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Cognitive intervention through virtual environments among deaf and hard-of-hearing children

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ABSTRACT

The lack of the auditory sense in the hearing-impaired raises the question as to the extent to which this deficiency affects their cognitive and intellectual skills. Studies have pointed out, that with regard to reasoning, particularly when the process of induction is required, hearing-impaired children usually have difficulties. They experience similar difficulties with their ability to think in a flexible way. Generally, a large body of literature suggests that hearing-impaired children tend to be more concrete and rigid in their thought processes. This study aimed at using Virtual Reality as a tool for improving structural inductive processes and the flexible thinking with hearing-impaired children. Three groups were involved in this study: an experimental group, which included 21 deaf and hard-of-hearing children, who played a VR 3D game; a control group, which included 23 deaf and hard-of-hearing children, who played a similar 2D (not VR game); and a second control group of 16 hearing children for whom no intervention was introduced. The results clearly indicate that practising with VR 3D spatial rotations significantly improved inductive thinking and flexible thinking of the hearing-impaired.

KEYWORDS

Cognitive intervention, induction, flexible thinking, virtual environment, virtual reality, deaf, hard-of-hearing, children

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INTRODUCTION

'Thinking' has many definitions and models. One of them defines thinking as: *a mental seeking process, which is directed to forming data system according to a conscious goal, and right or wrong criterion* (Glanz, 1989). Thinking includes many processes. This study addressed the inductive processes among hearing-impaired children. Trochim (1996) defined the inductive thinking as a bottom-up process, which goes through the stages of making specific observations, creating testable hypotheses that lead to generalization and creating generalized conclusions. Glanz (1989) reports on 'induction of laws' – a process in which induction leads to the inference of common rules that dictate the order of components within a given system. It is possible to identify the rule by formulating it verbally or by adding components to the system continuously or by both formulating and adding components. Researchers (e.g. Friedman, 1985; Hilleyeist and Epstein, 1991) have found that reaching a reasoned conclusion is a process in which hearing-impaired children have some difficulties.

Although it may seem that hearing-impaired people are similar to normal hearing people in the structure of their thoughts and in their cognitive capabilities, auditory and language deficiencies may lead to lower verbal functioning and an overall lack of appropriate experience. The consequences, it is suggested, can be lower results in reaching reasoned conclusions using inductive processing (Friedman, 1985; Hilleyeist and Epstein, 1991).

The goal of this study was to examine the influence of an intervention programme while practising spatial rotation in a Virtual Environment (VE), on the inductive thinking among hearing-impaired children. Another aspect which the study focused on was Flexible Thinking. Sternberg and Powell (1983) have defined flexible thinking as the ability to look at things from different angles. They point out that during adolescence the ability of the child to think flexibly is more prominent than in earlier years. This flexibility is expressed in two opposite directions. On the one hand, children exhibit a better ability to think consistently and adhere to methods that proved effective in solving problems. On the other hand, when necessary, they are capable of changing their work methods and exchanging them for more successful methods. Flexible thinking is one of the most important characteristics of intelligent behaviour. Guilford (1967, 1970) claimed that flexible thinking is the ability to create a flow of ideas while changing direction or correcting information.

Researchers studied the ability of hearing-impaired children to think flexibly both verbally and in terms of shapes. This study relates solely to non-verbal ability. Saraev and Koslov (1993) examined 100 deaf children and 164 hearing children between the ages of 7 and 12 years. One of their findings shows lesser ability in creative imagination among the deaf, and rigidity in their way of thinking. Moreover, King and Quigley (1985) claim that hearing children surpass deaf and hard-of-hearing children in creative ability.

Laughton (1988) compared the traditional approach of teaching art to teaching programmes geared to developing creative ability. He studied 28 deaf children between the ages of 8 and 10 years, who took part in one of two programs for 12 weeks. The children were tested in the Torrance formal test before and after the intervention. It was found that there was a significant improvement in flexibility and originality among the children who studied according to the new programme. Laughton (*ibid.*) also claims that by means of the appropriate teaching strategy it is possible to develop creative aptitudes with deaf children and to help them to become less concrete and rigid in their thinking.

In recent years, however, there have been growing efforts for intervening in the cognitive capabilities of the deaf children to improve their intellectual functioning.

This trend is backed by the new assumption that deaf children have the same intellectual potential as normal hearing children. Researchers believe that they may fulfil this potential if the environment, the instructions and the available materials are adequate and motivate learning. Thus, some researchers tend to emphasize the importance of intervention programmes as a mean to improve the cognitive achievement of hearing-impaired children (Gruler and Richard, 1990; Huberty and Koller, 1984; Martin, 1991).

The goal of such cognitive intervention programmes is to assist the deaf child and promote certain thinking capabilities. Some of the intervention programmes are using technology. Researchers report on the correlation between computerized activity and enhancing cognitive skills for the hearing-impaired. They believe the computer has a hidden potential that can enhance the intellectual skill of the learner, develop self-study strategies, enhance the ability to solve problems and develop thinking skills at all ages (Samaras, 1996). One can perceive the computer as a tool, which provides thinking and learning strategies. For example, Volterra *et al.*(1995) examined the interaction of hearing-impaired children (aged 6–16) with the computer. They found that if deaf children were given a learning context that allowed information with or without language through visual modelling, the children's motivation for learning would increase.

The purpose of this study was to examine whether it is possible to improve the induction process and the flexibility of thinking in hearing-impaired children with the help of a leading-edge technology, namely Virtual Reality (VR).

Pantelidis (1995) defines Virtual Reality as: *an interactive multimedia environment, based on the computer, in which the user is assimilated into, and becomes an active participant in the virtual world.* This technology can present information in a three-dimensional format in real time, so that the user becomes an active participant in the environment that communicates interactively without the use of words. Virtual Reality makes it possible to convert abstract symbols to more concrete ones by providing a perspective on processes that is not possible in the real world (Darrow, 1995; Durlach and Mavor, 1995; Osberg, 1995; Pantelidis, 1995).

This study is unique since, as far as we are aware, it is the first attempt to join the need of a cognitive intervention programme for hearing-impaired children with a 3D immersive Virtual Environment.

PARTICIPANTS

Forty-four hearing-impaired children aged 8 to 11 years participated in this study. The hearing loss in the better ear of the children ranged from 50 dB to 120 dB, with mean loss of 88.62 dB (Table 1). They had no additional handicaps. The children came from integrated classes. In these schools the hearing-impaired children are taught primarily in small segregated classes, but also participate in general school activities. In some cases, some of the classes are taken with normal hearing children of their age. After taking into consideration the children's background, the participants were randomly allocated to one of two groups, an experimental group and a control group. The two groups were matched for age, gender, degree of hearing loss, cause of deafness and equivalent prior experience with computers (see Table 1).

An additional group of 16 normal hearing children were selected in order to establish whether, in general, hearing-impaired children achieve lower results than normal hearing children in inductive skills. The ages of the hearing children ranged between 8 and 10 years (average age 8:8). The sample of 60 children, therefore, comprised the following three groups:

Table 1: Mean grade level, hearing loss level and gender

		Grade		Age	Hearing loss (dB)		Gender	
Group	N	M	SD	M	M	SD	Boys	Girls
Experimental	21	3.00	0.84	9:1	89.29	21.23	9	12
Control 1	23	3.60	1.35	9:6	87.95	18.30	12	11
Control 2	16	3.83	0.83	8:8	–	–	8	8
Total	60	3.42		9:2	88.62		29	31

- 21 hearing-impaired children who served as the experimental group;
- 23 hearing-impaired children who served as the control group;
- 16 hearing children who served as a second control group.

PROCEDURE

Each participant in the experimental group was given 15 minutes once a week over a period of three months to play unguided a VR 3D Tetris game, involving the rotation of objects in space. Children in the hearing-impaired control group played with a regular non-virtual 2D Tetris game involving rotation for the same period of time. The subjects of the normal hearing control group were given no rotation tasks.

The experimental and control groups were evaluated before and after the experiment using two tests: Cattell and Cattell's (1965) subtest *Structural Sequences*, and Torrance's (1966) subtest *Circles*. This was done in order to establish whether practising rotation exercises with VR has an effect on the structural inductive processing and on the flexible thinking of the participants.

Cattell and Cattell's (1965) subtest *Structural Sequences* has 12 items, each containing a series of three shapes that differ from each other according to a discernible pattern. The participant has to infer the pattern by induction and choose the missing fourth shape out of five possible choices. For each correct answer the participant receives 1 point. The range of possible scores is from 0 to 12. Cattell and Cattell (*ibid.*) report a reliability score of over 0.80 with groups of students.

The Torrance (1966) subtest *Circles* was used in order to study whether practice in the rotation of three-dimensional objects, which requires the ability to view objects from different angles, had an impact on the flexibility of thinking with the participants. The test includes verbal and non-verbal tasks. We used the non-verbal tasks owing to the verbal insufficiency of the participants. The test includes 36 identical circles. The participant has to produce as many associations as s/he can to each circle. The participant accumulates points only if the circle is an integral part of the painting. The number of the different categories is equal to the amount of points that the participant receives. This test has been carried out many times over the years and has received the high score of 0.90 in reliability (*ibid.*)

Instructions to the tests were given orally, in conjunction with sign language, to ensure that all children fully understood the requirements. The normal hearing participants did not receive an intervention programme and therefore took the test only once. We are now conducting other studies to test the impact of VR on similar and other thinking skills with normally hearing children. The results of these studies will be reported in the future. Since the focus of this study was an intervention programme with the hearing impaired, we did not see fit to complicate its procedure with a sketchy measurement.

VIRTUAL ENVIRONMENT

The VT hardware (Figure 1) used in this research was a virtual reality interactive game, with software that is able to create a three-dimensional environment. The software (Figure 2) included three games (*Tetris*, *Puzzle* and *Center-Fill*), in all of which the objective was to carry out certain demands via control over three-dimensional blocks. The participant had to fill a 3D block with various shapes made up of smaller blocks. The participant had to put the dropping blocks in the right place, and accordingly, accumulate points. In order to accumulate more points, the user had to act both accurately and rapidly. The optimal solution was reached by a combination of selecting the most appropriate shapes and rotating them as required. The participant had to complete the blank locations on the 'board' according to an induced rule, which s/he had inferred, and fit the appropriate shape in the blank locations. Similarly, the control group I practised a similar routine using a *Tetris*-style 2D (not VR game).

Figure 1: Virtual Boy – Nintendo

Figure 2: Three – Dimension Rotation

RESULTS

The primary assumption of this study was that before practising with spatial rotations, a distinct difference would be found between hearing-impaired children and normal hearing children in their inductive thinking of spatial structure. After practising in the VR mode, it was expected that the experimental group would improve to the point where no distinct difference would exist between them and the group of normal hearing children. That is to say, the scores of the hearing-impaired children in the experimental group will be similar to the scores of the normal hearing children. In order to test this hypothesis, a one-way analysis of variance was conducted for the *Index of Structural Induction* (ISI) in a before and after paradigm (Repeated Measures of Variance). In order to test the significance of change in each group, we have run a T-test before and after the intervention.

Table 2 exhibits the ISI scores for the three groups – the experimental group, the control group of the hearing-impaired and, finally, the control group of the normal hearing. In addition, Table 2 exhibits the results of the variance's analysis.

Significant differences were found in structural inductive thinking between the two control groups (deaf and hearing) and between the experimental group and the two control groups (see Table 2). After the intervention, the scores achieved by the experimental group of hearing-impaired children reached the same level as those of normally hearing children, while the scores of the hearing-impaired control group remained low.

The second hypothesis of this study was that a clear difference would be found between the experimental group of hearing-impaired children and the control group of hearing children in their ability to think flexibly before practising spatial rotation, by means of the VR game. After the practice, in contrast, the ability to think flexibly improved in the experimental group to such an extent that no clear difference was found between this group and the control group of hearing children. That is to say, the scores of the deaf and hard-of-hearing children in the experimental group were similar to those of the hearing children in this examination. In order to verify this, we conducted a one-way analysis of variance.

Table 2: SI, by group and time

Time		(1) Experimental HI	(2) Control HI	(3) Control Hearing*	F-scores	Contrasts significance
Before	M	5.23	5.13	10.93	F(2,57) = 62.48 P < 0.001	P(1,2) = n.s. P(1,3) < 0.001 P(2,3) < 0.001
	SD	2.04	2.00	0.57		
	N	21	23	16		
After	M	11.00	5.65	10.93	F(2,57) = 102.04 P < 0.001	P(1,2) < 0.001 P(1,3) = n.s. P(2,3) < 0.001
	SD	0.77	2.08	0.57		
	T	–16.1	–2.02	–		
	N	21	23	16		

Notes: HI = hearing-impaired.

*The normal control hearing group was tested only once. The results were entered for comparison with the 'before' and 'after' experimental results.

Table 3 presents the averages in the measurement of the *Index of Flexible Thinking* (IFT) of the three research groups. The table indicate that prior to the intervention there was a considerable gap in flexibility of thinking between the research group of hearing-impaired children (both experimental and control groups) and the control group of hearing children. The difference favoured the hearing children. No considerable difference was found between both research groups of hearing-impaired children (experimental and control groups). In contrast, after the practice, a clear difference was found between the experimental hearing-impaired group and the hearing-impaired control group in their ability to think flexibly, favouring the experimental group. A smaller but clear difference was found between the experimental group and the control group of hearing children, that is the children in the experimental group improved their achievements significantly but did not reach the level of the hearing children in this index.

DISCUSSION

One of the objectives in educating hearing-impaired children is to stress with them the importance of nurturing independent thinking; and here one question to be asked was: how can educators do this in a manner that will encourage and motivate the young children to be involved in an intervention programme designed to improve their cognitive achievements?

Studies have measured some improvements of skills with deaf people following adequate learning, practicing and training (Gruler and Richard, 1990; Martin, 1991). However, most of the current intervention programmes do not exploit the great possibilities available with today's technology, especially the leading edge technology of VR. Therefore, this study aimed at using VR as a mean for improving structural inductive processes and flexibility of thinking with hearing-impaired children. As such, this has become one of the first attempts to use VR technology to improve the cognitive skills of the hard-of-hearing population.

The current research focused on two main fields, namely structural induction (ISI) and flexible thinking (IFT). The results of this study point to a distinct difference in structural induction's ability among hearing-impaired and normal hearing children before practising VR, with the gap in favour of the normal hearing participants. This

Table 3: IFT by groups and time

Time		HI experimental	HI control	Hearing control*	Model P,F	Group P
Before	Average	7.05	5.91	23.00	F(2,57) = 177.92 P < 0.001	P(1,2) = n.s. P(1,3) < 0.001 P(2,3) < 0.001
	SD	2.85	3.50	2.37		
	N	21	23	16		
After	Average	18.10	5.96	23.00	F(2,57) = 102.04 P < 0.001	P(1,2) < 0.001 P(1,3) < 0.001 P(2,3) < 0.001
	SD	5.76	3.47	2.37		
	N	21	23	16		

Notes: HI = hearing-impaired

*The control group of hearing children took the tests once only, that is the data in the table was copied from 'before' to 'after'.

finding reflects other studies that have similarly found that deaf and hard-of-hearing children have difficulties in the inductive processes and need assistance in this skill (Friedman, 1985; Hilleyeist and Epstein, 1991). The improvement of the structural inductive skills of the experimental group while exploiting an immersive VR 3D game was such that no distinct difference remained between the hearing-impaired and the normal hearing control group after the intervention. The hearing-impaired control group, however, who had no VR training, still maintained low scores. The gap between them and the normal hearing group remained the same even after the 2D practice.

The second research assumption was that hearing-impaired children tend to be rigid in their way of thinking, as compared with hearing children. This study found a clear difference in the ability to think flexibly among hearing-impaired children and hearing children before practising, to the advantage of the hearing children. This finding is reinforced in previous studies which found that deaf and hard-of-hearing children possess lesser ability in creative imagination and have a tendency to rigidity in their thinking (Saraev and Koslov, 1993). After practice, the children in the experimental group improved in their ability to think flexibly with the help of the VR, and the gap between them and the hearing children narrowed. In contrast, the control group of hearing-impaired children continued to score poorly and the gap between them and the hearing children did not narrow. This finding echoes that of Bunch (1987), who claimed that if hearing-impaired children are afforded opportunities to develop their potential and the teachers are provided with methods of encouraging creative thinking, then deaf children will progress and will reach the level of hearing children.

These findings show a clear priority for the immersive 3D VR intervention over that of a 2D ‘routine’ (not VR). We may assume that these findings occurred due to the differences between the two types of exercises. While the children in both groups played the *Tetris* game for similar lengths of time, the only distinction between them – the 3D virtual reality game vs the 2D one – seems to have made all the difference.

A reasonable way to explain these results is through the essence of VR technology. VR technology creates a ‘pre-symbolic’ communication in which the users can communicate with imaginary worlds with no use of words. This creates a world charged with sights, voices and feelings distinct from language and syntax (Passig, 1996). The hearing-impaired children who used this technology were able to bring out their potential with no language or auditory limitations. VR does not limit the designer in the manner in which the information is presented or limit his/her movements, so that the user of the technology is able to immerse within the learning environment (Pantelidis, 1995). This is how probably the deaf children where immersed in the game. They felt as if they where moving the pieces, searching for the right ones, using inductive procedures and rotating them; that is, the abstract became less vague and more concrete. Different studies in the field of VR found that this immersion upgrades the interface with the senses and improves the understanding of abstract terms by converting them into more concrete ones (Darrow, 1995; Osberg, 1995).

One key attribute of VR is its interactivity – it allows users to take a very active role. The increased liveliness and interactivity allows the user to become part of a virtual world. This tool is able to present information in 3D form and in real-time. It is an elaboration of a reality in which a person can hear, look, touch and bond with objects and images. This technology allows the user to take an active role in the environment and not stay a passive bystander (Bricken and Byrne, 1992; Heim, 1992; Osberg, 1995; Powers and Darrow, 1994). It is probable that hearing-impaired children require a more active involvement in learning processes than normal hearing children do (Marzam, 1998) and VR is the tool to provide it.

Another way to explain the results is in terms of transfer strategies or tendencies from one field to another in order to explain a certain problem or phenomenon (Tishman and Perkins, 1996). The results of this study suggest that a transfer occurs from a rotation activity to a structural induction activity and to a flexible thinking activity. It seems possible to link rotation and induction or flexible thinking via mental imaging. Induction skills require the use of imaging (Millar, 1989; Daniels, 1984). Also, to perform rotation, it is necessary to use imagery. In order to rotate an object, one needs to imagine first what will be the position of the object after the rotation (Piaget, 1971). Researchers note the close link between creativity and imagination. The ability to solve problems in a flexible way requires the use of imagery (Kaufmann, 1985; Kosslyn' 1980).

SUMMARY

This study suggests a two-tier contributions to the literature dealing with the education of hearing-impaired children.

1. The structural inductive processes and flexible thinking ability of the hearing-impaired, using a virtual environment, can be improved.
2. The structural induction skill of hearing-impaired children can reach the levels of normal hearing children.

Even though the literature has suggested that some degree of achievement could be reached with regard to hearing-impaired children's thinking skills, this study demonstrated that it could be reached in a much simpler and attractive way through VR technology.

REFERENCES

BRICKEN, M. and BYRNE, C. M. (1992). *Summer Student in Virtual Reality: A Pilot Study on Educational Applications of Virtual Reality Technology* [online]. University of Washington HIT Lab. Available: http://www.hitl.washington.edu/projects/education/

BUNCH, G. O. (1987). *The Curriculum and the Hearing-Impaired Student*. Boston, Mass.: College Hill Press.

CATTELL, R. B. and CATTELL, A.K.S, R.B. & Cattell, A. K. S. (1965). *Culture Fair Intelligence Test: Scale 2*. Champaign, Ill.: Institute for Personality and Ability Testing.

DANIELS, R. R. (1984). *Selected Progressive Competencies for Education of the Gifted*. Kansas City, Kans.: Emporia State University.

DARROW, M. S. (1995). 'Increasing research and development of VR in Education and special education', *VR in the School*, 1, 3, 5–8.

DURLACH, N. I. and MAVOR, A. S. (1995). *Virtual Reality*. Washington, DC: National Academy Press.

FRIEDMAN, J. (1985). 'Classification skills in normally hearing and oral deaf preschoolers: a study in language and conceptual thought'. In: MARTIN, D. S. (Ed.) *Cognition, Education and Deafness*. Washington, DC: Gallaudet University Press, pp. 70–72.

GLANZ, J. (1989). *Thinking as a Three-directional Function*. Tel Aviv: Gomeh.

GRULER, H. E. and RICHARD, L. (1990). 'Active work and creative thought in university classrooms'. In: SCHWEBEL, MAHLER, and FAGLEY (Eds) *Promoting Cognitive Growth over the Life Span*. Hillsdale, NJ: Lawrence Erlbaum, pp. 137–164.

GUILFORD, J. P. (1967). *The Nature of Human Intelligence*. New York: McGraw-Hill.

GUILFORD, J. P. (1970). 'Creativity, retrospect and prospect', *Journal of Creative Behavior*, 4, 3, 149–168.

HEIM, M. (1992). *The Metaphysics of Virtual Reality*. New York: Oxford University Press.

HILLEYEIST, E. and EPSTEIN, K. (1991). 'Interactions between language and mathematics with deaf students: defining the 'language–mathematics' equation'. In: Martin, D. S. (Ed.) *Advances in Cognition Education and Deafness*. Washington, DC: Gallaudet University Press, pp. 302–307.

HUBERTY, T. S. and KOLLER, J. R. (1984). 'A test of the learning potential hypothesis with hearing and deaf students', *American Annals of the Deaf*, 78, 1, 22–28.

KAUFMANN, G. (1985). 'A theory of symbolic representation in problem solving', *Journal of Mental Imagery*, 9, 2, 51–70.

KING, C. M. and QUIGLEY, S. P. (1985). *Reading and Deafness*. Boston, Mass.: College Hill Press.

KOSSLYN, S. M. (1980). *Image and Mind*. Cambridge, Mass.: Harvard University Press.

LAUGHTON, J. (1988). 'Strategies for developing creative abilities of hearing-impaired children', *American Annals of the Deaf*, 133, 4, 258–263.

MARTIN, D. S. (1991). *Advances in Cognition Education and Deafness*. Washington, DC: Gallaudet University Press.

MARZAM, I. (1998). Social interaction, social cognition and social-moral reasoning in 4th, 5th and 6th grades children with hearing impairment who are fully included in regular education. Unpublished MA dissertation, School of Education, Bar-Ilan University, Ramat-Gan, Israel (in Hebrew).

MILLAR, R. (1989). *Doing Science: Image of Science in Science Education*. London: Taylor AND Francis.

OSBERG, K. M. (1995). 'Virtual reality and education: where imagination and experience meet', *VR in the Schools*, 1, 2, 1–3.

PANTELIDIS, V. (1995). 'Reasons to use VR in education', *VR in the Schools*, 1, 1, 9.

PASSIG, D. (1996). *Virtual Reality in Education*, School of Education, Bar-Ilan University, Ramat-Gan, Israel (in Hebrew).

PIAGET, J. (1971). *Mental Imagery in the Child*. New York: Basic Books.

SAMARAS, A. P. (1996). 'Children's computers', *Childhood Education*, 72, 133–136.

SARAEV, S. A. and KOSLOV, V. P. (1993). 'Characteristics of pathological personality development in deaf children', *Journal of Russian and East European Psychiatry*, 26, 1, 54–60.

STERNBERG, R. J. and POWELL, J. S. (1983). 'The development of intelligence'. In: MUSSEN, P. H. (Ed.) *Handbook of Child Psychology*. New York: Wiley., pp. 341–419.

TISHMAN, S. and PERKINS, D. (1996). The computerized Classroom. Jerusalem: Branco Weiss Institute (in Hebrew).

TORRANCE, E. P. (1966). *Torrance Tests of Creative Thinking*. Trenton, NJ: Personnel Press.

TROCHIM, W. M. (1996). *Deductive and Inductive Thinking* [online]. Available: http://trochim.human.cornell.edu/kb/dedind.htm [May 16, 1997].

VOLTERRA, V., PACE, C., PENNACCHI, B. and CORAZZA, S. (1995). 'Advanced learning technology for a bilingual education of deaf children', *American Annals of the Deaf*, 140, 5, 402–409.

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