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Problem Solving: A Comparison of Hearing-Impaired and Hearing Individuals

John Luckner
University of Northern Colorado

PROBLEM SOLVING: A COMPARISON OF HEARING-IMPAIRED AND HEARING INDIVIDUALS

JOHN LUCKNER, Ed.D.
University of Northern Colorado
Greeley, CO

Abstract

The purpose of this study was to compare the performance of a group of hearing-impaired young adults with a group of hearing individuals with regard to the number of moves and the time used to complete a problem solving task. Results indicated that the hearing group were able to solve the problem in less moves and faster than the hearing-impaired group. Suggestions for intervention and future research are presented.

Problem solving is a skill that everyone uses throughout their lives. It is the means by which individuals use previously acquired knowledge, skills, and understanding to satisfy the demands of an unfamiliar situation (Krulick & Rudnick, 1988). Helping students to be better thinkers and to solve problems are fundamental goals of education (Gagne, 1980; Hunter, 1982). In fact, all learning can be viewed as a form of problem solving that involves analyzing a learning task and devising a strategy appropriate for that problem (Deery, 1989). Andre (1986) argues that "Much of education is intended to make people better problem solvers. The justification for teaching children to read, write, or reckon is usually couched in some variant of: These skills will be useful in solving problems later" (p. 169). Similar support with regard to the importance of problem solving was expressed by Lenz and Deshler (1990) who stated that "individuals who are successful have effective and efficient strategies for approaching and solving problems' (p. 84).

Given the importance of problem solving in our lives, it is discouraging to note the small number of writers and educators in the field of deaf education (e.g., Greenberg & Kusché, 1989; Martin, 1984; McGehee & Pendergrass, 1979; Quigley & Kretchmer, 1982; Rohr-Redding, 1985) who express concern about the deficiencies of hearing-impaired students in the area of problem solving. However, while numerous references exist in the literature about the difficulty that hearing-impaired individuals have solving problems, to date, there has not yet been any direct empirical investigation to substantiate this contention. If problem solving is an area of difficulty for individuals with hearing impairments then it is important to verify this area of concern and implement interventions to help hearing-impaired individuals develop problem solving skills.

The present study was undertaken as a step in developing a database that focuses attention on the problem solving skills of hearing-impaired individuals. Specifically, the purpose of this study was to compare the performances of a group of hearing-impaired individuals with a group of

hearing individuals with regard to the number of moves and the time needed to complete a problem solving task.

Method

Subjects

Subjects included 21 hearing-impaired students and a matched sample of hearing students attending school at a midwest university. Each subject volunteered to participate in the study. The hearing and hearing-impaired students were matched on the variables of gender, age, and race. The mean unaided hearing loss of the hearing-impaired subjects was 84 dB (range = 68 dB to 115 dB) in the better ear, averaged across the speech range. In all cases, hearing losses were either confirmed or suspected prior to 2 years of age. Each group was comprised of 13 females and 8 males; 12 members of each group were Caucasian, 8 were African/American and one was Hispanic. Subjects ranged in age from 17.6 years to 21.6 years with a mean age of 19.7.

The hearing-impaired students were enrolled in a program for young adults that focuses on improving academic, vocational, social and independent living skills. The school records of the hearing-impaired individuals as well as the staff who worked with them indicated that there were no secondary handicapping conditions or intellectual impairments that might negatively influence their performance on the task.

The hearing students were drawn from two sources. Twelve were enrolled in a program for non-traditional students taking a career planning course. Nine were special education majors taking an introduction to special education course. All hearing students who were willing to participate in the study were asked to fill out a demographic information sheet. Those individuals who matched a hearing-impaired student on the variables of gender, age and race were administered the experimental problem-solving task.

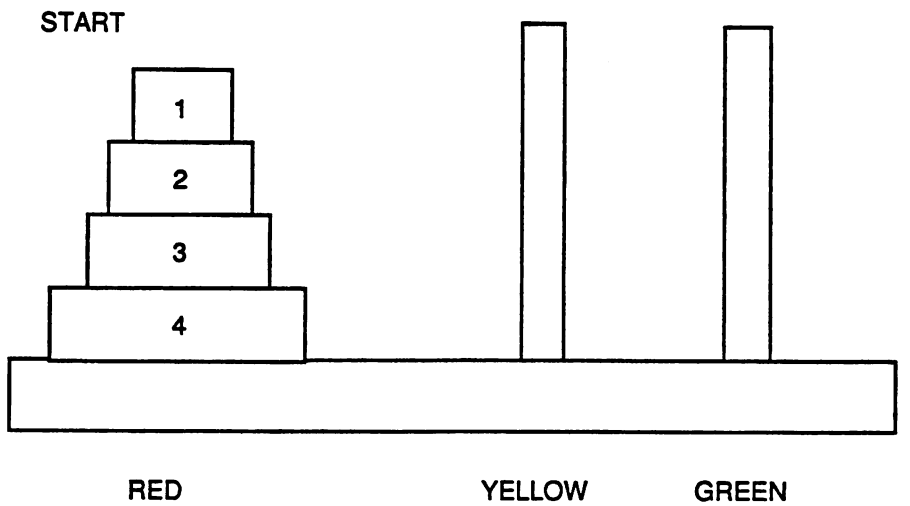
Materials

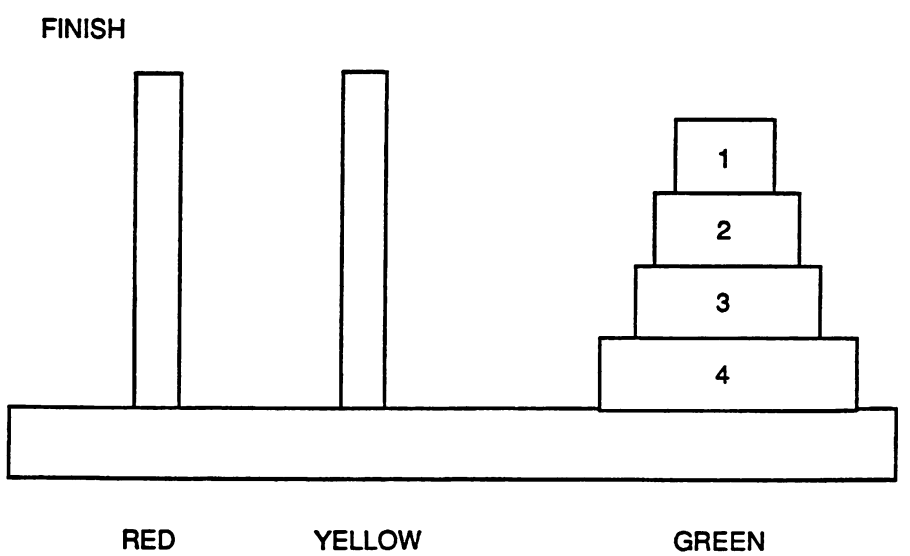
The problem-solving task used was the Tower of Hanoi puzzle (TOH) (see Figure 1). This task belongs to a class called transformation problems, which involve reaching a goal state through the execution of a series of moves. The task is unique in that subjects are able to develop an idea of good solution strategies with minimal experience. This problem-solving task was selected because it has been used in this type research in the past (Byrnes & Spitz, 1977; Gagne & Smith, 1962; Piaget, 1976, Simon, 1975; Wansart, 1990). Among the tower's assets are its nonverbal nature, which is especially appropriate for individuals with hearing impairments, and the fact that, by adding disks, it can be made increasingly more difficult.

The puzzle consists of three vertical pegs. On one of the pegs is a number of disks, graduated in size, with the largest disk on the bottom and the smallest disk on top, so as to form a pyramid. The task is to move the pyramid of disks to one of the empty pegs by moving one disk at a time and never placing a larger disk on a smaller one. There are a number of solution strategies for the TOH problems which, if correctly executed, will lead to minimum path solution of any standard problem. The minimum number of moves required to perform the transfer for the 4-disk problem used in this study is 15 moves.

The TOH puzzle has well-defined initial and final states, and a set of legal operations that, when applied in the appropriate sequence, can transform the initial state into the final state. Newell and Simon (1972) contend that these criteria conform to the definition of a well defined problem. The problematic aspect derives from the fact that the sequence of operations is not immediately apparent to problem solvers, but rather must be produced through some combination of trial and error, systematic search, and test planning. In its simplest version only two disks are used, requiring only three moves for a transfer. The complexity of the problem can be

FIGURE 1
THE TOWER OF HANOI PUZZLE





increased by using three, four, five or even six discs. Four discs were used in this study because of the age of the participants.

Design and Procedure

Testing was conducted by four professionals in the field of deaf education. Practice sessions and observations to assure consistency of presenting the directions and recording the scores were coordinated by the author. All experimental sessions were held in a private room where the experimenter (E) sat across the table from the subject (S). The puzzle was placed on the table between them with the red post always to E's left. At the beginning of the experimental session the experimenter introduced the puzzle and explained the directions. In addition to seeing the actual puzzle, each subject was shown a picture of the TOH in the starting and in the final position.

With the four disk problem placed in front of the participant, the E gave the following instructions. "I would like you to work this puzzle today. Have you ever seen a puzzle like this before?" If an S had worked the task before he or she was dismissed from the study. "I would like you to move this tower (E points to the discs) from this red post to the green post (E points to the green post) in the fewest number of moves possible and as fast as you can. There are a few rules that you must follow. You can only move one disc at a time. A larger disc cannot be placed on a smaller disc, and a disc cannot be held in your hand or placed on the table while another disc is moved. When you are ready go ahead and move the tower to the green post in as few moves and as fast as possible." The examiner then conducted all of the moves and used a stop watch to record the amount of time needed to complete the puzzle.

In this study a move was defined as any time that the subject picked up a disc and put it down again on any post, even the same post it was on at the beginning of the move. When S made an unacceptable move the E corrected the S by communicating that "it was an illegal move." Then the infraction was explained and S was helped to return the discs to their original position prior to the infraction. A trial encompassed all moves attempted from the initial placement of the tower on the start post until the subject succeeded in building the tower on the goal post. When a participant expressed a desire to give up they were encouraged to continue to try and solve the puzzle. All participants eventually solved the puzzle.

TABLE 1

MEANS, STANDARD DEVIATIONS, AND *T*-TEST RESULTS

Variable	Hearing		Hearing-Impaired		
	Mean	SD	Mean	SD	*t*-test
Number of moves	26.86	8.94	36.14	19.14	2.01*
Time (seconds)	107.62	75.58	224.29	204.91	2.45**

* $p < .05$

** $p < .01$

Results

Significant differences were obtained in t tests for both the number of moves and the time taken to solve the TOH problem. As can be seen by examining the means, standard deviations and *t* scores in Table 1, the hearing-impaired group used more moves to solve the problem and also took more time to complete the problem.

Discussion

The present study was conducted to investigate the problem solving skills of a group of young adults with hearing impairments as compared to a group of hearing individuals matched for age, race and gender. Specifically, the two groups were compared with regard to the number of moves and the time taken to solve the TOH problem. The results suggest that the observations noted by teachers of hearing-impaired students may be accurate. This is, students with hearing impairments do demonstrate greater difficulty solving a problem as compared to their hearing peers.

The results of this study must be considered with an awareness of the following limitations: subjects from this study are limited to a group of hearing-impaired young adults and, therefore, the conclusions should not be generalized to all hearing-impaired individuals. In addition, intelligence estimates were unavailable. Thus, the possibility that a difference in intelligence between the two groups may account for the differences in performance should be noted. Future research might test the effects of intelligence on performance differences between the two groups.

As stated earlier, the purpose of this study was to begin to develop a database that focuses attention on the topic of the problem solving abilities of individuals with a hearing impairment. The information gained from this study indicates that hearing-impaired individuals can solve transformation type problems. However, it takes them more time and more energy than their hearing peers to complete the task. It is recommended that this type of study be replicated to substantiate the findings and to determine if the results were specific to the particular sample obtained or influenced by other individuals or environmental variables. Additionally, it is suggested that a similar investigation be undertaken with younger students to examine their problem solving abilities. Research reported by Klahr and Robinson (1981) indicates that by the time hearing children are ready to enter first grade they have acquired the rudiments of general problem solving methods and they can apply those methods to a novel task. It would be valuable to investigate if hearing-impaired children demonstrate similar abilities, or do factors such as delays in language development, parental overprotection, or educational practices negatively affect their problem solving skills.

A final suggestion for future research would consider that effective problem solvers use a repertoire of strategies to interact with the problem at hand, before, during, and immediately after solving problems. Novice and poor problem solvers apparently do not develop this repertoire of strategies spontaneously (Jones, 1986). A line of inquiry should be undertaken that examines the presence or absence of strategies in the problem solving behaviors of individuals with a hearing impairment. If their behavior is strategic, what strategies are being used, and how do the strategies compare with those of hearing individuals. If their strategies are inefficient could their performance on problem solving activities be improved if they were instructed to use more appropriate strategies?

In summary, the main function of schools is to help students develop the attitudes, skills, and bodies of knowledge that will enable them to participate successfully in the general society

(Quigley & Paul, 1984). If, upon leaving school, hearing-impaired individuals are to be expected to assume responsibilities necessary for effective functioning, then schools must provide learning experiences that adequately prepare them for this role. In a society that is constantly changing and becoming more technologically complex it is essential that we assist hearing-impaired individuals in developing problem solving skills that can generalize to their lives beyond the classroom.

Many educators assume that expertise in problem solving develops incidentally as one experiences the daily events of life and solves many problems. While this may be true in part, the results of this study suggest that some hearing-impaired individuals are not skilled or fluent in solving problems. Over the past 10 to 20 years, many resources such as school programs and textbooks have been designed to help students improve their intellectual skills and problem-solving strategies (Gagne, 1980; Gardner, 1983; Glaser, 1984; Sternberg, 1984). Research reported by Martin (1984; 1985) and Haywood, Towery-Woolsey, Arbitman-Smith and Aldridge (1988) indicates that hearing-impaired students who are provided with experiences in cognitive education can improve their problem solving skills while simultaneously making gains in academic areas. Therefore, it may be time to consider systematic cognitive intervention as an integral component of the school curriculum for hearing-impaired students.

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