



“COMPARATIVE STUDY OF EXECUTIVE COGNITION IN DEAF AND NORMAL HEARING SCHOOL GOING SUBJECTS BETWEEN THE AGES OF 8 TO 18 YEARS”

Physiology

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ABSTRACT

Background : As it is very challenging to survive for normal human being in today's life for making his earning, we can imagine how difficult it would be for a physically challenged individuals. But if we study the literature we get to know that if one sense is deficient, the power other sense is enriched. As in deaf, the visual area of brain is more developed and widened as compared to normal hearing subjects.

Objectives : To study the executive cognitive function by comparison of

- 1) Eriksen Flanker Test (EFT) - Response Time
- 2) EFT - Accuracy

Materials and methods: The study population of 8 to 18 years of age and sex matched school going children. Group A were 20 deaf students, Group B were normal hearing 20 students under the criteria of inclusion and exclusion. Informed written consent and assent was taken. The ability of attentiveness is assessed by noninvasive computer based standardized test named Eriksen flanker test by using software cognitivefun.in. Statistical analysis was done by using GraphPad Prism 7 online software by Unpaired Student-t test.

Results : Comparison of response time and accuracy was highly significant ($p < 0.001$) between the groups which was suggesting that deaf children showed markedly faster response in execution of task as well as are more accurate in the Eriksen Flanker test as compared to normal hearing children.

Conclusions : When flankers were presented, it was seen that deaf children gave more correct answers than the hearing children. These findings suggest that deaf individuals may allocate their visual resources over a wider range than those with normal hearing. It may represent an alternative pathway for information transfer between different sensory and/or motor cortical areas.

KEYWORDS

Execution, Cognition

INTRODUCTION :

The ability to hear sound is one of the fundamental ways that organisms are able to perceive the external environment. This mechanical signal is converted to neural signals and relayed to the brain. The brain receives and interprets these signals and the result is what we perceive as hearing.

Neurocognitive testing, also known as neuropsychological testing, is a comprehensive evaluation of the patient's cognitive status by specific neurologic domains, i.e., memory, attention, problem solving, language, visuospatial, processing speed motor, and emotion. Testing is mainly comprised of paper and pencil tasks and/or computerized tasks, done in a one-on-one setting. It is physically non-invasive.

In profound deafness, detection of changes in the environment and orientation of attention occurs primarily through vision.

Here, in this study we will focus on visual perception and attentiveness along with the cognitive evidence in relation to auditory deprivation. It is known that physically challenged deaf children are more reserved, stiff, emotionally detached, less stable, shy, serious, dependent, withdrawn and have poor home and health adjustments than normal individuals. The facilities (helping aids, trained teachers, necessary physical training and exercises etc.) in special education institutes are quite inadequate as compared to normal schools. This study shows their special abilities and greater need of facilities for their development and growth.

METHODS

This is descriptive observational study. The subjects participating in this study were healthy school going children between the ages 8 to 18 years. They were grouped into two groups: Group A (cases): consisting of individuals with severe-to-profound deafness ($n=20$) and Group B (controls): consisting of individuals with normal hearing ($n=20$). Study was done in the school set up under the guidance and with the help of teachers who will explained the procedure to the participants in Proficient and fluent sign-language or best way of their understanding method.

Initial evaluation

Baseline information was collected: age, gender. For the participants

normal or corrected-to-normal vision was confirmed by Landolt's chart. Normal color vision was confirmed by Ishihara chart. Analysis for hearing were tested by hearing test: for Group A, Binaural hearing loss of at least 90 dB by Pure-tone Audiometry with average at 0.5, 1 and 2 kHz with or without hearing aid, from birth or from the age below 3 years were done and for Group B auditory threshold not less than 25 dB hearing level (pure-tone average at 0.5, 1 and 2 kHz) confirmed by Watch test.

Ethics :

Institute Ethical committee approval was taken prior to the study. Permission of Head of Department of Physiology was taken to conduct the study at school set up. Permission from the principal of respective schools were taken before conducting the study.

Informed verbal consent of each parent or guardian of the child was taken before the interview and nature & purpose of study was explained to them.

Privacy, confidentiality and anonymity were maintained throughout the study.

Study Protocol

Stimuli was presented and recorded the response using a MacBook Air laptop with 11.6-inch (diagonal) LED-backlit widescreen display monitor. Stimulus and collection parameters are programmed using cognitivefun.in online freeware. Participants seated directly in front of the monitor with their chins resting firmly in a chin rest at a distance of 18 in. The height of the chin rest was set 10 inch. above the table so that the eyes of each participant would be directly in front of the computer screen. The height of the chin rest was kept constant across participants. However, participants were able to adjust the height of the chair if they want. Eriksen flanker test for executive cognition: Identify the direction of center arrow as fast as possible and press the arrow key that matches the arrow in the centre. Number of correct answers for 20 stimuli and response time (in milliseconds) taken is recorded.

STATISTICAL ANALYSIS

Statistical analysis was done using GraphPad Prism 7 online software. Mean and standard deviation were calculated. p value less than 0.05 was taken as statistically significant.

RESULTS

TABLE NO. 1 : Sexwise Distribution Of Study Population

	Male	Female
Cases	12	8
Control	5	15

Chi-square = 3.683, D.F. = 1, p value is 0.0550, Statistically not significant.

TABLE NO. 2 : Age Wise Distribution Of Study Population

AGE (yrs)	CASES	CONTROL
MEAN \pm SEM	11.32 \pm 0.4284	11.91 \pm 0.4695

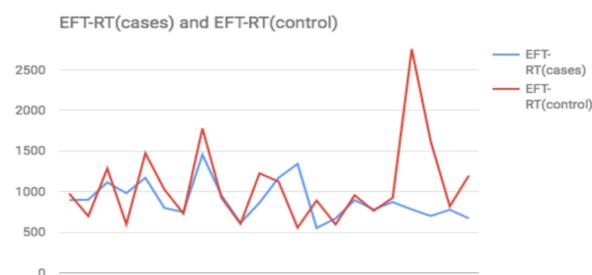
p=0.3578, using unpaired t-test, P value<0.05 is considered significant

TABLE NO.3 : Comparison of EFT-Response Time between Cases and Control in millisecond for 20 number of stimuli

GROUPS	CASES	CONTROL
MEAN \pm SD	895.8 \pm 232	1069 \pm 503.6

Unpaired t test, p value= 0.0008, CI = 95%, Statistically HIGHLY significant

(p < 0.05, Statistically significant)



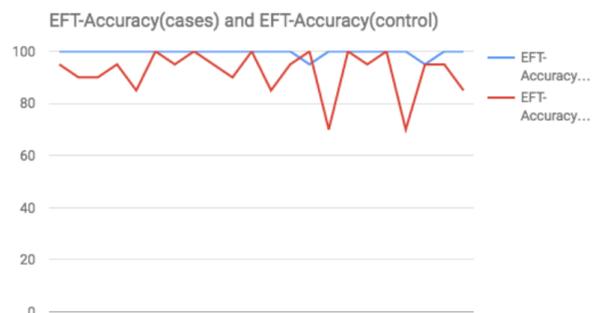
GRAPH NO. 1 : Comparison of EFT-Response Time between Cases and Control in millisecond for 20 number of stimuli.

This was suggesting that deaf children showed markedly faster response in execution of task as compared to normal hearing children.

TABLE NO. 4: Comparison of EFT-Accuracy between Cases and Control in percentage for 20 number of stimuli

GROUPS	CASES	CONTROL
MEAN \pm SD	99.55 \pm 1.471	92.05 \pm 8.682

Unpaired t test, p value= 0.0001, CI = 95%, Statistically HIGHLY significant



GRAPH NO.2 : Comparison of EFT-Accuracy between Cases and Control in percentage for 20 number of stimuli.

This data suggest that deaf children are more accurate in the Eriksen Flanker test as compared to normal hearing children.

DISCUSSION

The purpose of this study was to compare the neurocognitive functions of individuals with auditory impairment and those of controls without any impairment in order to investigate whether individuals who lack one sense have an enhanced ability with the other. The neurocognitive functions were tested using vision as the sensory stimuli.

The executing of any task means ability to complete or accomplish any assigned task. Eriksen Flanker test is test for executing a task which is focuses on attention and ignorance of flanker stimuli. The stimulus given was visual stimulus, which we found gave better accuracy and response time in hearing impaired children when compared to normal hearing children.

Like blindness, deafness has been shown to lead to crossmodal plastic phenomena. To date, adaptive plasticity has been largely shown only under circumstances where visual attention and/or processing of the peripheral visual field are manipulated. This phenomenon may be related to the connections existing between visual and auditory cortices, as evidenced in the primate, which involve primarily portions of visual cortex representing the periphery of the visual field. Similarly, crossmodal recruitment of auditory cortices appears to be more specific to particular stimulation paradigms such as visual motion and sign language. It is of interest to note that visual stimuli which are most effective at eliciting activation in typically auditory cortex are dynamic in nature, perhaps reflecting the well-known capacity of auditory cortex to process temporal cues.

Present study suggested that since individuals with auditory impairment rely mostly on visual modality to alert and analyze functions, they might have a different mechanism for organization of visual attention compared to those without any impairment. The similar findings as were seen as in study done by Parasnis and Samar (1982). Parasnis and Samar (1985) later reported that signers who were auditory impaired were better than signers without any impairment at redirecting visual attention to stress the performance of the attention system, which supports this hypothesis of compensation.

This supports **present study** findings in test of attention. As we have found the deaf children more attentive in terms of correct response to executive test like Eriksen Flanker task. In **present study** we have found that Eriksen Flanker test showed better response time and accuracy in hearing impaired children as compared to normal hearing children. This findings supports the study of Neville and Lawson (1983), and Neville, et al. (1983) suggest that individuals with auditory impairment had superior visual perception skills compared to those without any impairment.

As in **present study** the inclusive criteria for deaf population included the children who are trained in sign languages. This could be additive factor for better performance in deaf children. Therefore it is very necessary to provide the special schools with well trained and effective teachers and speech therapist. The development of children as early as possible is very crucial for their further progress in cognitive as well as motor performance.

Smith, et al. (1998) reported that the visual abilities of individuals with auditory impairment were better than those of individuals without any impairment, and that the reason for this was that individuals with hearing loss used their visual attention skills for lip reading or to read sign language. The findings of Smith, et al. (1998) was **similar to our study**, which involves sending stimuli with a central and non-verbal stimulant.

CONCLUSION

When flankers were presented, it was seen that hearing children gave more incorrect answers than the hearing impaired children. The hearing group had significantly more errors on this task than the deaf group, suggesting that the deaf participants may have been more deliberate in their responses. These findings suggest that deaf individuals may allocate their visual resources over a wider range than those with normal hearing. It may represent an alternative pathway for information transfer between different sensory and/or motor cortical areas. The learning may allow a faster transfer and even an integration of information across modalities. Interestingly, recent studies demonstrating enhanced attentional abilities in deaf subjects supporting cross modal plasticity with learning.

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