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ABSTRACT

This paper reviews the literature on the intellectual abilities and performance of deaf learners within educational settings. The paper addresses such questions as whether deaf learners learn differently from hearing learners; whether deaf learners have the same intellectual capacity as hearing learners; how opinions have changed regarding the intellectual abilities of deaf learners; and at what point intervention is effective. It is concluded that the most promising approaches to planned interventions are those which have: (1) a strong theoretical basis; (2) a focus on teacher training or re-training in the specific methodology; (3) a comprehensive incorporation of several, rather than only a few, cognitive skills; (4) regular opportunities for students to apply these skills to subject matter; and (5) an explicit metacognitive focus in helping students become aware of cognitive processes and strategies. (Contains 107 references.) (DB)

COGNITIVE PROCESSES AND THE HEARING-IMPAIRED LEARNER

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Introduction*

The question of intellectual potential in the deaf learner has puzzled educators, parents, and employers for centuries now. While pieces of this intriguing puzzle are clearly emerging and in some cases falling into place, the larger puzzle is far from definitively solved and continues to engage the interest of many, including the deaf community itself.

In the past decade, both interest in and proactive improvement of the intellectual performance of deaf learners within educational settings has been noteworthy; at the same time, heightened sensitivity to the needs of deaf persons both in schools and in the workplace have coincided with this trend. Thus, the 1990s may constitute a unique era in the education of hearing-impaired persons as an opportunity not only to examine what we have learned about cognition and deafness, but also to take some giant strides forward in both research on the subject and education of the public on the central issues within it.

Thus we arrive at a number of intriguing questions as educators:

- Do deaf learners learn differently from hearing learners?
- Do deaf learners have the same intellectual capacity as hearing learners?
- How have opinions changed in regard to the intellectual abilities of deaf learners?
- At what point is intervention effective in this area?

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- How can the intellectual capacity of deaf learners best be measured?
- How should educators of the deaf be best prepared to enhance the cognitive performance of deaf learners?

These questions and many more are highly engaging, and while they cannot all be answered in this paper, they can serve to form some advance-organizing principles for the analysis which follows.

Recent History

Pintner and others reviewed the available information on the intelligence of deaf persons and, in spite of sometimes contradictory results, concluded that deaf children had inferior intelligence (Pintner, Eisenson, and Stanton, 1941).

In 1924-1925, the National Research Council reported that the deaf were between two and three years "retarded" in comparison to hearing persons in their responses to the Pintner Non-Language Mental Test. On the other hand, Drever and Collins (1928) found in a study in Scotland, that on performance tests, the deaf were not more than one age level inferior to hearing persons, and they questioned whether or not deaf persons were at all retarded in intellect (McKane, 1933). McKane gave the Drever-Collins Performance Scale to both deaf and hearing subjects and replicated the conclusion that the deaf were not at any age level more than one year "retarded," although his study did not find any superiority on the part of the deaf at any age level. The study also found that deaf girls were inferior to deaf boys, and found no positive relationship between residual hearing and intelligence in the deaf group of subjects (McKane, 1933).

The work of Myklebust has been generally cited as another waypoint in the history of research on and attitudes toward the deaf. His work attributed a "concrete" nature to the intelligence of deaf persons, indicating that deafness restricts the learner to a world of "concrete objects and things" (Myklebust and Brutton, 1953). The influence of this attribution has been far-reaching in that educators of deaf children have for many years regarded the deaf learner as less able to work with abstract ideas; fortunately, subsequent research has proven this interpretation to be false. Nonetheless, the work of Myklebust represented one step forward in that he regarded the deaf learner as being at least quantitatively equal to the hearing learner, although inferior in quality.

Furth built on the work of previous researchers, and noted that it "would have been easy to assume from [the need to use simpler language] that the deaf were incapable of abstract thought which is so closely identified with verbal thought" (Furth, 1966). He wondered publicly about the causes to which one should ascribe deficiencies that make the deaf appear to be "concrete-minded," and deplored the past centuries during which the deaf were considered to be lacking in normal intelligence because they could not speak; he thus addressed the eternal question of the relationship between language and intelligence (Furth, 1966). Elsewhere, Furth (1964) concluded that the poorer performance of deaf persons on some cognitive tests could be explained either by a lack of world experience or by the conditions of those tasks that would favor a background of a spoken language. Further, he asserted that "the

deaf" can comprehend and logically apply concepts as well as hearing persons can (1964). Originally, Furth (1964) asserted that deaf people grow up without a symbol system for communication; more recently (1973) he made a useful differentiation between symbol discovery, which is a more difficult process for deaf persons, as opposed to the use of symbols. A misconception, which has fortunately been corrected, was Furth's original assertion that deaf people have possibly a different cognitive structure because they "lack language" (1966); subsequent work by others has clarified that the mastery of a visual language system provides the opportunity for full language development; thus, today we are far more careful about distinguishing between "language" on the one hand and the use of a spoken system of communication on the other hand.

Rosenstein (1961), after a review of a number of studies conducted with deaf learners, found no differences between deaf and hearing persons in regard to conceptual performance when the linguistic elements presented were within the language experience of deaf children; his important conclusion was that abstract thought is not closed to deaf persons.

In a comprehensive review of 31 research studies using more than 8,000 deaf children whose ages ranged from three to nineteen, Vernon (1967) found that in 13 experiments, deaf subjects had superior scores to either the test norms or control groups; in seven studies, the scores were not significantly different; and in the remaining studies the deaf performed at an inferior level. His

conclusion was that deaf youth perform as well in a wide variety of tasks that measure thinking as do other children (1967).

It is useful to review what researchers have reported in regard to specific cognitive skill performance in hearing-impaired subjects, skill by skill.

1. Memory: Research conducted over the last 80 years indicates that profoundly deaf subjects perform less well than do normally hearing subjects on short-term memory tasks as well as on certain other cognitive tasks (Karchmer and Belmont, 1976, p. 1). In a report on the results of a cognitive laboratory study, deaf subjects benefited greatly by adopting particular strategies that explicitly tailored the primary and secondary memory systems to the demands of information processing. These strategies brought their performance up to the levels that the hearing subjects had achieved using self-selected strategies (Karchmer and Belmont, 1976, p.4). Karchmer and Belmont concluded that what is often seen as a performance deficiency is instead a strategy deficiency, as opposed to some type of structural deficiency related to the physiological fact of deafness (1976, p. 8).

   Meadow reported that hearing-impaired children could better remember words that had a sign equivalent than words that did not. Further, she found that hearing-impaired children found it easier to remember geometric shapes than to remember digits (1980, p. 73). Thus, classroom intervention programs (as discussed later in this volume) that stress the direct teaching of particular strategies for cognitive tasks should hold promise of improvement of hearing-impaired subjects' performance in cognitive problem-solving situations.

2. Concept Application: Furth asserted that "the deaf" can comprehend and logically apply concepts as well as the hearing can (1964, p. 168). More recently, Meadow reported that hearing-impaired subjects learn concepts in the same sequence as hearing subjects, but at a later time (1980, p. 72). Furth remarked that the difficulties experienced by hearing-impaired subjects in several skill areas indicated that they have difficulty with the discovery of a concept rather than with its comprehension or use (1964, p. 146).

3. Part-Wholes: Furth found no difference in the performance of deaf as compared to hearing children (1964, p. 146).

4. Opposition: Furth found inferior performance among deaf subjects on this dimension (1964, p. 146), and the same finding was reported later by Meadow (1980, p. 72).

5. Sameness: Furth found the deaf subjects to be "equal" to the hearing subjects on understanding of sameness (1964, p. 146), and Meadow reported "little retardation" for hearing-impaired subjects in this domain (1980, p. 72).

6. Analogy: Meadow reported that hearing-impaired children had difficulty in this area (1980, p. 72).

7. Superordinate Reasoning: Meadow found this area posed difficulty for the hearing-impaired subjects (1980, p. 72). Johnson (1981) has reported that both the vocabulary and concept of cause-effect relationships are also more difficult for hearing-impaired youth.

8. Symmetry: Both Furth (1964, p. 146) and Meadow (1980, p. 72) found little, if any, difficulty for hearing-impaired children in this skill.

9. Classification: Prior research has reported that hearing-impaired children perform less well than hearing children on classification tasks that depend on verbal interaction with the environment (Best and Roberts, 1975). However, more recently, Meadow has found little retardation among hearing-impaired learners in this skill area (1980, p. 72).

10. Spatial Reasoning: Research thus far on this area suggests that because hearing-impaired children depend primarily on visual and tactile senses to a greater degree than hearing children, they may develop a different concept of space (Hauptman, 1980, p. 43). In a separate study, Parasnis and Long (1979) found that deaf students are more field-dependent when compared to hearing students and that spatial skills are significantly related to performance on a field-dependence test. They have suggested that the effect of auditory deprivation and/or knowledge of sign language for congenitally deaf individuals may be weak cerebral lateralization and thus greater fi[illegible]-dependence.

Thus, we can anticipate that a hearing-impaired child, whose cognitive style preference is for spatial reasoning, will have difficulty with nonspatial cognitive tasks. Some researchers assert that a hearing-impaired child who uses visual communication systems may be using the right hemisphere of the brain; therefore, cognitive tasks of a logical/sequential nature requiring left-hemisphere activity may be understandably difficult. This area remains controversial.

11. Working with More Than One Type of Data: Recent research (Ottem, 1980) indicated that hearing-impaired learners experience more difficulty on tasks requiring reference to two items of data than do hearing individuals. This research placed the fault with the hearing world, which has imposed on the deaf population a requirement about simple and unambiguous communication that is obtained by referring to single events.

12. Linguistic Abstraction: Hearing-impaired adults are reported to be able to abstract and integrate the semantic content of sentences into holistic semantic ideas (Brewer, Caccamise, and Siple, 1979, p. 22). Brewer et al. suggested that the abstraction process itself is a basic cognitive process whose functioning is "quite ubiquitous" and that the way in which the process operates in an individual is related to world knowledge and experience as well as to linguistic skills. But, they note that further research on children is needed in this area. Moores (1978) also challenged the traditional notion that hearing-impaired children are concrete thinkers, and he found no evidence to support that hypothesis (p. 137).

13. Use of Symbols: Furth (1964) remarked that deaf people grow up without a symbol system for communication, but a careful reflection on the nature of manual systems would seriously challenge his point. Manual systems of communication are also clearly based on symbols. More recently, however, Furth has implied that deaf people do use symbols. He noted that among deaf adolescents, symbolic life is simpler, more reality-oriented, and more firmly anchored in the self (1973, p. 49). He also made a useful differentiation between symbol discovery as a process and the use of symbols, and he reported a study in which 16-year-old deaf students were found to be significantly behind their hearing peers in discovery of symbols (1973, p. 59).

The crux of Furth's approach was the assumption derived from Piaget's work that intelligent thinking is not based on language, but is an internal process independent of language (Furth, 1964, p. 228). Moores challenged Furth's position as failing to demonstrate that deaf people lack language or are inferior at the formal operational level (Moores, 1978, p. 134). In fact, Suppes (1972) argued that deaf people are indeed using a type of language, but are using it internally (p. 41). Moreover, Debes and Williams (1978), in a seminal paper on visual literacy, indicated that for a person reading manual communication, no cognition occurs that is separate from or not based originally on signs that have been read (p. 142).

In recent years we have also witnessed a trend to actively intervene in the cognitive performance of deaf learners in terms of efforts to improve that functioning; these efforts are indicative of an encouraging philosophical point of view that maintains that deaf learners have the same range of intellectual potential as the hearing population and can achieve that potential if the environment, instruction, and materials are appropriate. In the later section of this chapter on Cognitive Interventions, the results of these efforts will be examined further. The results thus far can be summarized by the statement that indeed that potential is beginning to be realized.

As we then look backward at the history of attitudes toward the cognitive potential of deaf persons, we can identify a trend that passes from outright bias and in many cases discrimination, through the several phases of comparing deaf and hearing learners on some more specific measures but still over-generalizing or oversimplifying the results, through a period of more systematic analyses which remove the tendency to over-generalize but still confuse the thinking and language issues. The history then moved to a time when the performance of deaf persons began to be analyzed on its own terms and with a better understanding of the particular conditions under which a deaf learner develops; and that phase led in turn to the present time when those more specific analyses continue side by side with active efforts to improve cognitive performance of deaf learners in the firm belief that such improvement is not only possible but essential to accomplish.

Current Issues

1. Neuroscience

The fascinating area of neurological organization in the deaf learner, as compared to the hearing learner, has received much focus in recent years. The temptation is strong to become reductionist in terms of attributing most differences between hearing and deaf persons to differences in brain organization alone. While it is important to resist that temptation and to remember that much research remains to be done and that there remain also other social and psychological factors, it is nonetheless useful to examine what the research to date has indicated in regard to the organic aspect of these differences.

The research on deafness and the specialization of the brain hemispheres has been in some cases ambiguous because of difficulties with research methods; however, there is evidence that deaf persons do not have the same specialization in the left hemisphere of the brain for language functions (Kelly and Tomlinson-Keasey, 1977; Phippard, 1977). We know that deaf adults who have had deaf parents, have used sign language from birth, and have various types of aphasia as the result of strokes do show left hemisphere specialization for language and right hemisphere processing in the visualspatial area, as is found with most hearing persons (Bellugi, 1983). The conclusion from this finding is that the difference in lateralization is not the result of auditory deprivation or deafness, but rather is the result of a lack of early language stimulation (Kusché, 1985).

The implication of such findings is clear in terms of intervention at an early age with the deaf learner, so as to work at reducing or preventing deficiencies in linguistic processing, memory, reading, and hemispheric specialization.

At this time, even though research has indicated that hemispheric differences exist between hearing and deaf persons in processing both non-linguistic and linguistic stimuli, it is not clear whether these findings represent differences in brain organization, or information-processing strategies, or both (Greenberg and Kusché, in press). In addition, it is essential to remember that the deaf population is by no means homogenous in regard to hemispheric specialization; the factors of linguistic skill, proficiency in verbal and sign language skills, genetic factors, and early environment are all important to the development of cerebral specialization (Greenberg and Kusché, in press).

To further complicate the topic, the research on handedness indicates that deaf children do not appear to be as strongly lateralized as hearing children when hearing losses are greater than 90 dB (Weston and Weinman, 1983). Hearing boys appear also to be more strongly right-sighted then deaf boys but the same differences are not found for girls (Gottlieb, Doran, and Whitley (1964). And the work of Boyd (1967) indicated that deaf children showed better performance with their least preferred hand in regard to speed of manual dexterity.

2. Cognitive Processes

Cognitive style is a theoretical construct which has some useful classroom implications. An important dimension of cognitive style is the continuum of field dependence. A style of field-dependence is the tendency to use external referents, to experience surroundings in a rather global fashion, and to passively conform to the prevailing context. On the other hand, field-independence is the tendency to rely primarily on internal referents and to perceive one's surroundings analytically, experiencing objects as separate from their backgrounds. A study by Gibson (1985) indicated that the differences in developmental pattern on this dimension are not attributable to degree of hearing loss or age of onset of hearing loss; this finding indicates that deaf persons can have access to cognitive restructuring skills regardless of their location on the field dependence/independence continuum.

The topic of metacognition is an important one in the field of cognitive education. The term refers to the process by which a learner monitors, consciously plans, and retroactively evaluates the mental processes by which he or she solves a particular problem. However, it is useful to ask about the facility which deaf learners have in carrying out this process, which is considered to be essential in becoming a better thinker. Several experiments have indicated that indeed the deaf learner is as capable as the hearing learner in carrying out metacognitive activity. In an experiment on the metacognitive awareness of deaf

adolescents, Clark (1985) studied students' metacognitive knowledge of reading as reported by the learners themselves. She found that the deaf adolescent reader, whether strong or weak as a reader, had the rudiments of metacognitive awareness of all reading areas studied, and found that deaf and hearing readers demonstrated similarity in that regard.

In an excellent summary of the findings to date on the cognitive development of hearing impaired learners, Greenberg and Kusché (in press) indicate that deaf children first begin to show developmental delays near the end of the preschool years. Delays involving visual attention and perception do not appear to be serious, but when visual perception leads to incorrect inferences, some significant delays are seen. A large body of data indicates that deaf learners rely heavily on visual-spatial perception and processing, and have strength in simultaneous visual processing which is holistic. As indicated above in the section on the organic or neuro-anatomical aspect of cognition, weaknesses among deaf learners are found in verbal-sequential and abstract processing. Greenberg and Kusché posit that the linguistic deficits among deaf learners result in some experiential deficits, and those deficits in turn affect some areas of cognitive development and information processing. For example, appropriate labeling and categorizing information in linguistic form can lead to changes in the learner's visual perception of reality and then in turn contribute to the formation of new concepts.

Every school subject area has certain cognitive prerequisites which are essential for progress within those subjects. A clear example would be the area of reading comprehension. Various researchers in the field of reading have used what is known as schema theory (Rumbelhart, 1980) to develop better understanding of the reading process. The theory incorporates the use of schemata, the process of spontaneous comparison, and categorization--all important to the reading process; this approach views reading comprehension as the process of correctly accessing a cross-indexed conceptual filing system (Berchin, 1989). One may explain this notion of a file by thinking of each concept as having its own file in the mind, and the learner adds to the file by relating additional information to it, but the incoming information must also be related to what is already in the cognitive framework--in this way, the individual uses existing knowledge to expand upon incoming information and that process leads to the best opportunity for comprehension (Berchin, 1989). A strong explication of these ideas can be found in the work of Collins and Quillian, 1969; Collins and Loftus, 1975; and Kintsch, 1977.

Prior research has indicated that deaf learners have restricted semantic fields (Restino, 1969), and have difficulty in word definitions (Silverman and Rosenstein, 1969). Hearing-impaired children are similar to hearing children in their use of semantic clustering for the grouping of words (Hoemann, Andrews, and DeRosa, 1974; Tweeney, Hoemann, and Andrews, 1975; Liben,

1979), but they have a comparatively lower ability to recall categorizable items.

The work of Feuerstein (1980), explained elsewhere in this paper in regard to the program Instrumental Enrichment, provides classroom teachers with a specific intervention program that focuses on the development of particular cognitive skills, followed by particular activities in metacognition and opportunities to apply those skills to subject matter. Within that program are activities in both comparison and categorization, which are directly applicable to improving the performance of deaf readers.

An experiment conducted by Berchin (1989) examined the effect of the spontaneous comparison and categorization activities within the Instrumental Enrichment program on the reading comprehension of a group of deaf learners. Results indicated a significant treatment effect for the subjects in reading comprehension, in addition to their acquisition of the operation of categorization itself; in addition, they indicated a near-transfer of spontaneous comparison. A critical component of this intervention is the process of mediation, in which the instructor assists the learner through a variety of strategies including probing questions, suggestions of alternative strategies, and assistance with interpreting the stimuli of the problem. The results of this study are consistent with other studies done by Keane, 1983; Krapf, 1985; and Martin and Jonas, 1986. A particularly critical component within the mediation activity is the step of input manipulation, which is supported by the prior research of Huberty and Koller,

1984, who found that deaf learners may have more difficulty with initial input of information than hearing persons. This study, then, adds to the growing corpus of work supporting the importance of carefully trained teachers in the mediation area using appropriately selected cognitive materials for the enhancement of cognitive skills in deaf learners.

3. The Role of Language in Cognition

a. Traditional Views

We have alluded numerous times to the interaction between language and cognition. This critical area has been a source of puzzlement to researchers and educators for many years. The general theories in regard to this topic can be divided into many categories, but two would be psycho-linguistic and socio-linguistic. The psycho-linguists focus on the behavior underlying the development and use of language on a psychological level, and the work of Vygotsky is an important example of work in that area. Socio-linguists, on the other hand, try to explain the relationship between language and thought using observations of the social use of language, distinguishing between language used in formal versus informal communication. These two broad categories of theory should be brought to bear on the topic of language and cognition in the hearing impaired as well.

Quigley and Paul (1984) underline two questions that have engaged the interest of investigators in the past:

(1) whether quantitative or qualitative differences exist between deaf and hearing people in various dimensions of cognitive functioning, and

(2) whether there is a relation between language and thought, and if there is one, its nature.

In the field of linguistics, the argument about the primacy of language over thought or thought over language has been a long-standing one. The work of Benjamin Whorf concluded that language determines thought (known as the Whorfian Hypothesis). However, studies of hearing children by numerous investigators with deaf children have indicated that much perceptual and cognitive development takes place prior to language development, and thus does not support the view of Whorf (Quigley and Paul, 1984). A weaker form of the Whorfian Hypothesis indicates that although language does not dictate thought, it nonetheless has a significant influence on it; it is probable that most educators would agree with this view, and it remains for additional research to study this interaction more directly (Quigley and Paul, 1984).

Cognitive theorists oppose the idea that language is independent of other cognitive processes, and state that language is a "mapping out" of the cognitive skills that the individual has at that moment (Quigley and Paul, 1984). Most educators today would probably agree that the argument about origin may be, if not specious, at least an untestable one at this time, and that the critical point is that language and thought are at least interactive. In the meantime, additional studies are under way on this fascinating topic, and it behooves all educators and others who work with hearing-impaired persons to watch closely the results of these investigations.

A major problem in understanding the relationship between language and cognition in deaf persons is the mode of communication; spoken languages and manual languages use very different ways of expressing ideas. As was mentioned in an earlier section, spoken languages use mechanisms based on sequence while manual or visual languages use mechanisms based on spatial relationships. Yet, the reader will recall that in the section above on neuroanatomical aspects, there is still no strong evidence to support major differences in brain functioning between hearing and deaf persons at this time. Rodda and Grove (1987) correctly criticize the continuing trend to regard speech, American Sign Language, English, thinking, and auditory or visual perception as separate systems; instead they call for investigators to focus on the underlying and integrative cognitive processes and their neurological representations.

Considerable research has indicated that prelingual profoundly deaf persons rarely, if ever, reach high levels of proficiency in spoken language structures (Rodda and Grove, 1987). Numerous detailed summaries are available on this topic, and do not need further elaboration at this point; however, the implications for the workplace are clear--adjustments and accommodations on the part of the hearing persons in the work environment are as important as adjustments and accommodations on the part of the hearing-impaired worker.

b. Current Theories

In their penetrating analysis of language and cognition in

regard to deafness, Rodda and Grove (1987) identify two general problem areas for the deaf language user. The first is th difficulty in coping with the complex rule systems of English grammar, and the second includes processes such as relative clauses which involve resequencing and transforming entire segments of discourse. Further, in spite of some areas of performance in which hearing-impaired children perform better than hearing children, hearing-impaired children consistently perform lower than hearing children in short-term memory and skills in the English language. These authors indicate a relationship between memory and English skills in the ability of deaf children to develop phonological codes, thus implying the need for alternative strategies in visual coding. Some years ago, in fact, Vygotsky expounded on the notion of "polyglossia" which in modern terms would mean the acquisition of language (not speech) by any and all means possible, as the unique feature of the deaf child's development and as the most productive path to the child's intellectual growth (Knox and Kozulin, 1988).

We are led, then, to the current conviction that language development occurs in numerous ways, and that for the deaf learner a manual form of communication may be essential for that development, although there are some children for whom oral methods seem to be adequate. Rodda and Grove (1987) underline that a manual form of communication is a more effective medium of reception than lipreading for the majority of severely prelingually deaf persons; for those hearing-impaired persons for whom sign language is their

first form of communication, signs are easier to perceive and process than lip movements. But sign language alone is somewhat less effective overall than Total Communication and much less effective than reading. They indicate that the relevant data would render the oral-manual controversy somewhat absurd, since neither oral methods nor manual methods alone are best; instead, both are inferior to a combination of methods and reading.

Genuine conclusions about the topic of language and cognition in the deaf learner are, as is evident, not possible at this time in any large-scale sense. While the continuing development of new data is exciting and the opportunity for additional research is appealing, it is at the same time perplexing for the professional practitioner to derive a clear sense of action for her or his work with deaf persons. The most appropriate course of action for practitioners would seem to encompass at least the following principles:

1. Provide the deaf learner with all possible modes of communication,
2. Become proficient as a professional in as many of those modes as possible,
3. Actively encourage colleagues to do the same,
4. Maintain high expectations for the deaf learner since no evidence suggests anything other than the same range of intellectual potential for deaf persons as exists among hearing persons,
5. Orient employers to provide a work environment for the deaf person which reflects these ideas,
6. Insist that professional journals provide a balanced coverage of research in this field,

7. Remain an enthusiastic consumer of that research through professional conferences and professional reading

8. Encourage deaf persons to become trained researchers, and

9. Encourage deaf clients and students to participate in carefully controlled experiments to further answer the many puzzling questions in this fascinating field.

Assessment of Cognitive Performance

Another of the critical issues in the cognitive performance of hearing-impaired persons is the appropriate assessment of both the performance and the potential of deaf learners. At several points previously in this chapter, we have implied that the area of assessment has resulted in some unfairness in the past, and we have also alluded to some of the varieties of measures that are being used at this time. As was noted earlier, traditional measures of intellectual performance sometimes include only a verbal dimension, which in many cases is not an appropriate assessment for a deaf learner; however, some other instruments do employ both verbal and performance dimensions. Still another approach to the fairness question relates to the presentation of the verbal materials of such measures but using sign-language versions during the presentation.

Miller (1985) developed a signed presentation of the verbal scale of the WISC-R for testing profoundly deaf children. Findings indicated that this version produced a more complete profile of the deaf learner, and revealed that non-signed versions can prevent the deaf learner from receiving the entire message from the tester, and therefore a less than complete profile is obtained for those

learners. Luetke-Stahlman (1985) makes a strong case for approaching assessment of the cognitive potential of hearing-impaired learners by using cognitively demanding but context-reduced measures.

The work of Feuerstein (1979, 1980) assesses cognitive potential through a system which first attempts to teach the cognitive skill to the learner and then (and only then) tests for it, thus removing any effect of cultural disadvantage. When applied to deaf learners, it was found that deaf persons upon being given mediated intervention performed significantly better than a comparison group using traditional psychometric procedures (Keane, 1983; Keane and Kretschmer, 1983).

The tendency to rely on only the performance measures of I.Q. tests when working with deaf learners is a clear attempt at fairness. However, the recent work of Braden (1987) indicates that the performance I.Q. tends to obscure important differences between children who are hearing, children who are deaf from hearing parents, and children who are deaf from deaf parents; thus, it is necessary to develop and implement alternative forms of measurement.

Therefore, the state of the art in the appropriate assessment of hearing-impaired learners is still at a fluid and in some cases even early stage; it behooves anyone working with deaf learners or deaf adults in the workplace to demand balanced assessment measures which will be interpreted on their own terms and in the context of the specific history of the deaf individual and her or his etio-

logy. The next five years show promise of important improvements in the assessment of cognitive potential for deaf persons.

Intervention Strategies: Learning to Learn

a. Theoretical Bases

The data that have been reviewed and the conclusions from the more recent studies have all led to a consistent picture: not only are deaf learners capable of the same range of intellectual performance as their hearing counterparts, but it is possible to improve the intellectual functioning and cognitive potential of deaf (and hearing) learners. This latter implication, however, requires special interventions and appropriate pedagogy on the part of appropriately trained instructors. This final section, then, is a review of work that is under way to carry out productive intervention in improving the capacity of the deaf learner to learn.

The authors of one particular thinking and language skills program for hearing-impaired students have pointed out that thinking skills are not only essential to the development of reasoning and critical thinking, but also are fundamental to the child's total learning ability. These skills include the ability to recognize relationships, store and recall information, recognize logical order, evaluate information, do original thinking, adapt the known to new situations, do trial-and-error thinking, and acquire an understanding of different types of concepts (Pfau, 1975, p. 4).

Furth has defined logical and conceptual thinking as the tendency toward an intellectual grasp of reality undistorted by

symbols (1964, p. 187). Bruner (1969) has described thinking as a process originating with problem-solving strategies that are originally developed in acquiring specific skills. While Furth's latter point about symbols in the thinking process is debatable, these definitions provide a working tool for examining the need for curricular interventions for hearing-impaired populations, as will be discussed later.

An interest in cognitive training began to emerge in the late 1960s and early 1970s when researchers from several different orientations within special education began to focus on self-control processes. A longer tradition exists in teaching general and task-related strategies to exceptional children (Meichenbaum, 1980, p. 84). Among the relatively recent trends is a technique called cognitive behavior modification (CBM), which is defined as the student acting in some way as his or her own trainer or teacher through self-control, self-verbalization, self-instruction, and self-reinforcement. Verbalization by the student of what the student is doing is another trait of this technique. CBM also often involves identifying a series of steps or strategies for problem-solving (Lloyd, 1980, p. 53). Unlike CBM, in which a single general strategy is taught, another approach called strategy training teaches specific strategies for specific types of problems through a rote set of sub-skills and rules for combining them as applied to a class of problems (Lloyd, 1980, p. 59).

A characteristic of some CBM programs is metacognition, which is defined as one's cognitions about cognitions, or the thinking

about one's own thinking. The processes involved here include analyzing the problem, reflecting on what one knows that may be appropriate to a solution, devising a plan, and checking one's progress (Brown, 1978). Exceptional children have been considered to be deficient in metacognition as well as in certain academic areas.

Impulsivity is another characteristic of some learners who are achieving below their potential. One deficiency in the impulsive learner has been in the area of well-developed habits of self-observation (Gutentag and Longfellow, 1977), which is related to the skill of metacognition. Jerome Kagan's work (1971) has been significant in identifying impulsivity (versus reflectivity) as a learning style and the attendant problems that impulsivity brings. A number of teaching strategies have been evolved for teaching the impulsive learner; among them, strategy-training has been experimentally demonstrated to be effective in making the learner operate in a more reflective manner (McKinney and Haskins, 1980, p. 48).

Systematic intervention programs, then, for working with the cognitive deficits of exceptional children are not new phenomena. Such intervention techniques as those just mentioned have had varying success. That success has been related to certain identified variables. For example, it has been shown that a child's concept of causal relationships influences his or her reaction to an intervention program (Henker, Whalen, and Hinshaw, 1980, p. 23). In addition, individual differences in language and cognitive maturity are also considered to be influences on the appropriate-

ness and effectiveness of cognitive training interventions (Keogh and Glover, 1980, p. 79). One unresolved question is whether an intervention that is ineffective may be trying to use nonexistent prerequisite skills in the child when it should be developing those prerequisites (Keogh and Glover, 1980, p. 81).

Intervention programs used until now have had limited success in the critical area of generalizability (i.e., the transfer by the learner of learned skills to other areas where those skills can be appropriately applied). It has been suggested that generalizability may be limited by the strategies themselves; that is, transfer to a novel task with similar stimulus and response properties presents no difficulty, but transfer to a task involving different materials and responses is often not obtained (McKinney and Haskins, 1980, p. 49). On the other hand, generalizability across training programs appears more likely as a child matures because older children are more aware of the strategies available to them (Loper, 1980, p. 6). It has been recommended that generalizability can be enhanced if the training procedure ensures explicit feedback and includes direct instruction in generalizing (Meichenbaum, 1980, p. 86).

While few of the previously mentioned researchers have focused on the hearing-impaired learner, their work with exceptional learners in the cognitive realm suggests particular points of rationale for this volume.

Studies of cognition in relation to the hearing-impaired population have also been numerous in recent years. After an

initial focus on I.Q., the center of attention now is on the processes involved in cognition and perception. It appears to be a well-accepted fact that hearing-impaired subjects have the normal range of intelligence when tested on performance, rather than the verbal, subtests of various I.Q. instruments (Drever and Collins, 1928). An exception is found in students who have neurological impairments in addition to their hearing loss (Vernon, 1968, p. 8). In a more detailed examination of hearing-impaired subjects by specific etiology of loss, Vernon found some differentiation in performance; for example, the mean I.Q. for genetically deaf students was reported to be 114, while that for postmaternal rubella deaf students was 95 (1968, p. 7). We also know that when the influence of age is controlled, statistical data on hearing-impaired children indicate strong relationships between achievement test scores and variables such as age of onset of hearing loss, cause of loss, degree of loss, additional handicapping conditions, ethnic background, and type of special educational program (Jensema, 1975).

In summary, then, current theories about cognitive interventions and the potential for learning how to learn are based on a philosophy that high expectations are appropriate and that we are still in an era where much is yet to be learned; therefore, an open mind and a thrust toward further empirical investigations are most appropriate guiding principles. Let us look now at some of the specific cognitive intervention programs and their findings to date.

b. Applications

The specific types of intervention for promoting the capacity for learning in the deaf learner have included: special programs developed by teachers, commercial programs adapted for use with the hearing-impaired learner, and other cognitive education approaches which have been adopted for use with hearing-impaired classrooms. Some of these interventions have had anecdotal information gathered about them, while others have had more rigorous empirical studies conducted around them. In some cases, the programs used have required special in-depth teacher training or re-training, while others have been incorporated with a minimum of teacher re-training. All, however, have theoretical bases that share the common persuasion that the deaf learner is capable of improved cognitive performance from where he or she is at the moment of beginning the intervention.

One example of a teacher-developed program would be the one developed by Dietz (1985) in which the computer program LOGO was used to promote an understanding of geometric concepts by focusing on the abstract, non-graphic list-processing abilities of that particular computer language. Students were reported to become more persistent with dealing with difficult problems, and willing to explore on their own without continuous feedback from the teacher; evidence of improved and extended planning behaviors was also reported for the high school hearing-impaired learners in this small study. A separate study with elementary-age hearing-impaired children by Luft (1985) using LOGO found that students developed

new insights into how to become more precise, took more risks in problem-solving situations, and developed a better motivation toward achievement.

The Philosophy for Children program (Lipman, Sharp, and Oscanyan, 1980) was applied to hearing-impaired children in the context of philosophical inquiry in a small-scale study in a day school for the deaf (Rembert, 1985). The program, which emphasizes philosophical dialogue, was reported to result in a more clear expression by students of their ideas, more tolerance of the opinions of others, a strengthening of analysis skills in school subject areas, and greater patience in carrying out philosophical inquiry.

Martin and Jonas (1986) studied the effects of the program, Instrumental Enrichment, developed by Feuerstein (1980) with an experimental and a control group of hearing-impaired adolescents over a two-year period. The program requires teachers to use specific paper-and-pencil exercises on such cognitive skills as comparison, analysis, classification, and sequence, and to mediate students' reflection on the cognitive strategies they have used (metacognition), and then helping them to make applications (bridging) to the subject matter under study. Special in-depth teacher training is needed to implement the program. Results included significant improvement in tests of reading comprehension, mathematics computation, mathematics concepts, logical reasoning, as well as the observed application of greater detail, better organization, and greater precision in posed problem-solving

situations. Teachers not involved with the implementation also reported that Instrumental Enrichment students in their classes demonstrated improved attention to detail and a tendency to explore alternatives to solutions to a problem in the subject matter context, as compared to students who had not had this intervention. These results have been replicated in a study by Craig (1989) in another school, using the same approaches with similar methods of assessment. Similar results were noted in an application to the college-age hearing-impaired learner in another study using the same methodology and the same program (Martin and Jonas, 1987).

Another investigation (Keane and Kretschmer, 1987) found that the Feuerstein approach of mediated learning as outlined above also resulted in significant transfer of learning on other cognitive and behavioral measures not associated with the teaching method itself (Instrumental Enrichment).

Another study (Krapf, 1985) with deaf adolescents using mediated learning experiences similar to Instrumental Enrichment demonstrated that this approach has a measurable and positive impact on figural analogic reasoning; it was also found that deaf adolescents as a result of this methodology can use two or more sources of data if mediation takes place, and students were found to be capable of using metacognitive problem-solving skills in the sense of being able to explain why certain strategies did or did not work. The results of this study also demonstrated that deaf adolescents after mediation will use symbols and operations that reflect symbolic relational thought--that is, formal operational

thinking. Still another study with Instrumental Enrichment and deaf adolescents at the North Carolina School for the Deaf (Haywood and others, 1988) found significant positive effects from Instrumental Enrichment on students' reasoning aptitudes, although sharing inconsistent effects on achievement in academic areas.

In an active intervention with the hearing-impaired child's cognitive development, Yoshinaga and Downey (1986) demonstrated that such children can be helped to acquire appropriate schemata by teaching concepts and labels, elaborating, using questions to fill in conceptual gaps, and using imaginary play and storytelling.

In a study of metacognition and reading, Clark (1985) concluded that metacognitive abilities are useful in educational diagnosis and that strategies for students to monitor their comprehension and evaluate themselves should be taught as an integral part of a reading program in working with hearing students; this result would support the metacognitive findings of the study reported above by Martin and Jonas (1986) in which metacognitive discussion with deaf learners was also proven to be productive.

While several of the interventions cited were with older deaf students, it is equally important to focus on <u>early</u> intervention as well. Of course, the modality for intervention with the younger hearing-impaired (or hearing) learner would need to be more concrete, but the principles of intervention and mediation are equally important at the early age level. Many of the early childhood nterventions appear to concentrate on early training in language and communication, and can only be considered to be

cognitive interventions if they explicitly focus on cognitive strategies themselves and help students to consciously apply them to subject matter and other applications. Little has been done as yet in systematic intervention with deaf infants, and Nowell (1989) is correct in calling for the development of such techniques at this time.

To summarize, the most promising approaches to planned intervention appear to be those which have: (a) a strong theoretical basis, (b) a focus on teacher training or re-training in the specific methodology, (c) a comprehensive incorporation of several, rather than only a few, cognitive skills, (d) regular opportunities for students to apply these skills to subject matter, and (e) explicit metacognitive focus in terms of helping students to become aware of the cognitive processes and strategies which they are learning and applying. Clearly, additional research, particularly of a longitudinal nature, is needed. Greenberg and Kusché (in press) conclude that the reasoning and problem-solving literature indicates few differences between hearing and deaf children when mediation occurs through visual modes; the still small corpus of literature on this topic, they indicate, suggests that educational intervention is beneficial in making improvements in the reasoning and problem-solving abilities of deaf learners.

Conclusion

In looking both backward and forward in the fascinating area of cognitive development in the hearing-impaired learner, three concepts from the field of futurism are useful. Futurists make a

distinction between the probable future, the possible future, and the preferable future. The probable future is one in which, with no specific or pro-active initiative, it is possible with high likelihood to predict what the future will hold. The possible future is that scenario which could happen with some perhaps unexpected circumstances, although it is not highly likely. And the preferable future is that scenario which will happen only if specific initiatives are taken to ensure it. What, then, would be the probable, possible, and preferable futures in regard to the cognitive development of the hearing-impaired learner?

We can perhaps quickly dispose of the possible future as one in which we can imagine some unlikely events. A possible future is one in which educators and researchers would return to the old conviction that deaf learners have lower potential than hearing learners, or that no further serious investigation is worth undertaking in regard to cognition and deafness. This possible future is likely only if some complete cut-off of support for research were coupled with a change in attitude back to that of the earlier times discussed in the historical section of this chapter. The writer is certain that no reader would hope for such a possible future.

A probable future--one in which, with little intervention, certain events will happen with high likelihood--would include the continuation of certain trends that have already begun. For example, it seems highly likely that the just-beginning interest in neuro-anatomy as applied to cognition and deafness will expand

steadily; in addition, there will probably continue to be a focus on the interaction between language and thought, and we can also expect that the debate will persist about the primacy of one over the other as well as their interdependence. It is also probable that the gradual development of improved tools for assessment of the hearing-impaired learner's cognition will continue, with an emphasis on broader and more fair approaches to that assessment. And, it would appear that the continuing issue of American Sign Language versus other manually-coded systems of communication will be a source of debate, both in regard to the teaching of language itself, as well as to their respective relationships to the development of higher cognitive processes.

On the other hand, the preferable future is, of course, less likely without specific planning, initiative, and support (both human and financial). However, the preferable future is one toward which we should all strive. The preferable future, then, would include at least the following in regard to cognition and deafness:

1. Active support for each of the elements which were mentioned above under the probable future--in particular: serious investigations into modes of communication and cognition, neuro-anatomy and cognition, and assessment tools of a broader nature.

2. Incorporation of training in cognitive education within teacher education programs in deaf education.

3. Development and empirical testing of additional varieties of planned interventions in the classroom, and longitudinal studies to accompany them.

4. Greater emphasis and support for early intervention in cognitive development, including the preschool years.

5. Focus on the education of parents in terms of not only appropriate expectations of their deaf children but also appropriate interventions which they can do during the preschool years to promote higher-level thinking in their children, whether the parents are hearing or deaf.

6. Production by educational publishers of materials which will provide a greater cognitive challenge to the learner than at present.

7. Systematic education of employers and hearing colleagues of the deaf worker in the workplace in how to maintain high cognitive expectations (as well as adaptations) which are appropriate for the hearing-impaired person.

While it is tempting to declare that the preferable future is possible only with additional funding, such is not entirely the case. Although funding is a necessary condition, it is not a sufficient one; the sufficient condition is the continuing conviction, based now on clear evidence, that the hearing-impaired learner can indeed achieve the highest levels of cognitive performance, given the appropriate conditions and dedication by professionals. That challenge is the one to which educators and other professionals working with and on behalf of hearing-impaired persons must rise now.

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