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Assessment the Plasticity of Cortical Brain Theory through Visual Memory in Deaf and Normal Students

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Abstract

***Background*:** The main aim of this research was to assess the differences of visual memory in deaf and normal students according to plasticity of cortical brain.

***Materials and Methods*:** This is an ex-post factor research. Benton visual test was performed by two different ways on 46 students of primary school. (22 deaf and 24 normal students). The *t*-student was used to analysis the data.

***Results*:** The visual memory in deaf students was significantly higher than the similar normal students (not deaf).While the action of visual memory in deaf girls was risen in comparison to normal girls in both ways, the deaf boys presented the better action in just one way of the two performances of Benton visual memory test.

***Conclusion*:** The action of plasticity of brain shows that the brain of an adult is dynamic and there are some changes in it. This brain plasticity has not limited to sensory somatic systems. Therefore according to plasticity of cortical brain theory, the deaf students due to the defect of hearing have increased the visual the visual inputs which developed the procedural visual memory.

Introduction

The nervous system is amazingly flexible during its developmental process in the embryonic period. This system is able to make changes in its structure, the type and the localization of its cells and the interrelations between the cells [1]. Making local contact at times during sensitive periods may be affected by external effects in a way that the organization of the brain may change [2]. Recent evidence has shown that new neurons are produced in the brains of adult mammals also [3]. The brain's Plasticity is not confined to somato-sensory systems; rather, it is also observed in the auditory system. Vision is one of human's most important sensory channels of acquiring information and storage it in the memory [4].

One reason why people vary in memory is their individual differences in receiving and processing information. People with sensory deficits, e.g. the deaf, receive and process visual and audial information differently [5]. Further research on deaf people and their cognitive abilities, particularly memory, seems to be essential. Studies have shown that damage to sensory organs (such as eyes or ears) prevents the brain from functioning naturally. Nevertheless, various studies indicate that the human brain has the capability to improve the damages sense by strengthening others; hence, the powerful audial stimulations in the blind and the remarkable visual activity in the deaf [6].

The reason for the term plasticity lies in the fact that although effects in appearance are not brought about through physical re-organizations in the brain's neural circuitry, when main information is erased from an area in the brain, secondary information is activated from adjacent parts in the sensory map, which take over the work of the damages area. It should be noted, however, that the mechanism for these changes is yet unclear [7, 8]. Gazzaniga et al. made damages to each retina to discover what would happen to the visual maps based on the new data obtained from the visual cortex. They found that the receptive dimensions for the adjacent neurons to the damaged area almost immediately begin to change. After a few months, through stimulation of the areas in the vicinity of the damages area in the retina, the area that had become inactive starts to respond [9].

This is why the deaf people attempt to remember what they see very well; in other words, they are enhancing their visual memory [10-12]. When it comes to deafness, deaf people develop their cognition through vision [13]. According to the compensation theory concerning the Plasticity of the nervous system, the shortcomings deaf people have in audial experiences are compensated for due to the enhancement of their visual cognition [14]. Fine has shown that those who are born deaf compensate for their disability to some extent by means of certain cognitive skills. He states that the increased secondary vision in the deaf can be explained by the plasticity of the brain [14]. This research intends to reiterate the extraordinary visual capabilities of the cerebral cortex in deaf people, which can give therapists the opportunity to allow deaf students to receive education in a happier and more independent atmosphere.

Materials and Methods

The present research is based upon non-experimental, causal-comparative research methods. The statistical population included all deaf and hearing students studying at, respectively, primary schools for deaf and normal children in Shirvan in the school year 2008-2009. Among the hearing students, 24 were selected using random clustering methods based on the school districts in Shirvan and were subjected to accurate auditory evaluation. On the other hand, in the deaf group, all of the students available at the Shirvan School for Deaf Children were considered for the study due to the limited number of deaf students; from these students, those with eyesight problems were removed from the study, and the others were homogenized with the hearing students by means of the Cattell intelligence tests administered to both groups. Eventually, the deaf group consisted of 22 students. Out of the total 46 students involved, 25 were girls and 21 were boys.

It should be noted that due to the limited number of deaf students available, replication in the group of hearing students was done based upon characteristics such as age, gender, birth rank, grade, academic situation and family economic situation.

Furthermore, the students' families were provided with the necessary instructions on the day of the test. Some of these instructions included preventing the students from being subject to stress at home or at school the day before the test and no heavy examinations being given the day prior to the test. Students were not to take any particular medication before going to bed, have suitable nutrition and get enough sleep the day before the test. School officials were asked to avoid, while guiding the students to the test room, creating the impression for the two groups that the test would be difficult. Moreover, the atmosphere of the test room was asked to be equal for both groups. These measures were taken to control interfering, bothering variables.

Nevertheless, since these tests needed to be conducted in conformity with test administration standards, one of the serious limitations in this research was communicating with deaf students, which was overcome thanks to the use of special teachers for deaf children. The other limitation the research faced, however – the lack of deaf students available was to some extent controlled by using the sample at hand and replicating the second group according to them [15].

One of the measurement tools used in the present research was the Cattell intelligence test, which was administered to homogenize deaf and hearing students according to their intelligence variables.

In this study, Cattell test Scale 2 Form B, designed for children of ages 8-13, adults with education lower than high school diplomas and most people over 50 years of age, was used. It should be noted that this test consists of three forms.

Cattell Culture Fair is a test whose content is as independent as possible from cultural factors; thus, it evaluates fluid intelligence. This test consists of four subtests [16].The validity coefficients calculated for the Cattell test Scale 2 using methods such as re-administering, replication forms, halving and Cronbach's alpha were, respectively 0.7, 0.77, 0.84 and 0.77 [17]. Using the halving method in his research, Sufi reported a stability coefficient of 0.82, which is significant at the 0.01 level [18].

The second - and the main - tool used in this research in order to evaluate and compare visual memory knowledge in deaf and hearing students is the Benton visual test, a research and clinical means designed for assessing visual cognition, visual memory and capabilities.

This test consists of three parallel forms (C, D, and E); each form has 10 designs, and each design has one or several shapes. The time required for each form is 5 minutes. There are four ways to administer the test in order to study cognition and memory.

Administration A: Each design is shown to the examinee for 10 seconds, after which he/she should immediately begin rebuilding it in his/her, memory.

Administration B: Each design is shown to the examinee for 5 seconds, after which he/she should immediately begin rebuilding it in his/her, memory.

Administration C: In this form of administering the test, the examinee is to create a design as similar as possible to the original shape; the card is at the examinee's disposal as long as he/she is busy doing this.

Administration D: Each design is shown to the examinee for 10 seconds. The examinee is to keep the picture on the card in his/her mind for the next 15 minutes, and then rebuild from memory.

In this research, administration methods A and D were used to measure the visual memory of deaf and hearing students in Form C. It should be noted that among the four methods mentioned above, administration method C (copying) is used for assessing visual cognition, whereas other methods (D, B, and A) are used to measure visual memory. Scoring the test is done in two ways – scoring based on the number of correct copies and the number of mistakes. The scores show a high correlation ($r = 0.95$), and the selection of the scoring method is up to the researcher. If scoring is done based on the number of mistakes, 64 special mistakes are generally possible. These mistakes are categorized into six main groups: elimination, deformation, stagnation, rotation, misplacement and error in degree [19].

Hasanpour evaluated the validity of the test using discriminant and correlational validities as 21 percent for the correct scores and 18 percent for the wrong answers. By re-administering the tests, he also evaluated the reliability as 77 percent for the correct scores and around 95 percent for the wrong answers [19]. Descriptive statistical indices and also the student's *t*-test were used in order to analyze the data of the research.

Results

For the sake of brevity, descriptive data have not been included. As seen in the table 1 for the type-A Benton test, there is a significant difference between the hearing and deaf students' wrong answers on the A Benton test. With a certainty of 99 percent and $p \leq 0.01$, it can be accepted that the deaf students' hearing handicap has improved their performance on the type A Benton test (t=429.4 and $p \leq 0.001$).

Furthermore, the findings showed a significant difference between the two groups of deaf and hearing students on the D Benton visual test; the deaf students had lower error rates on the D test ($p \leq 0.001$ and t=079.5). The complete results can be seen in the the D-type Benton table 1.

To find out whether there was a significant difference between the error scores for the hearing and deaf girls in the D Benton visual test, the average scores were first calculated for the two groups of deaf and hearing girls; then, the student's t-test has been used to compare the two groups. Considering the test statistic, it can be concluded that the zero assumption at a 5 percent level of significance is overruled, and it can be accepted with 99 percent certainty that there is a significant difference between the wrong answers given by hearing and deaf female students in the A-type Benton visual test (see the table 1 for the A-type Benton for girls). As indicated in the table 1 for the D-type Benton test for girls, there is a significant difference between the wrong answers given by deaf and hearing girls in the D Benton visual test; there is also a significant difference between the wrong answers given by deaf and hearing girls in this test. Using the t-test statistical method (the results of which have been displayed in the A-type Benton for the boys), it was found that there is no significant difference between the wrong scores given by hearing and deaf male students in the A Benton visual test.

The results for the t-test on the wrong scores given by deaf and hearing students on the D Benton visual test and the calculated average points for the two deaf and hearing groups have been displayed in the D-type Benton for boys. According to the test statistic and the probability (p=0.01), it can be concluded that there is a significant difference between the wrong answers given by hearing and deaf boys in the D-type Benton test, and that the deaf students show a lower rate of errors.

Table 1. The results of A and D-types of Benton test

		Mean±SD	*p*-Value
Benton A	Hearing	18.71±4.4	0.0001
	Deaf	11.59±6.4	
Benton D	Hearing	18.65±3.9	0.0001
	Deaf	11.05±6.1	
Benton A Girls	Hearing	18.07±5.26	0.0001
	Deaf	8.18±2.52	
Benton D Girls	Hearing	17.86±4.28	0.0001
	Deaf	9.55±4.37	
Benton A Boys	Hearing	19.60±2.95	0.079
	Deaf	15.0±7.31	
Benton B boys	Hearing	19.70±3.27	0.01
	Deaf	12.55±7.29	

Discussion

The results of this study show that the deaf are superior to the hearing in performances related to visual memory. Moreover, both the boys' and the girls' groups proved to have better visual memory performances than their peers in Benton visual retention tests. The obtained results are in conformity with other studies.

One study has stated that when speaking of deafness, the improvement of visual perception must also be taken into consideration; as shown by various reports, the Plasticity of the brains of the deaf causes the lack of audial arousals be compensated for by developments in visual cognition and sight memory [13].

In his research, Golden compared visual memory between deaf and hearing students in equal conditions concerning age group, intelligence and the time allowed to answer the questions [20]. He concluded that if deaf students become familiar with the correct procedure for answering the questions on the test, they will do better than the hearing students; if they are not correctly briefed on how to answer the questions, they will have results similar to or worse than the hearing students [20].

As stated in previous studies, visual abilities in deaf people are the result of their lack of hearing; hence, the deaf heavily depend on sign language rather than their visual memory.

These researchers believe that the deaf are more able to pay attention to particular objects, persons and topics; such an attention is, of course, visual, for the human brain is capable of being flexible in senses and compensate for sensory limitations with other intact senses. Furthermore, these studies indicate that people born deaf or blind are more capable of using their other senses well the remarkable touch and auditory discrimination in people who are born blind and the high visual perception and pictorial retention in people who are born deaf are good examples. The researchers of this study also see the Plasticity of the cerebral cortex - the process of plasticity - as the reason for this [8, 9].

In their research concerning a comparison of various types of episodic and semantic memory in two groups of deaf and hearing students, Mousavi and Kormi Nouri have shown that deaf students generally have memory imperfections in some memory functions compared to hearing students [21]. They state, however, that the main problem the deaf suffer from is in retention, and that through support with signs and signals, their memories perform not only without imperfections, but even better than that of the hearing. These researchers also point out the various types of memory tests that can prove effective upon test results [22, 23]. Most studies show that the same as blind people partially compensating their inability to see by enhancing their hearing, the deaf also reduce their audial deprivation by means of increasing their visual performances, which proves the brain's powers of adjustment and Plasticity in such conditions. However, it is still not fully known how the damaged areas (cortex) of the brain receives the information it requires from other intact areas of the cerebral cortex [23].

Since deaf children account for the largest part of education for handicapped children in most countries, and these children are a part of mainstream education [24], this study has endeavored to achieve more accurate findings on deaf people's other cognitive abilities by means of psychological instruments as well as focusing upon the Plasticity of the cortex and proving its function in the deaf - particularly at earlier ages - in visual memory and adapting them to the findings of previous studies.

As a whole, it can be concluded that when an individual loses one of his/her senses, the enhancement of other senses to some extent makes up for the sensory deprivation; likewise, deaf people tend to compensate for their lack of hearing through increased visual functions such as visual memory or accuracy of sight.

This is, of course, in conformity with the findings made by other researchers. Many studies, while paying close attention to the use of visual signs by the deaf, have emphasized visual attention and visual memory in this group; despite the little and very limited use of verbal signs by the deaf, it is observed that the use of visual and non-verbal signs is much more common among them. In fact, the deaf attempt to memorize what they see very well, thus strengthening their visual memory. Apart from the acquired visual skills for the deaf - particularly those who use sign language - we can say that the deaf have certain strategies for using memory which are of course difficult to describe [12].

Hence, based on this feature, therapists as well as teachers and educational officials can devise curriculums in order to enhance and upgrade the dimensions of a stronger sense in such students. Thus, we will achieve the highest possible level of performance and efficiency in these students and also in adults; moreover, such ability enhancements will help the process of safeguarding and improving their well-being. In general, taking such measures can decrease disabilities, handicaps and their consequences and indirectly affect the social and mental health of families considerably.

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Authors’ Contributions

All authors had equal role in design, work, statistical analysis and manuscript writing.

Conflict of Interest

The authors declare no conflict of interest.

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