Bulletin of Special Education, 1985, 1, 191—230.
Taiwan Normal University, Taipei, Taiwan, R.O.C.

THE COMPARISON OF CONSERVATION ABILITIES BETWEEN HEARING-IMPAIRED STUDENTS AND HEARING STUDENTS

BEY-LIH CHANG

National Taiwan Normal University

ABSTRACT

This study was designed to compare the conservation abilities between hearing-impaired students and hearing students in Taiwan, R. O. C. Eighty hearing-impaired students drawn from a school for the deaf and 80 hearing students drawn from a public elementary school were the subjects of this study. They ranged in age from 9 to 12. There were 10 female students and 10 male students in each age level and group. The hearing-impaired subjects were prelingually and profoundly deaf without any other significant handicaps. They had hearing parents.

The conservation tasks involved number, liquid, weight, and volume. Each was presented using an attribute-specific instruction approach. The performance tests of the Wechsler Intelligence Scale for Children was used to evaluate the subjects' intelligence. The conservation tasks and the intelligence test were given to all subjects individually. A two-way (group and age) analysis of covariance, t-test, Newman-Keule test, Chi-square analysis, and proportional analysis were used to analyze all the data gathered. The significant level was set at .05.

It was found that excluding the effect of intelligence and the formal educational background (grade), there were still significant differences in conservation abilities of number, liquid, weight, and volume between hearing-impaired and hearing groups from age 9 to 12. The hearing-impaired students did not demonstrate conservation abilities of number, liquid, weight, and volume from age 9 to 12. However, the hearing students increased their conservation ability of number at age 10 and their conservation abilities of liquid and volume at age 12. Also, they did not demonstrate the conservation ability of weight until age 12. The conservation ability of the hearing-impaired students lagged behind hearing students by at least three years.

There were no significant differences in the types of justification givenby both hearing-impaired and hearing conservers and non-conservers. The results suggested that the curriculum design and teaching strategies for hearing-impaired students should be modified to an experiential besed curriculum and to student-centered teaching. Further studies were recommended to comprehend the developmental conservation ability of hearing-impaired students.

Introduction

Compared to hearing children, hearing-impaired children are handicapped by the differences in input. Hearing children easily process visual and auditory information simultaneously and store it in both modes (Bower, 1972; Paivio, 1972). In contrast, hering-impaired children must process most information in a visual mode. Study results from Kelly and Tomlinson-Keasey (1976) indicated that hearing children dual-coded words and picture stimuli which were visually presented, while a matched group of deaf subjects appeared to process all stimuli in a visual mode. They concluded that the exposure to a multi-faceted symbolic world for haering children seems to allow for easy integration of and transformation from the external world into a symbolic world. Hence, due to the lack of auditory input, hearing-impaired children may not be transforming information in the same manner as their hearing counterparts (Tomlinson-Keasey & Kelly, 1978). Myklebust (1964) also theorized that when one sensory perception is missing, it changes the integration of the others.

Traced by Piagetian developmental periods, Tomlinson-Keasey and Kelly (1974) pointed out the difference of cognitive development from the sensory motor period to the formal operational period between hearing-impaired and hearing children. In the sensory motor period, the first four months after birth, hearing babies exercise all five sensory pathways and then begin to modify their sensory abilities. For example, hearing babies will interrupt their hungry cries when another sound intervenes sufficientIy. But for hearing-impaired babies, the opportunities for feedback from themselves and the environment have been lost in one modality. The coordination of sensory pathways is the major advantage of the second phase in this period. Once the sensory motor structures are coordinated, children are equipped to efficiently and effectively process information about their worlds. But hearing-impaired children are not able to coordinate auditory input with any other senses. They rely mainly on visual, tactile, gestural, and olfactory cues to develop their cognitive structures. These modalitles provide incomplete data about their worlds. Hence, while babbling develops into speech in hearing children, it atrophies in hearing-impaired children at approximately 10 months of age (Lennenberg, 1967).

In the next stage, the preoperational period, which is usually about 18 months of age, there is an emergence of symbol (imagery) use with hearing-impaired and hearing children. Hearing children then attach a spoken symbol to an image and begin to form the symbol system known as spoken language. For hearing-impaired children of hearing-impaired

parents, the symbol which is attached to an image is a gesture. For hearing-impaired children of hearing parents not familiar with gestural symbol systems, imagery becomes difficult and frustrating. They have images and structures to code the world but they lack models for a well-developed gestural symbol system which would enable them to communicate. Hearing children vocalize themselves as feedback for understanding and practicing a skill or concept. Hearing-impaired children will sometimes sign to themselves while reading a book (Kent, 1971).

During the acquisition of language which is part of the preoperational period, children attach symbols to objects. Whether the symbol is a word or a gesture does not seem to be critical. Only after children feel secure in the meaning of the symbol they are able to manipulate that symbol with reference to objects. Hearing-impaired children's understanding of the meaning of symbolic and cognitive development in the preoperational period is very influenced by residual hearing (Meadow, 1975) and exposure to a clear and systematic symbol world which includes the communication modes and hearing states of parents, and children's formal educatlonal programs (Best, 1970; Meadow, 1975; Moores, Mc Intyre, & weiss, 1972).

After the preoperational period, according to Piaget, children enter the concrete operational period. Early studies about hearing-impaired children's performance of this period frequently have pointed out that there were delays of five years or more in the hearing-impaired children's development (Oléron & Herren, 1961, cited in Springer, 1977). More recently, greater efforts have been made to minimize the difficulties the hearing-impaired children have with the verbal system. The studies of Blank and Bridger (1966), Darbyshire and Reevers (1969), Furth (1964a, 1966), and Robertson and Youniss (1970) show a minimal lag between hearing-impaired and hearing subjects. In addition, these studies confirmed the hypothesis that the various thought processes typical of concrete operations are functional in hearing-impaired children. When problems with spoken symbol systems are minimized, the underlying struture of of hearing-impaired children's thought processes are very similar to the hearing children (Tomlinson-Keaey & Kelly, 1974).

Following the concrete operational period, children enter what Piaget calls the formal operational period. In this periood children will demonstrate ability to think abstractly and to consider suggested possibilities. Furth and Youniss (1971) compared the formal operations between deaf and hearing adolescents by three different operational tasks: a symbol logical task, a probability task, and a task generating all the possible combinations of several numbers. The hearing subjects performed better than the deaf subjects on all tasks.

In another study, Youniss, Furth, and Ross (1971) compared the logical symbology used by deaf and hearing children and adolescents. Results indicated that most deaf subjects initially performed at lower levels than their hearing peers. Many deaf subjects achieved the highest level when given additional training. These findings support their view that logical development can occur when there is no direct internalization of a societal language and that deaf adolescents are capable of propositional thought despite their language deficit.

Auditory deficiency has effects on hearing-impaired children's cognitivedevelopment from the sensory motor period through the formal operational period. Therefore, they might adapt the world in a different way.

The Comparison of Conservation Performance Between Hearing-Impaired and Hearing Students

Table 1 contains an up-to-date summary of conservation studies completed, comparing the performance of hearing-impaired and hearing students. According to this table, hearing-impaired students exhibit delays. Authors of these studies gave differerent reasons for these delays. Furth (1964b, 1971) reviewed 48 studies teported from 1964 to 1969 with hearing-impaired subjects in rule learning, logical symbols, Piaget-type, memory, and perception. He found that deaf children performed as well as their hearing age peers. Delays observed at young ages were often not observed at older ages. He also found that if cognitive tasks are represented with minimal requirements of verbal behavior, the thinking processes of deaf persons from preschool age to middle adulthood are found to be similar to those of

Table 1

Average Age Delays Observed in Deaf Subjects in Tests of Conservation Tasks

Author (date)	Deaf Age Delay
Oléron & Herren (1961)	6-8 years
Caouette (1964)	6-7 years
Furth (1964)	2 years
Furth (1966)	5 years
Piaget (1966)	2-3 years
Rittenhouse (1976)	5 years
Rittenhouse (1977)	2-8 years
Springer (1976)	1-4 years
Rittenhouse & Spiro (1979)	No difference
Watts (1979)	6 years
Rittenhouse (1981)	No difference

hearing subjects. He perceived that there is no significant difference between these two groups and attributed the delays to experiential factors. He concluded (1971):

> Comparative results on hearing controls are reported with a view to isolate the potential effects of linguistic deficiency on cognitive performance. The general conclusions of a previous review are confirmed in that the thinking processes of deaf children and adolescents are found to be similar to hearing subjects……Verbal processes could therefore not account for the emergence of cognitive skills even where developmental lags were noted. Occasional failures on certain logical tasks could be parsimoniously attributed to an unfavorable environment such as is observed in culturally different groups. (p. 58)

Besides the experiential factors, Furth (1966, 1973) also criticized the experimental procedures, for example: insufficient steps had been taken to communicate all the problems; and deaf subjects confused the relational terms "more" and "the same."

Caouette has completed the most extensive work, both a comparative (1964, cited in Springer, 1977) and a longitudinal (1976, cited in Springer, 1977) design in the area of the emergence of logical operations in the deaf in the period of concrete operations. He chose nine tasks which he felt would be easily administered to the deaf. Two of these tasks were conservation of area and liquid. He used the sign "+" and "=" for the concepts of difference and similarity and found that deaf children were lagging in development about 4 to 6 years. Springer (1977) commented that deaf subjects probably misunderstood the meaning of the signs. However, this result was the same as that obtained by Oléron and Herren (1961). All of them believed that the inferior performance of the deaf group is related to linguistic factors (Oléron, 1953, 1975).

Piaget (1966, cited in Springer, 1977) reported a summary of Affalter's work and supported the position that there is a minmal difference between hearing-impaired and hearinh groups on the conservation performance. He traced the inferior performance to the dfficulties of making the deaf children understand the task rather than language or experiential factors.

Youniss holds the same idea as that of Furth concerning the delays in cognitive development between hearing-impaired and hearing groups (1974a). In his stuyd with deaf subjects in Costa Rica (1274b), Youniss found deaf subjects to be advancing normally in operational development. He concluded:

> The role of language also appears to be noncritical for early operational development. Although unable to speak and communicate freely and understand written or oral speech, the deaf child still is not at a clear

intellectual disadvantage. The obvious social-educational limlts these deficits impose do not seem to deter development, at least up to formal operations. (pp. 215-216)

By averaging age delays in deaf subjects by tests of concrete operations from 1951 to 1967, Springer (1977) found that deaf children exhibit delays of 2.6 years. With this fact, he differs with Furth's conclusion "there is no significant difference between hearing-impaired and hearing groups." In addition, he found the data gathered comparing deaf and hearing groups on test of formal operations (Furth & Youniss, 1969, 1971; Furth, Youniss, & Ross, 1970; Ross & Hoemann, 1975) has also indicated significant lags; therefore, he confirmed the continuity of operatory retardation observed in the deaf group in conservation operations. His criticism was that Furth has taken too far Piaget's notion of language as serving a subordinate role to thinking. in his mind, although languge is subordinate, it is still necessary. According to Springer (1977), comparing the performance of deaf and hearing subjects on Piagetian tasks, he concluded that language and thought are related in a complex fashion during the age of concrete operations. So he placed emphasis on the importance of language in the development of conservation ability.

Rittenhouse (1976) studied the order of acquisition of conservation in deaf children Twenty-four profoundly deaf children from a residential school were presented with conservation problems of liquid, matter, weight, and volume. He found the order of acquisition, volume-matter-weight-liquid, was in disagreement with the order establishd by Piaget with non-handicapped children. At the same time there was a five-year delay in acquisition of both liquid and volume conservation. Although there was methodological weakness, his study seriously weakened Furth's position that deaf and hearing children do not essentially differ regarding cognitive development. Lessening the previous methodological defiency and using the attridute-specific instructions. Rittenhouse and Spiro studied the conservation in deaf and hearing children in 1979. In this study they found that there was not a statistically significant difference between the two groups under either conventional or attribute-specific instructions With respect to the order of acquisition of the four conservation forms. This finding supports the idea of the independence of language and cognition. Besides this, they found that when the conservation performance of the hearing subjects was compared to the conservation performance or the deaf subjects using attribute-specific instructions, the difference was a significant one in favor of the deaf subjects. So they concluded the extra-cognitive features of conventional Piagetian conservation problems are more problematic for deaf children than for hearing children.

In order to understand the influence of language on the development of conservation ability, Watts (1979) designed experiments for deaf, hard of hearing, and hearing children who ranged in age from 10 to 16 years old. In the conservation experiment, Watts found that the hearing group showed superiority over the deaf and hard of hearing groups. Comparing the deaf and hard of hearing group, up to age 14 the partially hearing group scored consistently better than the deaf group, and when the trend reversed with far more adequate language and better speech, the hard of hearing group performed less well than the deaf group. Watts concluded these results do not support a language based theory of development. In his study, there are two factors Which suggest that cognitive development does not appear primarily dependent on language, first, because of the similar performance between hard of hearing and deaf groups, and secondly, because of the improvement of the deaf group of conservation tasks without concomitant improvement in language. Watts (1979) concluded:

> The results have pointed that the development of deaf children's cognitive abilities is markably unaffected by the absence of verbal language. Valuable support has been given to the idea that if deaf children perform poorly on some intellectual tasks, this performance can be more adequately accounted for by experiential rather than linguistic deficiency. The suggestion that experiential deficiency more adequately explains performance in supported by the fact that the improvement of the deaf children on the conservation tasks took place without a concomitant improvement in the comprehension and usage of written language. (p. 55)

We see that in the aforementioned literature there are two basic positions. Furth and Younlss on one hand, authors who think there is no significant difference between hearing-impaired and hed hearing groups; and conversely, Oléron and Springer who hold the opposite position. With regard to the difference or delays between these two groups, three reasons have been advanced. Furth (1966, 1973), Piaget (1966), and Rittenhouse and Spiro (1979) argue that the communication during the test was the deciding factor, while Furth (1971), Watts (1979), and Youniss (1974a) argue instead for the experiential factors importance. Caouette (1976, cited in Springer, 1977), Oléron (1953), and Springer (1977) argue for the language influence. As research investigations reflect a more sophisticated understanding of procedural difficulties and the need for the clear communication of the task requirements, the results tend to show little or no difference between hearing-impaired and hearing groups (Moores, 1982). However, with respect to languge or experiential factors, it is still a debatable problem.

Dolman (1983) studied the relationship between syntactic develoment and concrete operations in deaf children and attempted to relate the findings to sign language background. Fifty-nine deaf subjects were classified into an "American Sign Language" (ASL) group, Who had a strong ASL background, a "manually coded English" (MCE) group, who had a strong MCE background, and a "no consistent language" (NCL) group, who had no consistent language beckground. Four kinds of tasks were used to test the operational level. Syntactic comprehension was used to test the subjects' syntactic abilities. The results indicated that operational abilities are related to language in deaf children. But there is no relationship at all between sign language background and operational ability which would support the Piagetian view (1973) that a strong language background is not sufficient to insure the development of operational structure. At the same time, the results demonstrated that ASL in itself or a consistent sign language background of any kind is not the critical factor in determining operational success. Under these conclusions, the belief that conceptual retardation of deaf child is related to their language abilities held by Oléron, Springer and others cannot be accepted totally. Hoeman and Briga (1980) commented on this problem and said:

> Deaf children lag behind hearing children at early ages but that the lags were often not observed at the older ages, a catch-up effect that is especially hard to reconcile with a linguistic deficiency hypothesis since deaf children's English-language deficit tends to increase during childhood. (p. 242)

For similar reasons it is difficult to accept the idea of an experiential deficit (Moores, 1982). In any case, the complex pattern of performances exhibited by deaf subjects, sometimes equal to hearing subjects and sometimes not, cannot be readily explained by any single factor, whether linguistic or experiential. In fact, the greatest problem existing in this field is that most research Studies are ex-post-facto design makking it difficult to determine which is the cause and which is the effect. Menwuk (1975) noted the difficulty of assigning causality in the areas of language and cognition. Therefore, the most acceptable statement about it is that language develoment is seen as a facilitator of cognitive development but not as a prerequisite nor as a necessity for cognitive development (Madsworth, 1970). The studies of conservation tasks concerning hearing-impaired children will be described in detail in the following section.

Studies of Conservation Tasks

Oléron and Herren (1961) studied the emergency of conservation of

weight and liquid in deaf children from 12 to 17 years of age and hearing children from 6 to 13 years of age. They devised nonverbal procedures which involved the substitution of pictures for the concepts "more, less, and the same." The results revealed that the average deaf child conserved weight at 14 years, 7 months, and liquid at 16 years, 7 months, compared to 8 years, 7 months, and 10 years, 7 months, for a hearing subject. There was a six to eight year delay in deaf subjects, However, the different age ranges of the two groups was a weakness of this study. According to the results, conservation of weight precedes conservation of lipuid for bpth deaf and hearing groups.

Furth (1964a) examined the conservation of weight with deaf and hearing subjects. He modified replication of Oléron's study (1961). Some modifications were indictated by his belief that in spite of Oléron's precautions and pretraining, the use of pictorial symbols introduced a new difficulty in assessing their conservation of weight. He attempted to make use of a more natural nonverbal symbol (gestural response) for the crucial concepts. For conservation of weight, Furth reported that deaf children aged 8 years, 6 months performed comparably to hearing children aged 6 years, 10 months. There was a two year delay, Compared to the delay obtained by Oléron and Herren (1961), the discrepancy was reduced in this study, Springer (1977) indicated that this study had serious methodolgical problems. He suspected that Furth's methodology was too difficult for 6 and a half year old deaf subjects. He also commented that Furth chose the data with prejudice.

Caouette (1964, 1974) reported a comparative study of conservation of surface and conservation of continuous quantity. In both tasks, he reported that the deaf showed delays of six or seven years. Whereas most hearing subjects conserved on both tasks by age 8, only 50% of the deaf subjects conserved by age 15.

Piaget (1966) reported a summary of Affolter's study. There was the same decalages, conservation of substance preceding weight which in turn preceded volume in both deaf and hearing subjects. Besides this, deaf subjects had two years' delay in conservation of surface area, and three years' delay in continuous quantity. Piaget concluded his summary by tracing the source of the observed delays not so much to language and general experience, but to the difficulties of making the deaf child understand the task.

Furth (1966) reprted a study of conservation of liquid. A complicated training task was used in the pre-experimental procedure. But he found that the deaf children between age 8 and 10 could get through it. According to the results, deaf children would be five years late in conservation of liquid. He concluded that "the age differences cannot be simply dismissed as minor variations, the particular testing procedure through which logical thinking is observed affects the result strongly so that the basic aim of the observation is overshadowed" (p. 124).

Rittenhouse has designed studies toinvestigate the order of acquisition of conservation in deaf children. In 1976, 24 residential school children ages 7-12 years with hearing losses of at least 80 dB (ISO) in the better ear were presented with conservation problems of liquid, matter, weight, and volume individually. Following each judgment, subjects were asked to explain their conservation or non-conservation judgment. All subjects were tested in the sequence of: liquid, weight, matter, and volume. The results indicated that there was no gender effect, and the order of acquisition was volume, matter, weight, and liquid. Compared to the hearing counterpart, there was a five year delay in conservation of liquid and volume in deaf subjects. The methodological problem in this study was the non-consideration for counter-balance in the testing procedure.

In 1977 Rittenhouse designed another study concerning the same problem. He lessened the methodological weaknesses in the preceding study and used a modified version which was called "attribute-specific condition" in this study. The difference between the conventional manner and the attribute-specific manner is that the latter makes the conservation attribute clearer. For this study, 40 deaf children age 7-19 years and 36 hearing children age 7-16 years were given the conservation problems. The results indicated that there was no significant difference between the two groups under either set of instructional conditions with respect to the order of acquisition of the four conservation forms. He also found that attribute-specific instructions significantly facilitated conservation acquisition in both groups. Besides this, he found that hearing-impaired students acquired the conservation ability of number at age 8, conservation ability of liquid at age 14, conservation ability of weight and volume at age 17. Compared to the hearing students, there was a two to eight years lag favoring hearing students.

Rittenhouse (1981) designed another study to verify the effect of attribute-specific instructions on the cognitive performance of deaf and hearing children. The performance of deaf and hearing children was compared on conservation tasks under conventional and attribute-specific instructions. According to the results, in the conventional instruction there were statistically significant differences between hearing and deaf children in favor of hearing children. But in the attribute-specific instruction there was no significant difference between the two groups. Rittenhouse concluded that the results of the study were viewed as

evidence that an apparent delay in deaf children is not a cognitive delay at all, but rather a problem with the language associated with a cognitive-type problem.

Rittenhouse and Spiro (1979) compared the conservation performance in day and residential school deaf children. Thirty-six hearing subjects, 24 deaf children attending day school programs, and 16 deaf children attending a state residential school were included in this study. The deaf subjects were prelingual and profoundly deaf with minimum IQ performance of 100 on a standardardized measure and no other handicaps, using the simultaneous method (oral and manual communication) in their educational setting. Conservation tasks of number, liquid, weight, and volume were presented under conventional and attribute-specific instructions to subjects.

They found that the attribute-specific instructions were significantly facilitative for the day school and the residential school deaf subjects. Using conventional instruction, of the 24 day school deaf subjects, 17% conserved on all four tasks, while no state residential school deaf subjects conserved on all four tasks. There was no significant performance difference between the hearing and day school deaf subjects; however, there was a significant difference between the hearing and the state residential deaf subjects in favor of hearing subjects. Using the attribute-specific instructions, there was no significant difference among the three groups. This indicated that the attribute-specific instruction did assist the subjects in making conservation decisions.

Springer (1977) carried out another study with regard to the performance of deaf and hearing children on concrete operations. Forty-eight deaf children were selected, aged 5 through 12 (6 children at each of the age levels). These subjects were profoundly deaf children of normal intelligence without any other handicaps. They were either prelingually deaf or of unknown etiology, and all of them were from hearing families. A matched hearing group was selected according to the same criteria except the hearing loss condition. Two conservation of number tasks were usd. One was a conservation of number of blocks and another one was a conservation of number of physical movements. The main finding of this study was that deaf subjects were delayed in relating to hearing subjects in age of attainment of conservation of number. There was a three-or four-year delay. This observed delay was less than those observed by other authors (e.g., Caouette (1964), Oléron (1961). Springer (1977) attributed the difference of the observed delay to his nonverbal methodological procedures, his conservation tasks, and great care in selecting deaf subjects. Springer concluded that the results were consistent with the importance of language in the development of conservation.

Following the Springer study, Watts (1979) investigated the growth of conservation in hearing-impaired students. Seventy deaf, 70 partial hearing, 70 hearing subjects between ages of 10 and 16 years were included. The tests of conservation covering cardinal numbers, discontinuous quantity, length, weight, and area were given to all subjects. He found the three groups quite dissimilar. The hearing group showed superiority over the deaf and partially hearing groups for all the tasks over the whole age range. Inspection of the scores showed that for the hearing group all tasks were roughly of equal difficulty, with the exception of conservation of area. For the hearing-impaired groups, the area task was the most difficult one, the number task was easier than the other tasks, and conservation of length was quite difficult.

From the studies described above, there are two major conclusions in comparing conservation performance of hearing-impaired subjects in comparison to hearing subjects revealed by the research. First, hearing-impaired children are delayed as compared to behind hearing children, but the extent of this delay varies from study to study. Secondly, as researchers understand the difficulties and the need for clear communication of the task requirements, the results tend to show little or no difference between hearing-impaired and hearing groups. All of these studies reflect different methodology, various criteria for selecting subjects, and different kinds of tasks. In other words, there are some weakness of problems in all of these studies. Therefore, it is difficult to compare the results and more difficult to get an affirmative conclusion from them.

The Purpose of the Study

These studies mentioned above have been conducted using hearing-impaired subjects with different characteristics such as degree of hearing loss, various ages of onset, and contrasting family backgrounds. In these studies they have also employed varied procedures and instruments. Study results from Furth (1966), Rittenhouse (1977, 1981), Rittenhouse and Spiro (1979), and Youniss and Furth (1965, 1966) indicated that there are no significant differences in the performance of conservation tasks between hearing-impaired and hearing subjects. However, study results from Bradshaw (1964) and Springer (1977) imply that there are delays observed in hearing-impaired subjects in tests of conservation tasks. The apparent contradictions of these results indicated the need for further study.

In Taiwan, the most often mentioned problem expressed by teachers of the hearing-impaired is that the curricula are not suitable for hearing-impaired students. The content is too difficult for them to learn (Ling, 1979; The Ministry of Education, 1981; Tsai, 1983). There are at least two reasons for this problem. First, preschool education for hearing-impaired children is not included in their compulsory education.. In other words, most hearing-impaired children in Taiwan do not receive early intervention or compensatory education. Compulsoty educational programs for hearing-impaired children are non-existant until age 6 or 7 when they enter elementary school (The Ministry of Education, (1981). Secondly, the curricula and textbooks used in the schools for the deaf are the same as those used in the regular public schools. Due to the lack of early intervention, hearing-impaired children are frequently not prepared for the content of the textbooks used in schools (Ling, 1981). There is a need to design proper curricula for this population (The Ministry of Education, 1981; Tsai, 1983).

In designing a curriculum for hearing-impaired students, it is necessary to understand hearing-impaired children's cognitive ability. It was found that no studied related to the cognitive development of hearing-impaired students in Taiwan. Recogning the need for designing the curricula for hearing-impaired students, the purpose of this study is to compare the conservation ability of hearing-impaired students and hearing students in Taiwan, the Republic of China, and investigate the development delay in hearing-impaired students. The following research questions will be answered by this study.

1. Is there a significant difference in conservation abilities between hearing-impaired and hearing students among various age levels?
2. Is there a significant difference in conservation abilities among hearing-impaired students at various age levels?
3. Is there a significant difference in conservation abilities among hearing students at various age levels?
4. What is the order in which hearing-impaired students acquire various forms of conservation?
5. What is the order in which hearing students acquire various forms of conservation?
6. Is there a significant difference in type of justification of conservation and non-conservation between hearing-impaired and hearing students at various age level?

The Hearing-Impaired Subjects

The hearing-impaired target population in this study met the following criteria:

1. They were currently enrolled in the Taipei Municipal School for

the Deaf.

2. The age levels were from 9 to 12.
3. They were prelingually deaf without any other significant handicaps.
4. They had a profound hearing loss (90 dB or more) in the better ear, averaged over 500, 1,000, and 2,000 Hertz.
5. They had hearing parents.
6. All subjects received hearing aids at age 5 to 6.
7. All subjects in this study use manual communication as their primary mode of communication which was introduced in the first grade (age 6 or 7).

The hearing-impaired subjects of this study were drawn from the target population of 101 hearing-impaired students by a random sampling method. Ten female and 10 male studens were selected from each age level. There were 80 hearing-impaired subjects totally.

The Hearing Subjects

The hearing target population of this study is the students aged 9, 10, 11, and 12 attending the Taipei Shuang Yuan Elementary School. They did not have any significant handicaps as determined by the school health examination. The hearing subjects were also drawn from the target population using a random number method. At each age level, 10 female and 10 male students were selected. Eighty hearing subjects were chosen in total. The composition of all subjects were shown as Table 2.

Table 2.

Composition of Subjects

Age in Yrs.	Hearing-Impaired No.	Hearing-Impaired Hearing Loss	Hearing No.	Total
9	20	M=101 dB	20	40
10	20	M=99 dB	20	40
11	20	M=100 dB	20	40
12	20	M=101 dB	20	40
Total	80	M=100 dB	80	160

Description of the Research Tasks

Piaget has been primarily concerned with the diagnosis of mental contents and abilities (Elkind, 1969). He wanted to explore children's spontaneous intellectual devlopment without the distortions of prior

assumption an adult infers from his own experience (Flavell, 1963). In other words, the children he studied were given an opportunity to respond to questions in their own words and in their own world. The main purpose of Piagetian tasks is to find out how children think and not how various factors affect the attainment of the concepts. Therefore, flexible diagnosis interview procedures are used in this field.

Conservation tasks including number, liquid, weight, and volume were used in this study. Each was presented using an attribute specific instruction developed by Rittenhouse (1977). This was a modification of the conventional approach. The difference in the attribute specific instruction implies that the subject has to take on a specific role. For example, in the number task, the researcher would say, "If you were real hungry, which row of candy would you choose to eat? In the liquid task, the researcher would say, "If you were real thirsty, which glass of water would you choose to drink?" The Piagetian four-step clinical procedure (equivalence, prediction, judgment, and justification) was followed under the attribute-specific condition. According to Rittenhouse (1981), the attribute-specific instructions significantly facilitated conservation acquisition in hearing-impaired and hearing subjects.

The pre-experimental instructions and the individual task materials and instructions are as follows:

> I have some games which are fun, but which do require you to think. After you tell me your answer for each game, I will ask you to explain to me why you chose that answer. Do not worry if the answer is right or not, just tell me why you chose that answer. Take your time on these games. Do you have any questions? (Rittenhouse, 1977, p. 22)

Number

Material: Three kinds of candy.

Instruction: Subject is shown three kinds of candy and asked: "Which of these three do you like best?" The subject's choice will then be used in the task.

Step 1: Equality--"Is there as much candy in this row as in this row or does one row have more candy than the other row?"

Step 2: Prediction--"Suppose you are real hungry now and you want to have a lot of candy to eat; however, you can have only one of these rows. If I make this row longer (researcher indicates), would you rather have these candies to eat or these candies (unextended row) to eat or will they have the same number so it doesn't matter which row you pick to eat?"

Step 3: Judgment--Researcher makes the extension mentioned in Step 2. "Now remember you are real hungry and you want to have a lot of candy to eat; however, you can only eat one of these rows. Would you rather have this row to eat (the extended one) or this row to eat (the comparison row) or do they have the same number so it doesn't matter which row you pick to eat?"

Step 4: Justification--"Why do you think it doesn't matter which row you pick to eat?" (conservation) or "Why did you pick this row to eat?" (non-conservation) (Rittenhouse, 1977).

Liquid

Material: Two drinking glasses (8 oz. each); one taller, thinner drinking glass (8 oz.).

Step 1: Equality--"Is there as much water in this glass as in this glass, or does one glass have more water than the other glass?"

Step 2: Prediction--"Suppose you are real thirsty now and want to drink a lot of water and you can have only one glass of water to drink. If I pour this glass of water into this one (Researcher introduces a third glass which is taller and thinner than the other two), would you rather have it (the tall, thin one) to drink or this glass of water to drink (the comparison one), or would they have the same amount of water, so it wouldn't matter which glass you choose to drink?"

Step 3: Judgment-Researcher makes transformation. "Now remember you are still real thirsty and you want to drink a lot of water; however, you can have only one of these glasses to drink. Would you rather have this glass (the tall, thin one) to drink, or this glass to drink (the comparison one), or do they have the same amount of water, so it doesn't matter which glass you choose to drink?"

Step 4: Justification-"Why do you think it doesn't matter which glass you pick to drink? (conservation) or "Why did you pick this glass to drink?" (non-conservation) (Rittenhouse, 1977).

Weight

Material: Two balls of clay (3 oz. each); a scale.

Prior to the actual testing in this task, the researcher made sure the subject knew how a scale worked (e.g. heavier items cause the scale's weight-indicator to move further to the right).

Step 1: Equality-Researcher gives two balls of clay to subject and asks him to judge their weight (Researcher demonstrates by moving both hands in an up-and-down motion as if trying to judge weight). "Is one ball of clay as heavy as the other ball, or is one ball heavier?"

Step 2: Prediction-Researcher places one of the balls on the scale and marks its weight on the face of the scale and points this out clearly to the subject, then removes the ball. "If I change this ball (the remaining on) into the shape of a banana, would it make the scale indicator go here (points to the right of the marking) or here (to the left) or here (on the mark)?"

Step 3: Judgment-Researcher makes the deformation as stated in Step 2. Researcher reminds the subject of the significance of the mark. "If I put this banana on the scale, would the scale indicator go here (points to the right of the marking), here (to the left), or here (on the marking)?"

Step 4: Justification-"Why did you say 'here'?" (Rittenhouse, 1977).

Volume

Material: A beaker (32 oz.); two balls of clay (3 oz. each).

Prior to the actual testing in this task, researcher demonstrates water displacement by submerging an object in the water in the beaker.

Step 1: Equality-Researcher has two balls of clay of equal size and weight and asks subject if they are the same. The subject is encouraged to handle them to judge their weight and dimension.

Step 2: Prediction-Researcher places one of the balls in the beaker one-half filled with water and marks the point or level to which the water rises, and points this out clearly to the subject. The researcher then removes the ball. If I changed this ball (the remaining one), into the shape of a banana, would the water rise to here (above the mark) or here (below the mark) or here (on the mark)?"

Step 3: Judgment-Researcher makes the deformation as stated in Step 2. The researcher reminds the subject of the significance of the mark. "If I put this banana in the beaker, would the water rise to here (above the mark), or here (below the mark), or here (on the mark)?"

Step 4: Justification-"Why did you say 'here'?" (Rittenhouse, 1977).

Scoring

One point was given for a correct response at prediction (Step 2), judgment (Step 3), and justification (Step 4). Each task had a potential maximum score of 3. Total maximum score was 12. Subjects scoring 0 and 1 were classified as non-conserver for the specific form of conservation.

Subjects scoring 2 and 3 were classified as conserver for the specific form of conservation (Rittenhouse, 1977).

Procedure

The conservation tasks and the performance tests of the Wechsler Intelligence Scale for Children, Revised (WISC-R) which was standardized in Taiwan in 1979, were given to all subjects individually. The performance tests of the Wechsler Intelligence Scale for Children Revised have been the most reliable intelligence test for hearing-impaired children (Levine, 1974; Sullivan & Vernon, 1979). All tasks and tests were administered during May, 1984. Each subject required 15 to 20 minutes for the presentation of the conservation tasks. Considering the counterbalance of the conservation tasks and the performance tests (WISC-R), half of the subjects in each group and age level were given conservation tasks first, and then performance tests of the Wechsler Intelligence Scale for Children. Half of the subjects were given the intelligence test first and then conservation tasks. The four tasks of conservation were also administered in counterbalanced order.

The researcher was the administrator of the conservation tasks for all subjects. There was an interpreter (a teacher at the school for the deaf) when tasks were given to the hearing-impaired subjects. Two teachers at the school for the deaf administered the intelligence test to the hearing-impaired subjects using total communication (sign language). Three students majoring in deaf education administered the intelligence test to the hearing subjects.

Data Analysis

Scores from the conservation tasks were considered as interval data. the two-way (group and age) analysis of covariance (ANCOVA) was used to test if there is a significant difference in conservation abilities between groups and ages. Newman-Keuls test and t-test were employed to study all post-comparisons including two main variables (group and age) as well as the various interaction of these two variables. Chi-square analysis was used to test if there is a significant difference in frequency of acquisition of various forms of conservation between hearing-impaired and hearing subjects at each age level. Propositional analysis was used to test if there is a significant difference in percentage in the type of justifciation between hearing-impaired and hearing subjects.

RESULTS

As shown in Table 3, the mean scores obtained by hearing-impaired students increased with age until age 12, then dropped. The mean scores made by hearing students continued to increase as they advanced in age.

Table 3

Means and Standard Deviations for Group and Age of Conservation Ability

Age in	Hearing-Impaired			Hearing		
Years	n	Mean	S. D.	n	Mean	S. D.
9	20	2.30	3.21	20	6.45	4.04
10	20	3.25	3.43	20	6.70	3.87
11	20	3.30	3.78	20	7.00	4.29
12	20	1.45	2.16	20	9.70	2.47

Table 4 presents the analysis of covariance of conservation ability. There was an interaction and group effect. As shown in Table 5, a t-test for the interaction related to group effect indicated that there are significant differences between two groups at every age level. Hearing students performed significantly better than hearing-impaired students. A t-test for the interaction related to age effect, as shown in Table 5 for the hearing-impaired group indicated that there were no significant differences between any two age levels. Even the mean score obtained by the 12 year-old hearing-impaired student was lower than the other three age groups, but excluding the intelligence and grade effects, there was no significant difference between the four age groups. But Table 7 indicated that within the hearing group there were significant differences between the age levels of 9 and 12, 10 and 12, and 11 and 12. According to Table 4, there was no significant main effect due to age.

Table 4

Analysis of Covariance of Conservation Ability

Source of Variance	Adjusted Sum of Square	df	Adjusted Mean Square	F
Group	772.56	1	772.56	6.45*
Age	32.05	3	10.68	.89
Group X Age	140.56	3	46.85	3.91*
Error	1798.12	150	11.99	
Total	2992.94	159		

*p <.01.

Table 5

t-Value for Group and Age of Conservation Ability

Age Level	Hearing-Impaired n	Adjusted Mean	Hearing n	Adjusted Mean	df	t
9	20	1.70	20	5.56	38	3.54*
10	20	2.85	20	6.47	38	3.32*
11	20	3.37	20	7.17	38	3.49*
12	20	2.36	20	10.64	38	7.60*

*p <.01.

Table 6

t-Value for Age in Hearing-Impaired Group of Conservation Ability

Age	Age 10	Age 11	Age 12
9	1.05	1.53	.60
10		.38	.44
11			.93

Table 7

t-Value for Age in Hearing Group of Conservation Ability

Age	Age 10	Age 11	Age 12
9	.01	1.49	4.67*
10		.65	3.83*
11			3.18*

*p <.01.

As shown in Table 8, the mean scores obtained by the two groups increased with age except that of the hearing-impaired students at age 12.

Analysis of covariance of conservation ability of number was shown in Table 9. There was a significant main effect on group. The Newman-Keuls test (shown in Table 10) indicated that hearing students have a superior ability of number conservation than the hearing-impaired students in the whole age range. According to Table 9, there was no significant main effect on age.

Table 8

Means and Standard Deviations for Group and Age of Conservation Ability of Number

Age in Years	Hearing-Impaired n	Mean	S. D.	Hearing n	Mean	S. D.
9	20	.80	1.28	20	1.90	1.37
10	20	.60	1.09	20	1.95	1.19
11	20	.70	1.17	20	2.25	1.25
12	20	.35	.74	20	2.60	.82

Table 9

Analysis of Covarianc of Conservation Ability of Number

Source of Variance	Adjusted Sum of Square	df	Adjusted Mean Square	F
Group	77.05	1	77.05	59.26*
Age	.35	3	.12	.09
Group X Age	5.92	3	1.97	1.52
Error	195.03	150	1.30	
Total	302.14	159		

*p <.01.

Table 10

Neman-Keuls Test for Group and Age of Conservation Ability of Number

Age Level	Hearing-Imparied n	Adjusted Mean	Hearing n	Adjusted Mean	Difference
9	20	.33	20	1.90	1.06*
10	20	.63	20	1.95	1.31*
11	20	.66	20	2.20	1.54*
12	20	.41	20	2.57	2.16*

*P<.01; W_2=.93.

Table 11 indicated that the mean scores acquired by the two groups increased with age except for the hearing-impaired students at age 12 and the hearing students at age 11. The analysis of covariance shown in Table 12 indicated that there was interacton and group effect. As shown in Table 13, a t-test for the group effect indicated that there were significant differences between the groups of the whole age range favoring the hearing students. At the age effect, with hearing-impaired students (shown in Table 14), there were no significant differences between any age levels. But the hearing students (shown in Tablble 15), exhibited significant differences between age levels of 9 and 10, 9 and 12, 10 and 12, and 11 and 12. According to Table 12, there was no significant main effect due to age.

Table 11

Means and Stand Deviations for Group and Age of Conservation Ability of Liquid

Age in	Hearing-Impaired			Hearing		
Years	n	Mean	S. D.	n	Mean	S. D.
9	20	.55	1.00	20	1.55	1.32
10	20	.90	1.16	20	2.20	1.20
11	20	.95	1.28	20	1.85	1.31
12	20	.50	.94	20	2.85	.49

Table 12

Analysis of Covariance of Conservation Ability of Liquid

Source of Variance	Adjusted Sum of Square	df	Adjusted Mean Square	F
Group	59.95	1	59.95	48.07**
Age	6.17	3	2.06	1.65
Group X Age	11.59	3	3.86	3.10*
Error	187.06	150	1.25	
Total	288.94	159		

*P<.05; **P<.01.

Table 13

t-Value for Group and Age of Conservation Ability of Liquid

Age	Hearing-Impaired		Hearing			
Level	n	Adjusted Mean	n	Adjusted Mean	df	t
9	20	.45	20	1.39	38	2.66*
10	20	.84	20	2.16	38	3.77*
11	20	.95	20	1.86	38	2.60*
12	20	.69	20	3.01	38	6.63*

*P<.01.

Table 14

t-Value for Age in Hearing-Impaired Group of Conservation Ability of Liquid

Age	Age 10	Age 11	Age 12
9	1.11	1.43	.68
10		−.31	−.15
11			.74

Table 15

t-Value for Age in Hearing Group of Conservaion Ability of Liquid

Age	Age 10	Age 11	Age 12
9	.22*	1.37	4.66*
10		−.86	2.43*
11			3.28*

*P<.01.

As shown in Table 16, the mean scores in weight conservation increased with age in both groups except for the hearing-impaired students at age 12. There was a significant main effect of the group shown in in Table 17 through the analysis of covariance of conservation abiliy of weight. The Newman-Keuls test (shown in Table 18) indicated that hearing students have a significantly higher abiliy of weight conservation by age 9 and 12. But at ages 10 and 11 there were no significant differences between two groups. According to Table 17, there was no significant main effect of age.

Table 16

Means and Standard Deviation for Group and Age of Conservation Ability of Weight

Age in	Hearing-Impaired			Hearing		
Years	n	Mean	S. D.	n	Mean	S. D.
9	20	.50	1.05	20	1.50	1.28
10	20	.80	1.32	20	1.20	1.44
11	20	.75	1.33	20	1.35	1.42
12	20	.40	.94	20	1.75	1.41

Table 17

Analysis of Covariance of Conservation Ability of Weight

Source of Variance	Adjusted Sum of Square	df	Adjusted Mean Square	F
Group	24.56	1	24.56	15.00*
Age	2.66	3	.89	.54
Group x Age	4.80	3	1.60	.98
Error	245.62	150	1.64	
Total	284.84	159		

$*P<.01.$

Table 18

Newman-Keuls Test for Group and Age of Conservation Ability of weight

Age Level	Hearing-Impaired n	Hearing-Impaired Adjuseted Mean	Hearing n	Hearing Adjusted Mean	Difference
9	20	.26	20	1.17	.91*
10	20	.64	20	1.12	.48
11	20	.80	20	1.44	.64
12	20	.70	20	2.12	1.42**

$*P<.05,\ W_2=.79;\ **P<.01,\ W_2=1.06.$

Table 19 indicates that the mean scores increasd between the ages of 9 and 10 and dropped between 11 and 12 for the hearing-impaired group; while the main scores increased with age for the hearing groups. Analysis of covariance of conservation ability of volume was shown in Table 20. There was a main effect of group and interaction by age. As shown in Table 21, a t-test for the group effect indicated that there were significant differences between groups at age 9 and 12 in favor of hearing students. But at age levels 10 and 11, there were no significant differences between groups. Within the hearing-impaired group (shown in Table 22), there was a sigificant difference between age 9 and 11, but no significant differences existed between any other two age levls. Within the hearing group, shown in Table 23, there were significant differences between age levels 9 and 12, 10 and 12, and 11 and 12. There were no significant differences exising for the other two age levels. According to Table 20, there was no main effect of age.

Table 19

Means and Standard Deviations for Group and Age of Conservaton Ability of Volume

Age in Years	Hearing-Impaired n	Hearing-Impaired Mean	Hearing-Impaired S. D.	Hearing n	Hearing Mean	Hearing S. D
9	20	.45	1.00	20	1.50	1.32
10	20	.95	1.39	20	1.35	1.46
11	20	.90	1.33	20	1.55	1.32
12	20	.20	.70	20	2.50	1.10

Table 20

Analysis of Covariance of Conservation Ability of Volume

Source of Variance	Adjusted Sum of Square	df	Adjusted Mean Square	F
Group	39.93	1	39.93	27.15*
Age	5.18	3	1.73	1.17
Group x Age	20.58	3	6.86	4.67*
Error	220.59	150	1.47	
Total	301.10	159		

$*P<.01.$

Table 21

t-Value for Group and Age of Conservation Ability of Volume

Age Level	Hearing-Impaired n	Hearing-Impaired Adjusted Mean	Hearing n	Hearing Adjusted Mean	df	t
9	20	.16	20	1.10	38	2.47*
10	20	.75	20	1.25	38	1.31
11	20	.97	20	1.67	38	1.84
12	20	.55	20	2.95	38	6.32**

$*P<.5;\ P<.01.$

Table 22

t-Value for Age in Hearing-Impaired Group of Conservation Ability of Volume

Age	Age 10	Age 11	Age 12
9	1.52	2.10*	1.05
10		.58	−.53
11			1.10

$*P<.05.$

Table 23

t-Value for Age in Hearing Group of Conservation Ability of Volume

Age	Age 10	Age 11	Age 12
9	.39	1.50	4.87*
10		1.10	4.47*
11			3.37*

*$\underline{P}<.01$.

As shown in Table 24, there were no significant differences in the frequency of various conservation tasks of each age level. According to Piaget's criteria, only 75% of the subjects at this age level should have demonstrated conservation of a specific task; therfore, the age for acquisition of specific conservation can be retained (1928). In this study, 15 was the criteria for determining the age of acquistion of specific conservation. Referring again to Table 24, it was found that hearing-impaired students did not demonstrate any form of conservation during the ages of 9 to 12.

Tables 24

Chi-Square Analysis in Frequency for Age of the Hearing-Impaired Group in Conservation Tasks

Age in Years	Number	Liquid	Weight	Volume	df	X^2
9-year:						
Conservation	6	5	4	3	3	1.58
Non-conservation	14	15	16	17		
10-year:						
Conservation	5	8	5	6	3	1.43
Non-conservation	15	12	15	14		
11-year:						
Conservation	5	7	5	6	3	.67
Non-conservation	15	13	15	14		
12-year:						
Conservation	3	4	2	1	3	5.62
Non-conservation	17	16	18	19		

As shown in Table 25, there were no significant differences in conservation frequency at age 9, 10, and 12. The only significant difference was found at age 11. Using the same criteria mentioned in the preceding paragraph it was found that hearing students demonstrated conservation ability of number by age 10 and conservation ability of liquid and volume by age 12. But they did not demonstrate conservation ability of weight until age 12.

Tables 25

Chi-Square Analysis in Frequency for Age of the Hearing Group in Conservation Tasks

Age in Years	Number	Liquid	Weight	Volume	df	X^2
9-year:						
Conservation	13	11	9	10	3	1.76
Non-conservation	7	9	11	10		
10-year:						
Conservation	15	14	8	9	3	7.57
Non-conservation	5	6	12	11		
11-year:						
Conservation	15	12	8	9	3	8.78*
Non-conservation	5	8	12	11		
12-year:						
Conservation	17	19	12	17	3	6.05
Non-conservation	3	1	8	3		

*$\underline{P}<.05$.

According to Table 26, almost all conservers (including both hearing-impaired and hearing) related their justifications to invariability. They explained that there was nothing to be added or deducted when the shape of the subject was changed. Only a few hearing conservers (two in liquid conservation, one in weight conservation) related their justifications to compensation. They explained that the glass is taller but also thinner. Obviously, there are not significant differences in the type of justification between the groups of the whole age range and at all conservation tasks.

Tables 26

Type of Justification Given by Conserver for Age, Group and Conservation Tasks

	Hearing-Impaired		Hearing		
	n	%	n	%	Z
Number:					
9-year Invariability	6	100	13	100	.00
10-year Invariability	4	100	15	100	.00
11-year Invariablity	5	100	15	100	.00
12-year Invariability	5	100	18	100	.00
Liquid:					
9-year Invariability	5	100	9	82	1.01
Compensation	0	0	2	18	−1.01
10-year Invariability	7	100	14	100	.00
11-year Invariability	7	100	12	100	.00
12-year Invariability	3	100	19	100	.00
Weight:					
9-year Invariability	4	100	9	90	.66
Compensation	0	0	1	10	−.66
10-year Invariability	6	100	8	100	.00
11-year Invariability	5	100	8	100	.00
12-year Invariability	2	100	12	100	.00
Volume:					
9-year Invariability	3	100	10	100	.00
10-year Invariability	7	100	9	100	.00
11-year Invariability	6	100	9	100	.00
12-year Invariability	2	100	17	100	.00

According to Table 27, almost all non-conservers (both categories) related their justifications to a perceptual cue. They explained that they look like they have more or are heavier. Only a few hearing-impaired non-conservers (one in number conservation, one in liquid conservation, and two in volume conservation) did not give any answer for justification. Obviously, there were no significant differences in the type of justification between groups in the whole age range about the conservation tasks.

Table 27

Type of Justification Given by Non-Conserver for Age, Group and Conservation Tasks

	Hearing-Impaired		Hearing		
	n	%	n	%	Z
Number:					
9-year Perceptual Cue	13	93	7	100	−.71
No Answer	1	7	0	0	.71
10-year Perceptual Cue	16	100	5	100	.00
11-year Perceptual Cue	15	100	5	100	.00
12-year Perceptual Cue	17	100	2	100	.00
Liquid:					
9-year Perceptual Cue	15	100	9	100	.00
10-year Perceptual Cue	13	100	6	100	.00
11-year Perceptual Cue	12	92	8	100	−.84
No Answer	1	8	0	0	.84
12-year Perceptual Cue	17	100	1	100	.00
Weight:					
9-year Perceptual Cue	16	100	10	100	.00
10-year Perceptual Cue	14	100	12	100	.00
11-year Perceptual Cue	15	100	12	100	.00
12-year Perceptual Cue	18	100	8	100	.00
Volume:					
9-year Perceptual Cue	16	95	10	100	−.66
No Answer	1	5	0	0	.66
10-year Perceptual Cue	13	100	11	100	.00
11-year Perceptual Cue	14	100	11	100	.00
12-year Perceptual Cue	17	95	3	100	−.38
No Answer	1	5	0	0	.38

Findings

1. There were significant differences in conservation ability between hearing-impaired and hearing students of the whole age range.

2. There were no significant differences in conservation ability among hearing-impaired students of the whole age range.

3. There were significant differences in conservation ability between hearing students at ages 9 and 12, 10 and 12, and 11 and 12. But there was no significant difference between hearing students at ages 9 and 10, 9 and 11, and 10 and 11.

4. There were significant differences in the conservation ability of number between hearing-impaired and hearing students of the whole age range.

5. There were significant differences in the conservation ability of liquid among hearing-impaired students of the whole age range.

6. There were no significant differences in conservation ability of liquid among hearing-impaired students of the whole age range.

7. There were significant differences in the conservation ability of liquid between hearing students at ages 9 and 10, 9 and 11, 10 and 12, and 11 and 12. There were no significant differences between hearing students at ages 9 and 11, and 10 and 11.

8. There were significant differences in the conservation ability of weight between hearing-impaired and hearing students at age levels 9 and 12. There were no significant differences between hearing-impaired and hearing students at age levels 10 and 11.

9. There were significant differences in the conservation ability of volume between hearing-impaired and hearing students at age levels 9 and 12. There were no significant diggerences between hearing-impaired and hearing students at age levels 10 and 11.

10. There was a significant difference in conservation ability of volume between hearing-impaired students age levels 9 and 11. But there were no significant differences between hearing-impaired students in any of the other two age levels.

11. There were significant differences in the conservation ability of volume between hearing students at age levels 9 and 12, 10 and 12, and 11 and 12. But there were no significant differences between hearing students at age levels 9 and 10, 9 and 11, and 10 and 11.

12. There were no significant differences in the frequency of conservation of various conservation tasks among hearing-impaired students of the whole age range. The abilities of number, liquid, weight, and volume were not demonstrated from age 9 to 12.

13. There was a significant difference in frequency of various conservation tasks among hearing students at age 11. But there were no significant differences at other age levels. They demonstrated conservation ability of number at age 11, and conservation ability of liquid and volume

at age 12. They did not demonstrate conservation ability of weight until age 12.

14. There were no significant differences in the type of justification given by hearing-impaired and hearing conservers for any specific conservation across all age levels.

15. There were no significant differences in the type of justification given by hearing-impaired and hearing non-conservers for any specific conservation across all age levels.

Discussion of Findings

The main findings of this study were that excluding the effect of intelligence and formal educational background (grade), therre was still a significant difference in overall conservation performance between hearing-impaired and hearing students. This finding was consistent with the conclusion given by Olĕron and Herren (1961), Rittenhouse (1976, 1979), and Springer (1977). The conservation ability of hearing-impaired students was inferior to that of hearing students. In this study, it was found that hearing-impaired students did not demonstrate any conservation ability from age 9 to 12. In other words, at the elementary school level, they were still in the pre-operational period, and did not enter into the concrete operational period until later. This was in agreement with the finding discovered by the California School for the Deaf—Riverside (1977, cited in Gonzales, 1984).

Hoeman and Briga (1980) mentioned the catch-up effect for older hearing-impaired children which reduced or overcame the lag of hearing children at early ages. In this study, this effect cannot be found. Data from Olĕron and Herren (1961), Rittenhouse (1977), and Watts (1979) indicated that the age for hearing-impaired students to demonstrate conservation ability was beyond age 14. Therefore, one plausible explanation for no age effect was due to the hearing-impaired students not demonstrating conservation ability before age 14.

Another result found in this study was that hearing-impaired conservers/non-conservers gave the same types of justification for their judgments as that of their hearing counterparts. This finding mentiored ahove confirmed that hearing-impaired students have developmental delay in cognition rather than a real incapacity (Olĕron, 1953; Rittenhouse, 1981).

This study was not designed to explore the reasons for observed lag, but rather to establish if a lag existed. Any discussion about the lag can be only speculative and remains for further study. According to Doise (1975), hearing students can use social experience to promote their cognitive development. During interaction with others, hearing students

are forced to notice more attributes about a given subject. This assists them to understand another person's point of view and thus become flexible in their own reasoning (Doise, 1975). Because of their inability to hear and use language, hearing-impaired students often suffer from social experience (Gonzales, 1984; Liben, 1978). Before schooling, they develop some simple signs and some minimal communication occurs between the hearing-impired students and their families. After schooling, they learn how to sign more extensively. However, this communicatication mode is used only in the hearing-impaired environment. The hearing-impaired may suffet from social deficits since interaction with the same hearing-impaired peers often does not bring fresh levels of social enlightenment to those students (Gonzales, 1984). Limited social experience, then, may be one reason for their lower cognitive development.

Campbell (Gonzales, 1984) pointed out that teaching strategies may influence the hearing-impaired students' cognitive development. He listed seven conditions which are not good for hearing-impaired stndents in their cognitive development: (a) when the child is exposed to only teacher-and parent-centered teaching techniques; (b) when "learning" activies are limited to teacher and parent direction, and are not child centered and discovery based; (c) when the bulk of situations for learning are contrived; (d) when an inordinate amount of emphasis is placed on rote learning; (e) when language acquition opportunities are primarily confined to specific sentence pattern drills without an informal experiential base; (f) when parents and teachers only ask convergent questions, the answers to which can be labeled right or wrong; and (g) when the child has no opportunity to frequently and independently act upon his developing cognitive structures, thus rendering the structure nonactive. In the teaching techniques used for hearing-impaired students in Taiwan, it is easy to find that almost all the mentioned conditions are embraced. Improper teaching skills may be another reason for hearing-impaired students' cognitive delay.

Equilibriation refers to a process by which children compensate external disturbance (the other person's point of view) into a current cognitive structure (Wadsworrth, 1979). Equilibriation is a necessary factor for cognitive development (Gallagher & Reid, 1981). According to Liben (1975), restriction of social experience will diminish the opportunity for external disturbance and may affect epuilibriation. Therefore, lack of external disturbance may be the third plausible explanation for the poor conservation performance in hearing-impaired students.

The following discussion will focus on comparing the findings with Rittenhouse's study completed in the U. S. A. in 1977, with this study.

Before this discussion two poins should be mentioned. First, it is necessary to review the difference in the conservation ability of the students in these two countries. According to Bybee and Sund (1982) aud Wadsworth (1979), children develop conservation ability of number around age 6 to 7, conservation ability of liquid around 7 to 8, conservation ability of weight and volume around age 9 to 12. In Taiwan, R. O. C., it was found that children develop conservation ability of number at age 8 to 9, conservation ability of weight and volume at age 9 to 11 (Liou, 1973; Su, 1973). There is a two years lag in Chinese children. Liou and Su attributed it to culture difference (1973).

Secondly, the attribute-specific instruction developed by Rittenhouse (1977) and used in this study should be discussed. According to Rittenhouse (1981), attribute-specific instruction can assist in the measurement of conservation ability of hearing-impaired students. In this study, it was found that hearing students demonstrate conservation ability of number at age 10, and conservation ability of liquid and volume at age 12. Also, they did not demonstrate the conservation ability of weight until age 12. This is a two-year difference of that reported by Liou (1973) and Su. (1973), It was found that these studies were designed to evaluate the consevation abilities of students with normal intelligence (in Liou's study, the subjects' mean IQ was 104; in Su's study, the subjects' mean IQ was at percentile rank 54; in this study, the subjects' mean IQ was 108). The same procedures and scoring were used in all the above studies. The only difference was the instruction methods used during the investigation. Liou and Su used the conventional instruction approach making it doubtful that attribute-specific instruction could have facilitated Chinese students in demonstrating measurable conservation ability. Culture differences and instructional effects should be kept in mind for the further studies.

Rittenhouse (1977) used the attribute-specific instruction to investigate the conservation ability of hearing-impaired and hearing students. He found that the hearing-impaired students acquire the conservation ability of number at age 8, the conservation ability of liquid at age 14, and the conservation ability of weight and volume at age 17. In the same study, hearing students were found to have acquired the conservation ability of number at age 6, and the conservation ability of liquid, weight, and volume at age 9. There was a two-to eight-years lag between hearing-impaired and hearing students. Comparing his results with this study, there were differences in the hearing-impaired students and hearing students in these two countries. Of the hearing-impaired groups, it was found that the U. S. group developed conservation ability of number at least four years earlier than the Chinese group. The limitations of the data

make it impossible to compare the age norms for the other three conservtion abilitles. In the hearing group, it was found that there was a three-to four-years lag between these two groups, favoring the U. S. students. Three plausible reasons for the difference are as follows. First, there was an intelligenc e difference between these subjects. In Rittenhouse's study, the mean IQ of the hearing-impaired students was 117 with the range from 110 to 126; the mean IQ of the hearing students was not reported, but it was indicated that their IQ was beyond 110. In this study, the mean IQ of hearing-impaired students was 102 with the range from 71 to 140; the mean IQ of hearing students was 108 with the range from 83 to 126. Therefore, it was obvious that the U. S. students had reportedly higher IQs in the studies. The other two reasons were cultural differenes and instructional effects mentioned above.

The gap difference between the students in these two countries was only minimally estimated in this study. However, it can be said that there was a similar gap between subjects used in the two countries. The gap differende found in this study was consistent with others (Springer, 1977; Watts, 1979).

Conclusions

The conclusions of this study were drawn from the findings as follows:

1. The hearing-impaired students were inferior in overall conservation ability: conservation ability of number, liquid, weight, and volume, by at least three years when compared to hearing students.

2. The hearing-impaired students did not increase their conservation ability during the ages 9 to 12.

3. The hearing students increased their conservation ability of liquid and volume during the ages 9 to 12. But there was no increase in conservation ability of number and weight.

4. The hearing-impaired students did not demonstrate conservation abilities of number, liquid weight, and volume from age 9 to 12.

5. The hearing students demonstrated the conservation ability of number at age 10 and the conservation ability of liquid and volume at age 12. The order which they demonstrated various forms of conservation was number-liquid, volume-weight.

6. The hearing-impaired and hearing conservers gave the same type of justification for their conservation.

7. The hearing-impaired non-conservers and hearing-nonconservers gave the same type of justification for their nonconservation.

Implications

The conclusions of this study revealed that the hearing-impaired students lagged behind hearing students in cognitive development by at least three years. They are generally still functioning at the preoperational period when they are at the elementary school level. Because of these results, it can be suggested that the curriculum design and teaching strategies used in the education of hearing-impaired students iu Taiwan be revised.

In Taiwan, the curriculum used in the schools for the deaf is the same as those used in the regular schools. This curriculum is designed for hearing students. Obviously, the hearing-impaired students are taught beyond their cognitive ability. As stressed by Gonzales (1984), the curriculum used with hearing-impaired students at the pre-operational level should be based on experiential design. In other words, their learning should be matched with meaningful experienes. Schools should create an intellectually challenging environment and assist hearing-impaired students to think and solve problems with their own abilities by helping them to promote their own cognitive development (Gonzales, 1984). In order to arrive at this goal, teaching skills used for hearing-impaired students should be modified and focused on student-centered activities, along with developing more question skills. Teachers of hearing-impaired students must avoid rote learning and inexperiential drills in favor of an experiential and cognitive based approach.

Recommendations

More research is needed to comprehend the conservation ability of hearing-impaired students. The following are suggested for further studies:

1. The hearing-impaired students for this study were limited to those with hearing parents. An additional study should be conducted with hearing-impaired students of hearing-impaired parents.

2. The hearing-impaired students for this study were limited to ages 9 to 12. Additional studies should be conducted with those who are below age 9 and above age 12.

3. In order to understand the age effect on conservation ability for the hearing-impaired students, a follow-up study should be conducted with the same hearing-impaired students observed in this study.

4. A study comparing the effect of attribute-specific instruction and the conventional instruction approach should be conducted to verify the suitability of attribute-specific instruction for Chinese students.

REFERENCES

Best, B. (1970). *Development of classification skills in deaf children with and without early manual communication.* Unpublished doctoral dissertation, University of California.

Blank, M., & Bridger, W. H. (1966). Conceptual cross model transfer in deaf and hearing. *Child Development,* **37**, 29-38.

Bower, G. H. (1972). Mental imagery and associative learning. In L. Gregg (Ed.), *Cognition in learning and memory.* New York: Wiley.

Bradshaw, D. H. (1964). *A study of inferred relations using no verbal methods.* Unpublished doctoral dissertation, Catholic University of America.

Bybee, R. W., & Sund, R. B. (1982). *Piaget for educators* (2nd ed.). Columbus: A Bell & Howell Company.

Darbyshire, I. O., & Reeves, V. R. (1969). The use of adaptions of some of Piaget's tests with groups of children with normal and impaired hearing. *British Journal of Disorders of Communication,* **4**, 194-202.

Doise, W., & Perret-Clerment, A. N. (1975). Social interaction and the development of cognition operations. *European Journal of Social Psychology,* **5**, 18-29.

Dolman, D. (1983). A study of the relationship between syntactic development and concrete operations in deaf children. *American Annals of the Deaf,* **128**(6), 813-819.

Elkind, D. (1961a). Quantity conceptions in junior and senior high school students. *Child Development,* **32**, 551-560.

Elkind, D. (1961b). Children's discovery of the conservation of mass, weight, and volume: Piaget replication II. *Journal of Genetic Psychology,* **97**, 219-227.

Elkind, D. (1969). Piagetian and psychometric conceptions of intelligence. *Harvard Educational Review,* **39**, 319-337.

Feigenbaum, K. D. (1963). Task complexity and IQ as variables in Piaget's problem of conservation, *Child Development,* **34**, 423-432.

Flavell, J. H. (1963). *The developmental psychology of Jean Piaget.* New Jersey: D. Van Nostrand Company, Inc.

Flavell, J. H. (1977). *Cognitive development.* Englewood Cliffs, NJ: Prentice-Hall, Inc.

Furth, H. G. (1964a). Conservation of weight in deaf and hearing children. *Child Development,* **34**, 143-150.

Furth, H. G. (1964b). Research with the deaf: Implication for language and cognition. *Psychological Bulletin,* **62**, 145-164.

Furth, H. G. (1966). *Thinking without language.* London: Collir-MceMillan.

Furth, H. G. (1971). Linguistic deficiency and thinking: Research with deaf subjects 1964-1969. *Psychological Bulletin*, **76**(1), 58-72.

Furth, H. G. (1973). *Deafness and learning*. Belmont, CA: Wadsworth.

Furth' H' G., & Milgram, N. A. (1965). The influence of language on classification: A theoretical model applied to normal retarded and deaf children. *Genetic Psychology Monographs*, **72**, 317-351.

Furth, H. G., & Youniss, J. (1969). Thinking in deaf adolescents language and formal operations. *Journal of Communication Disorders*, **2**, 195-202.

Furth, H. G., & Youniss, J. (1971). Formal operations and language: A comparison of deaf and hearing adolescents. *Interventional Journal of Psychology*, **6**, 49-64.

Furth, H. G., Youniss, J., & Ross, B. M. (1970). Children's utilization of logical symbols. An interpretation of conceptual behavior based on Piagetian theory. *Developmental Psychology*, **3**, 36-57.

Gaito, J. (1980). Measurement scales and statistics: Resurgence of an old misconception. *Psychological Bulletin*, **87**, 564-567.

Gallagher, J. M., & Reid, D. K. (1981). *The learning theory of Piaget and Inhelder*. California: Books/Cole Publishing Company.

Ginsburg, H., & Opper, Opper, S. (1969). *Piaget's theory of intellecttual development*. Englewood Cliffs: Prentice-Hall, Inc.

Goldschmid, M. L. (1967). Different types of conservation and nonconservation and their relation to age, sex, IQ, MA, and vocabulary. *Child Development*, **38**, 1229-1246.

Goldschmid, M. L, & Bentler, P. M. (1968). Dimensions and measurement of conservation. *Child Development*, **39**, 787-802.

Gonzales, B. R. (1984). On target changes in the education of the deaf at the California School for the Deaf-Riverside. Part II. The theoretical base of the developmental education of hearing impaired children. Unpublished.

Goodnow, J. J., & Bothon, C. (1966). Piaget's task: The effects of schooling and intelligence. *Child Development*, **37**, 573-582.

Hauk, S. C. (1967). *Effects of maternal attitudes, field-dependence and curiosity on weight and volume conservation in children*. Unpublished doctoral dissertation, The Catholic University of America.

Hermier, R. K. (1967). *Age and intelligence as related to the concepts of mass and volume conservation*. Unpublished doctoral dissertation, The University of Iowa.

Hoemann, H., & Briga, J. (1980). Hearing impaired. In J. Kauffman & D. Hallahan (Eds.), *Handbook of special education*. Englewood Cliffs: Prentice-Hall.

Kelly, R. R., & Tomlinson-Keasey, C. (1976). Information processing of visually presented picture and word stimuli by young hearing-impaired and normal hearing children. *Journal of Speech and Hearing Research*, **19**, 628-638.

Lenneberg, E. H. (1967). *The biological foundations of language*. New York: Wiley.

Levine, E. (1974). Psychological tests and practices with the deaf. *Volta Review*, **5**(76), 298-319.

Liben, L. (Ed.). (1978). *Deaf children: Developmental perspectives*. New York: Academic Press.

Ling, P. K. (1979). A survey study of the methods and materials for teaching hearing-impaired children. In *The propect of special education in The Republic of China*. National Taiwan Normal University: Special Education Center.

Ling, P. K. (1981). *A study of communication and language teaching for hearing-impaired children*. Taipei, The Republic of China: The Ministry of Education.

Liou, S. C. (1973). Conception of conservation in Chinese children. *Bulletin of Graduate Institute of Education*, **16**, 97-159.

Meadow, K. P. (1975). The development of deaf children. In E. M. Hetherington (Ed.), *Review of child development research* (vol. 5). chicago: University of Chicago Press.

Menyuk, P. (1975). The language impaired child: Linguistic or cognitive impairment? *Annals of the New York Academy of Science*, **263**, 59-69.

The Ministry of Education. (1981). *The introduction of special education in the Republic of China*. Taipei: The Ministry of Education, R.O.C.

Moores, D. F. (1982). *Educating the deaf, psychology, principles, and practices* (2nd ed.). Boston: Houghton Mifflin Co.

Moores, D. F., McIntyre, C. K., & Weiss, K. L. (1972). *Evaluation of programs for hearing impaired children: Report of* **1971-72** (Research Report No. 39). University of Minnesota: Research Development and Demonstration Center in Education of Handicapped Children.

Myklebust, H. R. (1964). *The psychology of deafness*. New York: Grune and Stratton.

Myklebust, H. R., & Brutten, M. (1953). A study of the visual perception of deaf children. *Acta Oto-Laryngology* (Supp. 1953. 105).

Nelson' R. J. (1969). *An investigation of a group test based on Piaget's concept of number and length conservation and its ability to predict first-grade arithmetic achievement*. Unpublished doctoral dissertation, Purdue University.

O'Bryan, K. G., & Boersma, F. J. (1971). Eye movement, perceptual activity, and conservation development. *Journal of Experimental Child Psychology*, 12, 157-169.

Oléron, P. (1953). Conceptual thinking of the deaf. *American Annals of the Deaf*, **98**, 304-310.

Oléron, P. (1975). *Deaf children's psychological evaluation*. Paper presented to the International Congress on the Education of the Deaf.

Paivio, A. (1972). A theoretical analysis of the role of imagery in learning and memory. In P. W. Sheehan (Ed.), *The function and nature of imagery*. New York: Academic Press.

Piaget, J. (1928). *Judgment and reasoning in the child*. London: Routelede & Kegan Paul.

Piaget, J. (1952). *Child's conception of number*. Routledge: Kegan Paul.

Piaget, J. (1963). *The psychology of intelligence*. New Jersey: Littlefield, Adams.

Piaget, J. (1967). *Six psychological studies*. New York: Vintage Books.

Piaget, J. (1973). *The child and reality*. New York: Grossman.

Rittenhouse, R. K. (1976). *Deaf children's judgment on conservation problems of liquid, matter, weight and volume: A pilot study*. Unpublished master's thesis, University of Illinois.

Rittenhouse, R. K. (1977). *Horizontal decalage: The development of conservation in deaf students and the effect of the task instructions on their performance*. Unpublished doctoral dissertation, University of Illinois, Urbana-Champaign.

Rittenhouse, R. K. (1981). The effect of instructional manipulation on the cognitive performance of normal-hearing and deaf children. *Journal of Childhood Communication Disorders*, **5**(1), 14-22.

Rittenhouse, R. K., & Spiro, R. J. (1979). Conservation performance in day and residential school deaf children. *Volta Review*, **81**, 501-509.

Robertson, A., & Youniss, J. (1969). Anticipatory visual imagery in deaf and hearing children. *Child Development*, **40**, 123-135.

Ross, B. M., & Hoemann, H. (1975). The attainment of formal operations: A comparison of probability concepts in deaf and hearing adolescents. *Genetic Psychology Monographs*, **91**, 61-119.

Springer, S. A. (1977). *A study of the performance of deaf and hearing subjects on Piagetian and neo-Piagetian tasks*. Uupublished doctoral dissertation, Canada York University.

Spriner, S. A. (1978). *Piaget and the deaf: Educational implication*. Paper presented at the Annual Meeting of the American Educational Research Association.

Su, C. W. (1973). A study in conception of conservation of Chinese children. *Bulletin of Assessment*, **20**, 61-75.

Sullivan, P., & Vernon, M. (1979). Psychological assessment of hearing-

impaired children. *School Psychology Digest*, 8(3), 271-290.

Sund, R. B. (19L5). *Piaget for educators. A multimedia program*. Columdus, OH: Charles E. Merrill Publishing Company.

Tomlinson-Keasey, C., & Kelly, R. R. (1974). The development of thought processes in deaf children. *American Annals of the Deaf*, **121**, 693-700.

Tomlinson-Keasey, C., & Kelly, R. R. (1978). The deaf child's symbolic world. *American Annals of the Deaf*, **123**, 452-459.

Tsai, A. H., et al. (1983). *A survey study for the education of hearing-impaired children at regular elementary schools in Taiwan area*. Chi-Yi Junior Teacher College.

Tisher, R. P. (1971). A Piagetian questionnaire applied to pupils in a secondary school. *Child Development*, **42**, 1633-1636.

Wadsworth, B. J. (1978). *Piaget for the classroom teacher*. New York: Longman.

Wadsworth, B. J. (1979). *Piaget's theory of cognitive development* (2nd ed.). New York: Longman.

Watts, W. J. (1972). Some aspects of operational research with deaf children. *The Teacher of the Deaf*, **70**, 470-484.

Watts, W. J. (1979). The influence of language on the development of quantitative, spatial, and social thinking in deaf children. *American Annals of the Deaf*, **124**(1), 46-56.

Watts, W. J. (1980). Problems of fundamental research into cognitive functioning. *Teachers of the Deaf*, **4**(5), 155-160.

Youniss, J. (1967). Psychological evaluation of the deaf child. Observations of a researcher. *The Ear Nose and Throvt Monthly*, **46**, 458-464.

Youniss, J. (1974a). A Piagetian perspective on thinking and language. *Journal of Education*, **156**(1), 43-51.

Youniss, J. (1974b). Operational development in deaf Costa Rican subjects. *Child Development*, **45**, 212-216.

Youniss, J., & Furth, H. G. (1965). The influence of transitivity on language in hearing and deaf children. *Child Development*, **36**, 533-538.

Youniss, J., & Furth, H. G. (1966). Prediction of causal events as a function of transitivity and perceptual congruency in hearing and deaf children. *Child Development*, **37**, 73-81.

Youniss, J., Furth, H. G., & Ross, B. M. (1971). Logical symbol use in deaf and hearing children and adolescents. *Developmental Psychology*, **5**, 511-517.

國立臺灣師範大學特殊教育中心
特殊教育研究學刊，民74，1期，191—230頁

聽覺障碍學童與聽覺正常學童保留概念能力之比較

張 蓓 莉

國立臺灣師範大學

摘 要

本研究旨在比較聽覺障碍學童與聽覺正常學童之保留概念能力。受試學童包括80名聽覺正常學童與80名聽覺障碍學童。年齡範圍 8 至12歲（每年齡組20人，男女各半）。聽覺障碍學童爲學習語言前卽失聰之重聽者，沒有其他障碍；父母均爲聽覺正常者。保留概念能力測驗包括數量、液體、重量及體積的保留概念。每一種測驗均以特殊屬性方式呈現。受試學童的智力以魏氏兒童智慧量表操作部分分數代表。所有的測驗均以個別方式進行。測驗所得資料分別以雙因子共變數分析，t 檢定，紐曼一一柯爾氏檢定法及 χ^2 檢定法等分析。研究結果發現，排除智力及年級（教育背景）的因素後，在數量、液體、重量及體積之保留概念能力方面，兩組受試學童間有明顯的差異。9 歲至12歲階段的聽覺障碍學童尚未具備數量、液體、重量及體積之保留概念能力。聽覺正常學童10歲時具備了數量保留概念能力，12歲時具備了液體及體積的保留概念能力。但是在12歲以前重量的保留概念能力並沒有顯示出來。兩組學童在保留概念能力方面至少有 3 年以上的差距，但是在論證方面，兩組受試學童間並沒有明顯的差異。

國立臺灣師範大學特殊教育中心
特殊教育研究學刊，民74，1期，231—248頁

視覺障礙學生自我概念與人際關係之研究

楊 振 隆

臺北市立啓明學校

本研究旨在探討視覺障礙學生的「自我概念」、「人際關係」和「自我概念與人際關係間之相關情形」。自我概念是根據「田納西自我概念量表」所測得之分數表示；人際關係則是根據自編「人際關係問卷」，分工作、休閑二準據正、反面題，以猜人測驗方式測得。研究之樣本是以七十二學年度就讀於臺北、臺中兩所啓明學校國一至高三的全體同學爲對象，其中高職部72人（男生48人，女生24人），國中部70人（男生42人，女生28人）共計 142人。結果發現：

1. 不同性別、級部的視覺障礙學生在自我概念的表現上無顯著差異。
2. 視覺障礙學生自我概念的得分顯著低於一般正常學生。
3. 視覺障礙學生自我概念與智力、學業成就有顯著的正相關。
4. 在人際吸引的選擇上高職男生最受歡迎，而國中男生受拒斥最多。
5. 在人際投選趨勢上，有集中於組內選擇的現象；在受選對象上，則選票有集中在少數人身上的趨向。
6. 視覺障礙學生之自我觀念與人際關係間有顯著正相關。

研究動機與目的

一、研究動機

對於一個殘障者來說，生理上的障礙通常不是影響他是否能有良好適應的唯一因素；個人的自我概念與人際關係的良窳反而常是決定其能否適應現實環境的關鍵。一個是他對現實自我的接受態度，一個則是他是否能爲別人所接受。兩者之間往往也是相互影響的。

在現實的社會中，假如一個殘障者他能不被因殘障所帶來的不便征服，不爲自己生理的缺陷而感到沮喪、自卑，他將會受到社會更多的激勵和讚賞。郭爲藩（民61）認爲殘障者若能使自我由消極的防衛進而爲積極的擴展，當他自我强化後，必能容受較高的挫折；他能接受自己感到快樂；他也能接受別人，而有較好的社會關係；進而能有較淸晰的自我認同，體認到生活的目標和生命的意義，這樣自然就能重新適應這個社會了。

許多學者在討論到一個人是否心理健康，是否對社會有良好的適應時，均不排除「自我概念」與「人際關係」兩個因素；像 Maslow（1951）卽認爲心理健康的表現不能缺乏適當的自我評價、自