability (target) | 20% |
| Polarity | Rarefaction |
| Presentation ear | Binaural |
| **ACQUISITION PARAMETERS** |
| No. of sweeps | 300 |
| Amplification | 50,000 (lesser for larger response) |
| Analysis time | 900ms |
| Filter setting | 1-30Hz |
| Notch filter | No |
| Electrode type | Disc |
| Electrode montage | Reference: Fpz Active: A1 Ground: Nasion |

*Response Analysis*. The P300 was identified in each participant. The response was analyzed to note down the onset latency, peak latency, and offset latency and the peak amplitude. P300 was analyzed by giving the waveforms to two Audiologists with experts in P300. They were asked to mark any positivity seen around 300 ms for infrequent stimulus. P300 onset latency, offset latency, peak latency, and amplitude wasmarked.

## Chapter 4 Results

The aim of the present study was to assess the effect of different levels of physical activity on auditory P300 and working memory. To fulfill the aim, participants were divided into four groups based on the different levels of physical activity. The auditory P300 was recorded binaurally, and working memory was also assessed binaurally from all the participants. The details of the participant in each group are given in Table 4.1. The Shapiro-Wilk test of normality was done to check the normal distribution of data for P300 and working memory. The result of the Shapiro-Wilk test showed that data was normally distributed (p>0.05) and hence parametric test was used to analyze the data.

Table 4.1

*Details of the total number of participants in each group*

Group No. of Participants

Active 10

Moderately active 10

Moderately inactive 10

Inactive 13

### Effect of Physical Activity on Auditory P300

Auditory P300 was recorded from all the participants of four groups using speech stimuli /ba/ and /da/ at a repetition rate of 1.1 Hz. The P300 waveforms were analyzed by

two experienced Audiologist for onset latency, offset latency, peak latency, and amplitude. It was noted that the P300 was present for all the participants in a physically active group, moderately active group and moderately inactive groups and it was present for only 6 out of 13 participants in physically inactive groups. Figure 4.1 shows the P300 waveforms of one participant from each group. Table 4.2 shows the mean and standard deviation (SD) of onset latency, peak latency, offset latency and amplitude of P300 of the four groups.



*Figure 4.1* Representative example of P300 waveform of one participant from each group

Table 4.2

*Mean and SD of different parameters of P300 of the four groups*

|  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  |  | A |  |  | MA |  |  | MI |  | I |  |  |
|  | Mean |  | SD | Mean | SD | Mean |  | SD | Mean | SD |
| Onset Latency (ms) | 245.70 | 53.24 | 259.12 | 64.60 | 217.18 | 8.49 | 232.90 | 50.73 |
| Peak Latency (ms) | 295.95 | 55.28 | 292.70 | 64.16 | 261.36 | 38.65 | 271.96 | 47.28 |
| Offset Latency (ms) | 351.41 | 90.97 | 333.64 | 49.11 | 290.45 | 16.11 | 320.18 | 47.82 |
| Amplitude (µV) | 3.06 |  | 0.65 | 1.79 |  | 0.43 | 1.12 |  | 0.17 | 0.44 | 0.23 |

Note: „A‟: Active Group; „MA‟: Moderately Active Group; „MI‟: Moderately Inactive Group; „I‟: Inactive Group.

## Chapter 5 Discussion

The aim of the present study was to see the effect of different levels of physical activity on P300 and working memory. To fulfill the aim of the study 43 participants were divided into four groups based on the different level of physical activity. The results of the present study are discussed below:

### Effect of Physical Activity on P300

The result of the present study showed no significant difference between the different physically active groups in terms of onset latency, peak latency, and offset latency of P300. However, the amplitude of auditory P300 differed significantly among the groups. Physically active groups had higher P300 amplitude than the other groups of the present study. The results of the present study are in consensus with the studies in the literature (Chang, Huang, Chen & Hung, 2013; Kamijo et al. 2011; Lardon & Polich 1996; Magine et al. 2000; Pontiflex, Hillman, & Polich 2009; Kamijo et al. 2011. Kim et al. (2015) studied the effect of Thi-chi exercises on cognitive function in elderly individuals using P300, and they also reported better amplitude of P300 in the physically active group. Pontiflex et al. (2009) also reported that group with more physically active individuals had a higheramplitude of P3a and P3b than the non active groups.

Increase in the amplitude of P300 in the physically active group could be attributed to the benefits associated with increased physical activity. Various forms of

## Chapter 6 Summary and Conclusion

Regular physical activity has shown to have a positive impact on mental, emotional (Kirk-Sanchez & McGough, 2014), as well as on auditory system performance (Yagi, Coburn, & Estess, 1999). The benefits of physical exercises are well documented in the literature (Ozkaya et al., 2005; Yagi et. a1., 1999; Zhang et al., 2014). The effect of physical activity on the functioning of the brain can be assessed by using event-related potentials reflecting cortical activities related to cognition (Pedroso et al., 2017). The aim of the present study was to investigate the effect of physical activity on P300 and working memory.

To fulfill the aim of the present study, 43 participants in the age range of 40 to 60 years were taken and were divided into four groups based on their physical activity. They were divided into four groups, i.e., active (A), moderately active (MA), moderately inactive (MI) and inactive (I) based on The General Practice Physical Activity Questionnaire (GPPAQ). The auditory P300 was recorded using the stimulus odd ball paradigm with /da/ as frequent and /ba/ infrequent stimulus. The response of P300 was analyzed for onset latency, peak latency, offset latency and the peak amplitude. Working memory was assessed using digit span and digit sequencing tests digit span tasks, forward and backward digit span was assessed and in digit sequencing tests, ascending and descending digit test were done.

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### APPENDIX 1

**Informed Consent Form**

Title: Effect of Physical Activity on P300 and Working Memory

I have been informed about the aims, objectives and the procedure of the study. The possible risks- benefits of my participation as a human subject in the study are clearly understood by me. I have understood that the research aims at obtaining voluntary responses from me and the total duration of this would be around 1 hour. I am also aware that by subjecting to this investigation, I will have to give time and that these assessments may not result in any benefits to me. I understand that I have a right to refuse participation or withdraw my consent at any time. I am interested in participating in the study and at this moment give my written consent for the same.

I, , the undersigned, give my consent to be participant of this research.

Signature of Individual Signature of the Researcher (Name and Address)