DEVELOPMENT AND TRAINING OF REFERENTIAL COMMUNICATION IN CHILDREN WITH MENTAL RETARDATION

by

Marni Diane Brownell

A thesis
presented to the University of Manitoba
in fulfillment of the
thesis requirement for the degree of
DOCTOR OF PHILOSOPHY
in
Department of Psychology

Winnipeg, Manitoba

ISBN 0-315-76639-5

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ABSTRACT

One deterrent to adaptive functioning in individuals with mental retardation involves deficits in communication skills, such as referential communication. Two experiments were conducted in order to compare referential communication skills of mentally retarded and nonretarded children and adolescents, and determine if training found to be effective with young, nonretarded children would improve these skills for mentally retarded individuals.

The purpose of Experiment 1 was to compare referential communication skills of mentally retarded and nonretarded children and adolescents. Sixty-nine nonretarded children were matched with 69 mentally retarded subjects on the Quick Test, which measures vocabulary development. These pairs were divided into three groups differing in mental age (MA): mean MAs 5, 8, and 11 years. Each subject received 36 trials in a referential communication task. On each trial, subjects were asked to describe one designated referent picture so that it could be distinguished from one or two other pictures. On 12 trials, two dissimilar pictures were presented. Twelve trials depicted two similar pictures where comparison activity was necessary for adequate

performance, and on the remaining 12 trials, three similar pictures were displayed, requiring more sophisticated comparison activity.

All subjects produced informative messages on trials requiring no comparison activity. On trials where comparison activity was required, performance of the 5-year MA group was inferior to that of the 8-year MA group, which in turn was inferior to that of the 11-year MA group. Nonretarded subjects significantly outperformed mentally retarded subjects on trials requiring comparison activity for adequate performance.

The purpose of Experiment 2 was to determine if training found to be effective with young, nonretarded children would improve the referential skills of mentally retarded children and adolescents. Half of the mentally retarded participants who had not consistently produced informative messages in Experiment 1 were given perceptual feedback training, whereas the other half served as controls. Perceptual feedback training involved providing explicit instructions as to why messages were informative or uninformative. One week after the 24 training trials, they received 16 posttest trials with materials used in training and 16 transfer trials with novel materials. Perceptual feedback training significantly improved communicative competence of the

mentally retarded subjects during training, as well as on posttest and transfer tasks.

The results of these experiments demonstrate that mentally retarded children and adolescents lag behind MA-matched nonretarded children in referential communication skills. They can learn rules of communication, however, and by doing so, enhance their communicative competence.

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ACKNOWLEDGEMENTS

I would like to express my sincere gratitude to my advisor, Dr. John Whiteley, for his guidance, encouragement, and assistance throughout this project. I would also like to thank my committee members, Dr. Warren Eaton, Dr. Les Leventhal, Dr. Murray Singer, and Dr. Lois Brockman, and my external examiner, Dr. Susan Sonnenschein, for their insightful suggestions and comments.

I am greatly indebted to the superintendents, principals, and teachers in the Winnipeg school divisions for their cooperation in the data collection phase of this project. I am especially grateful to all the students who participated, and to their parents for their interest and cooperation. Thank you also to Kim Saudino for her assistance with data collection.

I would also like to thank the Natural Sciences and Engineering Research Council of Canada for supporting my work for four years with a postgraduate scholarship.

Finally, I wish to thank my parents and family for their continued support, understanding, and encouragement.

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INTRODUCTION

Development and Training of Referential Communication in Children With Mental Retardation

The American Association on Mental Deficiency (AAMD) defines mental retardation as "significantly subaverage general intellectual functioning existing concurrently with deficits in adaptive behavior and manifested during the developmental period" (Grossman, 1983, p. 1). Although deficits in intellectual performance have generally been regarded as the defining characteristic of mental retardation, the AAMD definition also acknowledges the importance of adaptive functioning. One deterrent to adaptive functioning involves deficits in interpersonal communication skills, which are common to all mentally retarded individuals (Grossman, 1983). Improvements in communicative competence of mentally retarded individuals should result in concomitant ameliorations in adaptive behavior. The present studies investigate the development of communication skills in mentally retarded children and methods for improving those skills.

The importance of interpersonal communication skills for adaptive functioning has been highlighted by the results of research on mainstreamed classrooms. In these classes, mentally retarded children are integrated with nonretarded children. Although well-intentioned, mainstreamed programs have sometimes led to social isolation of mentally retarded children (Gresham, 1982) and social rejection by their nonretarded peers (Gottlieb, 1975). Gresham (1982) suggests that a major problem with mainstreamed programs is their reliance on the faulty assumption that social interaction and acceptance will increase by merely placing retarded and nonretarded children in the same classroom. Gresham contends that mentally retarded children lack the social competence necessary for social interaction and peer acceptance. One important factor involved in social competence is communicative ability (Guralnick & Groom, 1987). Because communication problems are common to all mentally retarded children (Grossman, 1983), and effective social interaction is highly dependent on effective communication skills, these communicative deficits will likely impede social interactions.

Social interactions often involve referential communication. Referents are defined as objects, events, or ideas about which people communicate by means of talking, writing, or gesturing (Rosenberg & Cohen, 1964). Social

referential communication refers to an interaction between a speaker and a listener such that both participants modify their behavior towards one another in an exchange of information about some objects or events (Whitehurst & Sonnenschein, 1985). Referential tasks usually require the description of some object or event, so that it can be discriminated from alternative, and often similar, objects or events. An example would be a child describing a desired doll to a store clerk, so that the clerk could distinguish it from several other dolls. If the dolls were all on view, the child could simply point to the desired doll to indicate his or her choice. If the dolls were not on display, however, the child would have to give a description of the doll that would distinguish it from other dolls with which the clerk could potentially confuse it. In the laboratory, referential communication tasks allow for the explicit definition of the referential array. For example, a designated speaker may have three objects placed before him or her and be asked to describe one of the objects so that a listener could choose it from among the same array.

Although referential communication is only one component of communication, Dickson (1982) suggests that a substantial amount of everyday communication involves referential exchanges. Referential communication is one of the most basic functions of language (Asher, 1979; Flavell,

1977; Glucksberg, Krauss, & Higgins, 1975), and it is a component of more complex types of communication (Asher, 1979). Examining the development of referential communication can add to our knowledge about the development of communication in general, as many of the same cognitive processes are involved (Glucksberg et al., 1975; Shatz, 1983). Indeed, enhancing referential communication skills may foster other cognitive skills, such as knowledge acquisition, vocabulary development, and metalinguistic awareness (Dickson, Hess, Miyake, & Azuma, 1979; McDevitt, Hess, Kashiwagi, Dickson, Miyake, & Azuma, 1987).

Models of Referential Communication

Young children tend to do poorly on referential tasks. Rosenberg and Cohen (Rosenberg, 1972; Rosenberg & Cohen, 1964, 1967) and Whitehurst and Sonnenschein (1985) have proposed theoretical models that attempt to explain the poor performance of young children and account for the development of referential communication skills.

Rosenberg and Cohen's Model

Rosenberg and Cohen (Rosenberg, 1972; Rosenberg & Cohen, 1964, 1967) have proposed a two-stage stochastic model of communicative competence. They suggest that in a

referential task the speaker first samples his or her vocabulary, or repertoire of descriptors associated with the referent, and selects a term with high association to the referent. In the second stage, the speaker compares the relative associative strengths of the sampled descriptor to each stimulus in the referential array. If the sampled term is highly associated to one or more of the nonreferents, as well as the referent, it is rejected and the speaker returns to the sampling stage. This process will continue, in the order of sampling then comparison, until the speaker is satisfied that the term selected is more highly associated with the referent than any of the nonreferents.

Lack of communicative competence evidenced in young children could be due to failure at either or both of these stages. During the sampling stage, restrictions in vocabulary could limit the repertoire of descriptors associated with the referent. During the comparison stage, communicative competence may be impeded by a lack of awareness of the necessity to engage in comparison activity.

Although much research has verified the importance of comparison activity to the development of communicative competence (e.g., Asher & Parke, 1975; Asher & Wigfield, 1981; Whitehurst & Sonnenschein, 1981), the conceptualization of referential communication as involving

a two-stage, often cyclical process is debatable. While empirical studies can demonstrate the relevance of certain processes and components, postulated within each stage, to the development of communication, it is difficult to demonstrate the stages themselves. As well, it is likely that other factors, besides comparison activity and vocabulary, play an important role in the development of referential communication skills (Asher & Wigfield, 1981). A more comprehensive and testable conceptualization has been put forth by Whitehurst and Sonnenschein (1985) to explain the development of referential communication skills in children.

Whitehurst and Sonnenschein's Model

Whitehurst and Sonnenschein (1985) propose a model that incorporates vocabulary and comparison activity as important elements of referential communication; however, referential processes are viewed as involving a number of learnable components and rules, rather than two stages. According to Whitehurst and Sonnenschein, referential communication involves three components, each comprising several subskills. They refer to these three components as substantive knowledge, enabling skills, and procedural rules. Changes in the components or subskills account for developmental changes in referential communication skills.

Substantive knowledge. Substantive knowledge refers to the factual or conceptual knowledge associated with the referential array. In order to communicate about certain objects or events, one must have some knowledge about them, and the domain-specific vocabulary necessary to impart that knowledge. According to Whitehurst and Sonnenschein (1985), any interaction involving referential communication is limited by the substantive knowledge of the least knowledgeable member of the dyad. If the concepts imparted by one individual are beyond the comprehension of his or her partner, then the communication will fail. The developmental nature of substantive knowledge is axiomatic: Individuals tend to acquire more knowledge in different areas, as they develop.

Enabling skills. Developmental changes evidenced in referential communication skills can also be accounted for by changes in enabling skills. Enabling skills refer to general abilities that are necessary, though not sufficient, for communicative interaction. For example, one must be able to perceive the referents and remember what has been perceived, in order to communicate about them. One also needs language to communicate about objects or events which are not in view. Social skills, such as being cooperative, are also considered enabling skills.

Procedural rules. Procedural rules refer to rules or operations one must utilize in order to communicate effectively. Whitehurst and Sonnenschein (1985) refer to rules as classes of actions on classes of stimuli. Procedural rules can be considered a subset of what Flavell (1981) refers to as metacommunicative knowledge, or knowledge about communication (Sonnenschein & Whitehurst, 1984b). That is, in order to utilize these rules, one must have some understanding of their contribution to communicative competence.

Whitehurst and Sonnenschein (1985) delineate four procedural rules that are relevant for the speaker in a referential interaction. The first procedural rule is referred to as the "listener rule." This refers to the attention a speaker pays to certain listener cues, such as status, knowledge, and ability, in order to produce a message that will likely be comprehended by the listener. The tendency of mothers to simplify their speech when interacting with young children (Snow, 1972) illustrates the operation of this procedural rule. Even children as young as 4 years of age show evidence of the listener rule, adjusting their speech in accordance with the age (Shatz & Gelman, 1973), cognitive abilities (Guralnick & Paul-Brown, 1977, 1980, 1984, 1986), and perceptual abilities (Maratsos, 1973) of their listeners.

The second of Whitehurst and Sonnenschein's (1985) procedural rules is termed the "feedback rule." A speaker using this rule attends to signs of noncomprehension on the part of the listener. This feedback leads the speaker to a reformulation of the message. Evidence of the feedback rule begins in children as young as 2 years, although at this age the response to feedback is fairly unsophisticated, consisting primarily of repetition of the original message (Wellman & Lempers, 1977).

The third procedural rule is what Whitehurst and Sonnenschein (1985) label the "difference rule," which is similar to the comparison activity postulated in Rosenberg and Cohen's comparison stage. The speaker is required to determine how the referent is different from other stimuli which may be similar to it, and to recognize the importance of communicating any differences to the listener. Whitehurst and Sonnenschein consider the difference rule to be particularly important to referential communication, and implicate failure to apply this rule as one of the main determinants of inadequate communication in young children. The difference rule is not reliably applied until 7 to 9 years of age (Whitehurst, 1976).

The fourth procedural rule relevant to speakers in referential communication is known as the "editing rule"

(Whitehurst & Sonnenschein, 1985). When applying this rule, speakers assess their message before it is delivered, in terms of listener and context cues, and determine whether it is likely to be understood. Although there is little or no work which has directly examined the development of a speaker's ability to evaluate his or her own message, information on the development of the editing rule has been derived from studies involving children's judgements of the adequacy of messages delivered by others (Whitehurst & Sonnenschein, 1985). This work (Robinson & Robinson, 1976, 1977a, 1977b, 1977c) suggests that children do not employ the editing rule before 7 years of age, and Whitehurst and Sonnenschein suggest that it may be several years subsequent to its emergence before the editing rule is well-developed.

The interaction of the components. Using the difference rule as an example, it is apparent that all three of the components of referential communication (i.e., substantive knowledge, enabling skills, and procedural rules) are implicated in the development of communication. In order to apply the difference rule, the speaker must have the perceptual ability to discriminate differences between the referent and nonreferents (enabling skills), know that it is important to describe differences rather than similarities (difference rule), and have the domain-specific vocabulary necessary to describe those differences

(substantive knowledge; Whitehurst & Sonnenschein, 1985). Whitehurst and Sonnenschein believe that each of these components are important to communicative success, and the skills involved with each develop at different ages. Although deficits in any of the three areas can account for the lack of communicative competence evidenced in children, Whitehurst and Sonnenschein suggest that procedural rules account for the greatest degree of developmental variance, and thus are "the keystone to successful communication" (Whitehurst & Sonnenschein, 1985, p. 16).

Empirical Studies

Research with Nonretarded Children

Whitehurst and Sonnenschein's (1985) model helps to explain the research findings with nonretarded children, which indicate that young children are notably deficient in referential skills (e.g., Robinson & Robinson, 1976, 1977a,c; Sonnenschein & Whitehurst, 1984b; Whitehurst & Sonnenschein, 1981). When asked to describe a referent so that a listener can choose it from among an array of similar stimuli, children 5 years of age frequently deliver ambiguous messages, which may apply to several of the stimuli (e.g., Flavell et al., 1968; Glucksberg et al., 1966; Sonnenschein & Whitehurst, 1984b; Whitehurst & Sonnenschein, 1981).

Glucksberg et al. (1966) employed a referential communication task using six novel forms for which common labels were not readily available. Speaker and listener were visually separated from one another, and each had the same six novel forms placed before him or her, as well as a pole on which to stack the forms. The speaker was to stack the forms, one by one, on the pole, explaining to the listener the order of the forms. The listener was to try to stack his or her forms in the same order, according to the speaker's instructions. Glucksberg et al. found that the 4- and 5-year-old children in the study did very poorly on this task. In fact, there were no trials in which both speaker and listener ended up with the forms stacked in the same order.

Five-year-old children perform poorly as speakers on referential tasks, even when it is demonstrated that they possess the requisite substantive knowledge and enabling skills for the task (Whitehurst & Sonnenschein, 1978, 1981). Whitehurst and Sonnenschein (1978) presented 5-year-olds with pairs of pictures of triangles. The triangles differed along one of three dimensions: color, size, or pattern. The children were given an attribute discrimination pretest in which they were asked to point to the big triangle, and then the small one, the red then the black one, the striped then the spotted one. Mistakes were rare. In another

pretest, the children listened while adults delivered informative messages as to which triangle to choose. Once again, mistakes were rare. These two pretests suggest the children possessed the receptive vocabulary and perceptual skills necessary to complete the task. When the children served as speakers, however, they often failed to provide their listeners with contrastive messages. This was especially true for children in the "complex condition," in which the relevant attributes varied along the three dimensions of size, color, and pattern from trial to trial. In this case the number of contrastive messages delivered did not exceed what was expected by chance.

According to Whitehurst and Sonnenschein (1985), young children fail on these tasks because they fail to apply the difference rule. That is, they fail to realize that, for a message to be informative, the referent must be differentiated from its surroundings. At this age, children tend to consider any correct description of the referent as informative communication, regardless of whether it distinguishes the referent from nonreferents (Robinson & Robinson, 1977b). Robinson and Robinson (1977b) had children watch two dolls engage in a referential communication task. The exchange was controlled such that half the time an adequate message was delivered by the speaker doll, and half the time the message was inadequate.

As well, half of each of the adequate and inadequate messages resulted in the correct choice of the referent by the listener doll, and half resulted in the incorrect choice. These researchers found that the younger children (5- and 6-year-olds) tended to judge both adequate and inadequate messages as good, as long as they described the intended referent in some way (Robinson & Robinson, 1977b,c). This was particularly the case when the listener chose the correct referent. By 7 years of age, however, children tend to judge adequate messages as good and inadequate messages as bad, regardless of the listener's choice (Robinson & Robinson, 1977b).

It is also not until 7 to 9 years of age that children reliably formulate informative, contrastive messages (Whitehurst, 1976). Whitehurst (1976) evaluated the types of messages produced by children at different ages. In this experiment, children were asked to describe the cup under which a marble was placed. Each child was presented with either two or three similar cups, each of which had a window to allow the child to see the marble. The cups differed along three 2-valued dimensions: size, color, and pattern. Children were drawn from four age groups: 4, 6, 7, and 9 years of age. Ambiguous messages, which did not distinguish the referent from the nonreferents, were very common for the 4-year-old children; however, they decreased with age,

becoming uncommon responses for the 7- and 9-year-old children. Adequate messages, defining the referent uniquely, were at chance levels for the 4- and 6-year-old children; however beginning at 7 years of age, children reliably produced adequate, contrastive messages. Interestingly, as the task difficulty increased (i.e., three cups, differing along more than one dimension) more incomplete messages were produced by all age groups. Thus, the use of the difference rule appears to increase with age, but may be abandoned if the task increases in complexity.

Research with Mentally Retarded Children

In contrast to research with nonretarded children, very little research has examined the development of referential communication in mentally retarded children. Longhurst (1974) examined the referential communication skills of mildly and moderately retarded adolescents. Speakers were given a sheet of paper onto which four of a possible six novel figures were photocopied. The listener had the six novel figures placed before him or her and was to arrange four of them according to the speaker's directions. The figures were novel in the sense that they were unusually shaped, and labels were not readily available for them. Mildly retarded subjects produced more adequate messages than moderately retarded subjects; however, all of the

adolescents had difficulty formulating messages which distinguished the referent, and thus performed poorly relative to nonretarded peers. Longhurst's use of novel figures may have made the task too difficult, however. It has been suggested that these figures are very difficult to describe (Flavell, 1977), taxing both the enabling skills and substantive knowledge of those performing the task. Thus, it is not easy to determine whether Longhurst's subjects did poorly because they lacked the substantive knowledge and enabling skills necessary for successful referential communication, or because the demands of the task placed too great a strain on their already developed skills (Flavell, 1977; Shatz, 1983).

Reuda and Chan (1980) used a simpler task to examine the referential communication skills of moderately mentally retarded adolescents. Subjects had pairs of pictures of Dr. Suess-like animals, characters, and objects placed before them. The speaker was instructed to describe the designated referent so that the listener could choose it from the pair. The subjects were given a total of 36 pairs of pictures. For 12 of the pairs, the referent was physically different from the nonreferent, and could not be described by use of the same label. For example, for one pair, one card depicted a bear-like animal, while the other card showed a bell. For 12 other pairs, the physical features of the

referent and nonreferent were very different, although they could be described by use of the same verbal labels. For example, for one pair, both cards depicted a tree; however, one tree was depicted as large and black, and resembled an oak tree, while the tree on the other card was small and unshaded, and looked like a Christmas tree. Finally, for 12 of the pairs, the referent and nonreferent were similar both physically and in their verbal labels. For example, for one pair, both cards depicted a clown that differed between the two cards only in the shape of the hat, buttons and shoes. Reuda and Chan found that although the mentally retarded adolescents did well on the card pairs where the referent and nonreferent were different in both physical features and verbal labels, they performed significantly worse on the other two types of card pairs. According to Reuda and Chan, these adolescents were able to describe the referents; however, they failed to engage in comparison activity, which resulted in descriptions that did not discriminate the referent from the nonreferent when these were similar physically or by verbal label.

Prior to testing, all the adolescents in Reuda and Chan's study were given a screening task to ascertain whether they could visually discriminate the stimuli, and whether they had the necessary verbal skills to describe the referents. To assess their ability to visually discriminate

the stimuli, the adolescents were presented with one of the referents and asked to select its duplicate from among four alternatives. The four alternatives consisted of the referent, its experimentally paired nonreferent, and two similar figures. To assess vocabulary skills, the adolescents were required to verbally label each of the referents. Any subject lacking the necessary vocabulary (substantive knowledge) or discriminal ability (enabling skills) was excluded from the study.

Thus, in terms of Whitehurst and Sonnenschein's (1985) model, the subjects in Reuda and Chan's study had the necessary enabling skills and substantive knowledge to perform the task. What seems to have impeded the performance of Reuda and Chan's subjects was the lack of the necessary procedural rules to formulate informative messages. Although the screening task demonstrated they were capable of discriminating a referent from its surroundings, the adolescents failed to describe the differences between the referent and nonreferent to their listeners. This suggests that these adolescents failed to recognize the importance of describing differences, in order to make their messages informative. According to the Whitehurst and Sonnenschein model, then, the Reuda and Chan subjects did poorly on the communication task because they failed to apply the difference rule.

The adolescents in the Reuda and Chan study had a mean mental age of approximately 7 years, the age at which most nonretarded children are expected to be using the difference rule. It is unclear from this study whether mentally retarded children lag behind their nonretarded mental age counterparts on use of the difference rule, because nonretarded children were not tested with Reuda and Chan's stimuli. What also remains to be demonstrated is whether mentally retarded children are capable of utilizing procedural rules in a referential communication situation, and whether application of these rules would increase communicative competence.

Theoretical Orientations on Mental Retardation

For several years a debate has raged, under the rubric of the "developmental-difference controversy" (Zigler & Balla, 1982), concerning the nature of cognitive functioning of mentally retarded individuals compared to their nonretarded peers. In essence, this debate revolves around whether the cognitive development of mentally retarded children is similar to normal children or qualitatively different.

Proponents of the developmental position on mental retardation (e.g., Weisz & Yeates, 1981; Weisz & Zigler,

1979; Zigler, 1967, 1969) suggest that mentally retarded children who are free from organic impairment do not differ qualitatively from their nonretarded peers. The inferior intellectual performance of these mentally retarded individuals is seen as resulting from differences in rate of development, rather than defective cognitive functioning. Zigler (1967, 1969) proposes that such mentally retarded children develop the same cognitive processes, in the same sequence, as nonretarded children; however, the rate and upper limit achieved may differ for the two groups. According to Zigler, when nonretarded and mentally retarded children are matched on level of cognitive development, as indicated by mental age, there will be no fundamental differences between the two groups in the cognitive processes utilized in task performance. Any differences in performance would be due to noncognitive factors, such as motivation or experience (Zigler, 1967, 1969).

In contrast, proponents of the difference position (e.g., Ellis, 1963; Ellis & Cavalier, 1982; Milgram, 1969; Spitz, 1963, 1983) suggest that the cognitive processes of mentally retarded individuals differ from nonretarded individuals, over and above differences in rate and upper limit achieved. That is, the cognitive functioning of mentally retarded and nonretarded children is assumed to be qualitatively different, with mentally retarded children

showing specific deficits in cognitive processes. Difference theorists would thus predict differences in performance on cognitive tasks between mentally retarded and nonretarded children, even when the two groups are matched on mental age. In addition, the development of cognitive processes in mentally retarded children would not necessarily be expected to proceed in the same developmental sequence as for nonretarded children.

The research on referential communication with mentally retarded children appears to offer more support to the difference position than to the developmental position. In both Longhurst's (1974) and Reuda and Chan's (1980) studies, mentally retarded children exhibited performance inferior to that expected by nonretarded children of equivalent mental ages. This would suggest that even when cognitive development is equated, fundamental differences remain between mentally retarded and nonretarded children on referential communication tasks. Unfortunately, neither study provided information regarding the etiology of their subjects' mental retardation, and one cannot rule out organic impairment for at least some of the subjects. Thus, these studies do not provide a fair assessment of Zigler's developmental position.

One limitation of the developmental position, which necessarily restricts the developmental-difference controversy, is the exclusion from the model of mentally retarded individuals suffering from organic impairment. Zigler intended the developmental position to apply only to those mentally retarded persons free from organic impairments. Unfortunately, the technology available for diagnosing organicity is not yet at the point of sophistication where mentally retarded individuals with nonorganic and organic etiologies can be reliably separated (Baumeister, 1984; Ellis & Cavalier, 1982). Moreover, an approach that applies to only one group of mentally retarded individuals, excluding all those with known organic impairments, has limited theoretical comprehensiveness and heuristic utility.

Cicchetti and Pogge-Hesse (1982) have advanced a model of development for mentally retarded children which extends and elaborates Zigler's developmental position, embodying Heinz Werner's organismic theory of development (Werner, 1948, 1957). Development is seen as an orderly, cumulative, unidirectional process, governed by the same laws and principles for all human beings, with cognitive processes becoming more organized, adaptive, and integrated as individuals develop. This more liberal version of the developmental position would predict similar processes and

sequencing of cognitive development for all children, while the rate of development would be open to variation (Cicchetti & Pogge-Hesse, 1982). Thus, all mentally retarded children, regardless of etiology, would be expected to show similar sequencing and organization of cognitive processes.

Because communication skills rely on cognitive processes, this liberal developmental model of mental retardation can be applied to the development of referential communication skills. Mentally retarded children would be expected to develop the same processes necessary for referential communication as nonretarded children, though in a different time frame. The prediction that follows from the liberal developmental position, is that mentally retarded children with the substantive knowledge and enabling skills necessary for referential communication, should have the potential to utilize procedural rules. It would be expected that if mentally retarded children do not spontaneously use these rules in a referential communication task, they could be taught to do so.

Training Studies

Work with nonretarded children, within the framework of Whitehurst and Sonnenschein's model, has shown that communicative competence can be improved through specific instructions regarding procedural rules. Whitehurst and Sonnenschein (1985) suggest that preschoolers do poorly on referential tasks because they fail to utilize the difference rule to make the necessary comparisons between the referent and nonreferents. A series of studies by Whitehurst and Sonnenschein (1981) suggest that preschoolers know how to compare, that is, they have the subskills necessary to engage in comparison activity, but they seem to lack the knowledge that comparison is relevant to communication. In one experiment, Whitehurst and Sonnenschein (1981) presented 5-year-old children with pictures of triangle pairs which differed in color, size, or patterning. Children were to describe the intended referent designated by a dot, so the experimenter could choose the one to which they were refering. Two groups of children were given different instructions for the task. The communication group was instructed: "Tell me about the triangle with the star above it so that I will know which triangle you are talking about." After five trials, this was shortened to "Tell me about it." The perceptual group was instructed: "Tell me how the triangle with the star

above it looks different from the other triangle." After five trials, these instructions were shortened to "How is it different?" All children received 20 training trials. The perceptual group produced significantly more informative messages than the communication group. In fact, 73% of the messages given by the perceptual group were informative, compared to only 50% in the communication group.

In subsequent experiments, Whitehurst and Sonnenschein (1981) found perceptual feedback to be even more effective than perceptual instructions, yielding 83% informative messages. During perceptual feedback training, when the child delivered a message that described the distinctive features of the intended referent, the experimenter responded: "That's good; you told me how the triangle with the star above it was different from the other." If the message failed to distinguish the referent from the nonreferent, the experimenter responded: "That's wrong; you did not tell me how the triangle with the star above it was different from the other." This feedback was significantly more effective than noncontingent social feedback (i.e., "okay"), and communication feedback (i.e., "That's good (wrong); you told (did not tell) about the triangle with the star above it so that I knew (didn't know) which one you were talking about.").

Whitehurst and Sonnenschein (1981) also found that perceptual feedback resulted in significant transfer effects. After being trained with perceptual feedback on the triangle task, 5-year-old children were tested on a novel task where they received no feedback. The transfer task was novel in the sense that pairs of pictures of common objects were presented rather than pairs of triangles. As with the training task, picture pairs differed in color, size or pattern. In the transfer task, 93% of the messages given by children who had received perceptual feedback were informative, which was significantly higher than children in the other feedback groups. Perceptual feedback training was also effective with children 4 years of age, and the increments in performance, evidenced in both 4- and 5-year-old children, endured at least one week. The success of perceptual feedback training has been replicated several times (Sonnenschein, 1984; Sonnenschein & Whitehurst, 1983, 1984a, 1984b). It appears, then, that unless differences between the referent and nonreferents are perceptually salient (Whitehurst & Sonnenschein, 1978), preschool children do not spontaneously apply the difference rule, although they are capable of doing so. When instructed to describe perceptual differences, preschoolers perform at a level typically not expected until 7 to 9 years of age (Whitehurst, 1976).

A series of studies by Robinson (1981a, 1981b) utilizing different materials and feedback, parallel Whitehurst and Sonnenschein's findings. Children 5 to 7 years of age were shown six drawings of a man holding a flower, which differed on a number of attributes: shape of the hat, type of shoes, color of flower, and facial expression (Robinson, 1981a). Children were provided with either implicit feedback, such as, "I'm not sure which one you mean. Can you help me?", or explicit feedback, such as, "I've got three like that. I'm not sure which one you mean. Can you help me?" With implicit feedback, young children gave more information, but they generally did not improve their messages. When provided with explicit feedback, performance improved dramatically. These improvements in performance transferred to other materials not involved in training, where no feedback was provided.

Despite the substantial increments in communicative competence evidenced in the laboratory when preschoolers are provided with explicit feedback, such corrective feedback rarely occurs in young children's everyday interactions (Robinson, 1981b). Yet, preschool children who receive such feedback from their parents display more advanced communication skills at the age of 6 years than their peers who do not receive such feedback (Robinson, 1981b). To demonstrate this phenomenon, Robinson (1981b) analyzed

transcripts of recordings of interactions between mothers and their preschool children to determine the frequency of communicative failures and the way these failures were handled. The recordings were made every 3 months while the children were between the ages of 2 and 3 1/2 years, and once at the age of 5 years. When the children were 6 years old, Robinson tested them for their understanding of communicative failure. The 6-year-old children were divided into two groups, according to whether they possessed or lacked an understanding of communicative failure.

There was no difference between the two groups on the number of communicative failures experienced as preschoolers, or in the number of ways these failures were dealt with by the mothers. There was, however, a significant difference between the groups in the number of explicit statements of nonunderstanding, during communicative failure, given by the mothers. Every child whose mother had provided at least one instance of explicit feedback during the recordings had been categorized as possessing an understanding of communicative failure. In contrast, of the 6-year-olds categorized as lacking such an understanding, none had been provided with explicit feedback by their mothers during the recording sessions. The results of this study suggest that adults could assist young children in their development of an understanding of

communicative effectiveness by providing them with feedback regarding the adequacy of their communications. Furthermore, children who display an understanding of communicative failure are likely to produce informative messages in a referential communication task (Robinson, 1981a; Sonnenschein, 1984; Sonnenschein & Whitehurst, 1984a).

Robinson (1981a) suggests that for very young children it is important to maintain the flow of interaction and encourage confidence in communicating; therefore, explicit feedback at this early stage would probably not be effective. It may be that very young children would not possess the necessary subskills to engage in comparison activity. However, as young children become more fluent and confident in their interactions, and develop requisite subskills, some explicit information on communicative adequacy may be effective in increasing their understanding of communication.

This work offers optimism to those concerned with the communicative skills of mentally retarded children. If, as the Reuda and Chan (1980) study suggests, the lack of requisite procedural rules is the main impediment to effective referential communication in some mentally retarded individuals, then perhaps the techniques

successfully employed with nonretarded preschoolers may improve the communicative competence of mentally retarded children. For example, requesting more explicit information from mentally retarded children might provide them with a greater understanding of the communicative process, as well as increased communicative competence. Considering the importance of communicative competence to the development of cognitive skills in general (Dickson et al., 1979; McDevitt et al., 1987), successful implementation of a procedure designed to improve referential communication skills in mentally retarded children would have significant implications indeed.

The Present Research

It is important to investigate referential communication skills in mentally retarded children and adolescents, considering the dearth of information in this area. Although the results from the Reuda and Chan (1980) study suggest mentally retarded adolescents perform similarly to 5-year-old nonretarded children, it would be imprudent to draw such a conclusion considering the absence of a nonretarded control group in their investigation. The first experiment in the present study addressed this omission by testing both nonretarded and mentally retarded subjects on the same referential task. Also lacking from

previous studies is information on referential communication skills of mentally retarded individuals at different mental age levels. In Experiment 1, nonretarded and mentally retarded participants at three mental age levels were compared to provide information about the development of referential communication.

Previous research with mentally retarded adolescents has also failed to address the use of procedural rules, which Whitehurst and Sonnenschein (1985) consider to be the antecedents of successful communication. The first study examined the role of the difference rule in communicative competence. A pretest was administered to ensure that subjects possessed the requisite enabling skills and substantive knowledge to perform the task. The task was structured so that failure to use the difference rule would result in poor performance on some trials, despite the possession of these requisite skills.

A second experiment was performed in an attempt to improve the communication skills of mentally retarded children. Those children unable to provide discriminating messages in Experiment 1 were provided with perceptual feedback training to determine its effectiveness for enhancing performance. Training studies are a means of exploring the nature of communication deficiencies evidenced

in young children (Sonnenschein & Whitehurst, 1984b). By training the difference rule, through the use of explicit feedback, it can be determined if this rule is relevant to communicative interactions, and whether mentally retarded children have the necessary component skills for the deployment of this rule. If communicative competence is improved, the importance of procedural rules, in this case the difference rule, to referential communication in mentally retarded children can be demonstrated.

EXPERIMENT 1

This study compared the development of referential communication skills of nonretarded and mentally retarded children. Specifically, use of the difference rule in referential communication was explored. Groups of children with mental age (MA) means of 5, 8, and 11 years were compared. Findings with nonretarded children have shown that before the chronological age of 5 years, children do not spontaneously utilize comparison skills in a referential task of moderate difficulty (Whitehurst & Sonnenschein, 1981). After 7 years, children usually provide informative messages (Robinson & Robinson, 1977b; Whitehurst, 1976), and by 9 years, the comparison skills are even more reliable, and evidenced in a variety of tasks (Whitehurst, 1976).

The nonretarded children were paired with the mentally retarded children using the Quick Test (Ammons & Ammons, 1962) as a measure of mental age. The Quick Test was chosen because it is primarily a vocabulary test, and the referential task relies heavily on vocabulary development (cf. Watson & Greenberg, 1988). The Quick Test is a brief, verbal test of intelligence made up of three forms, each comprising four black and white line drawings. The

respondent is required to point to the picture which best fits with the word presented verbally by the tester. Lamp and Barclay (1967) describe the Quick Test as a valuable screening instrument for use with mentally retarded children. Studies comparing Quick Test IQ scores to IQs scored on the Wechsler Intelligence Scale for Children - Revised (WISC-R; Wechsler, 1974) report moderate correlations (Nicholson, 1977; Paramesh, 1982; Vance, 1988), mean $\underline{r}$ = .72 with Full-Scale IQ, .71 with Verbal IQ, and .55 with Performance IQ. In the present study, Forms 1 and 3 of the Quick Test were administered, because this combination of forms had the highest correlations with WISC-R scores (Nicholson, 1977), and because Coyle and Erdberg (1968) found that stereotyped response patterns exhibited by some mentally retarded subjects can produce more correct answers than would otherwise be obtained on Form 2.

Three levels of message difficulty were utilized: easy, intermediate, and difficult. It was hypothesized that the number of informative messages provided by both nonretarded and mentally retarded participants would increase with mental age. Subjects in the 5-year MA group were expected to provide a high proportion of informative messages only for trials at the easy level, those in the 8-year MA group were expected to provide a high proportion of informative messages at the easy and intermediate levels

of difficulty, and those in the 11-year MA group were expected to provide a high proportion of informative messages at all three levels of difficulty.

Although equated for mental age with nonretarded children, performance of the mentally retarded participants was expected to be inferior to that of the nonretarded children at the intermediate and difficult levels. This prediction was based on Reuda and Chan's (1980) finding that even by adolescence, and an average mental age of approximately 7 years, moderately mentally retarded individuals do poorly when required to make fine distinctions between similar objects. Most of the mentally retarded participants were expected to provide informative messages on the trials at the easy level, as these trials required no comparison activity.

Method

Subjects

Both nonretarded and mildly to moderately mentally retarded subjects participated in this study. They were recruited from five school divisions in the city of Winnipeg. Parental permission was required for participation. A copy of the parental permission letter is in Appendix A.

Mentally retarded subjects were chosen on the basis of placement in school programs for children with mental retardation. The majority (83%) of the mentally retarded subjects were drawn from classrooms for the trainably mentally handicapped (TMH), where functioning is generally three standard deviations below the mean on a standardized intelligence test. For mentally retarded subjects not in TMH classrooms, assessment information was acquired, and only those subjects functioning more than two standard deviations below the mean were included. This resulted in 74 mentally retarded subjects, ranging in chronological age from 6 years, 2 months to 21 years, 3 months. All of these participants were given the Quick Test. Two of these subjects were excluded because they failed to meet the pretest criteria (see p. 42) necessary for participation and three others were excluded because their low Quick Test scores did not permit suitable matches with nonretarded subjects. This resulted in 69 mentally retarded participants.

Ninety-one nonretarded children were given the Quick Test: thirty-four 5-year-olds, thirty 7-year-olds, and twenty-seven 9-year-olds. Each of the 69 mentally retarded subjects was matched with a nonretarded subject using Quick Test scores. For 49 of the subject pairs both nonretarded and mentally retarded members of the pair had identical

Quick Test scores. For 19 subject pairs the Quick Test score differed by 1 point; for 10 of these pairs the nonretarded subject was 1 point higher than the mentally retarded subject, and for 9 pairs the mentally retarded subject was 1 point higher than the nonretarded subject. For one subject pair the mentally retarded subject was 2 points higher than the nonretarded subject.

These pairs of subjects were divided into three groups with mean MAs of approximately 5, 8, and 11 years. These MA groups were established by examining the Quick Test score distribution of the subjects, and choosing cut-offs that achieved groups with nonoverlapping scores. Each group represented a 15-point spread on the Quick Test. Twenty-six of the pairs were in the 5-year MA group, 30 pairs were in the 8-year MA group, and 13 pairs were in the 11-year MA group. The mean, range, and standard deviation of mental ages, Quick Test scores, and chronological ages for each group of subjects are given in Table 1.

Table 1

Mental Ages, Quick Test Scores, and Chronological Ages for the Nonretarded and Mentally Retarded Groups

MA Level	Mental Age		QT Score		Chronological Age	
	Non-retarded	Mentally Retarded	Non-retarded	Mentally Retarded	Non-retarded	Mental Retarded
5 (N=26)						
Range	3.0-6.0	3.0-6.0	21-35	21-35	4.9-7.5	6.2-20.2
M	4.6	4.7	28.9	29.0	5.4	14.4
SD	.91	.87	4.3	4.2	.47	4.2
8 (N=30)						
Range	6.0-9.5	6.0-9.5	36-50	36-50	5.2-9.9	10.4-21.3
M	7.9	7.9	43.6	43.6	7.3	16.2
SD	.99	1.0	4.0	4.1	1.0	2.65
11 (N=13)						
Range	10-13	10-13	51-64	51-64	8.8-9.8	12.4-20.0
M	11.1	11.2	56.4	56.5	9.5	16.5
SD	1.0	1.0	4.1	4.2	.34	2.8

Note. N = number of matched pairs of subjects.

Referential Task and Stimuli

The referential communication task was a modified version of a task developed by Whitehurst and Sonnenschein (1978). Pictures of common objects were depicted on 21.5 by 28 cm cards to serve as referents and nonreferents. There were 36 trials, with a different array of cards for each. The cards portrayed four different objects: a car, a ball, a fork, and a chair. Black and white miniature reproductions of the stimuli appear in Figure 1. For each object there were color and size variations, such that a given object was large or small, and red or yellow.

There were three levels of difficulty-- easy, intermediate, and difficult-- with 12 trials at each level. The array at the easy level contained two cards depicting two dissimilar objects that differed in color and size. For example, one trial at this level consisted of a card depicting a large yellow chair and a small red ball. At the intermediate level of difficulty the array contained two cards depicting the same object with variations in size or color. For example, one trial at the intermediate level consisted of a small yellow chair and a small red chair. At the difficult level each trial contained three cards depicting the same object where the intended referent had two other attributes in common with both nonreferents. For

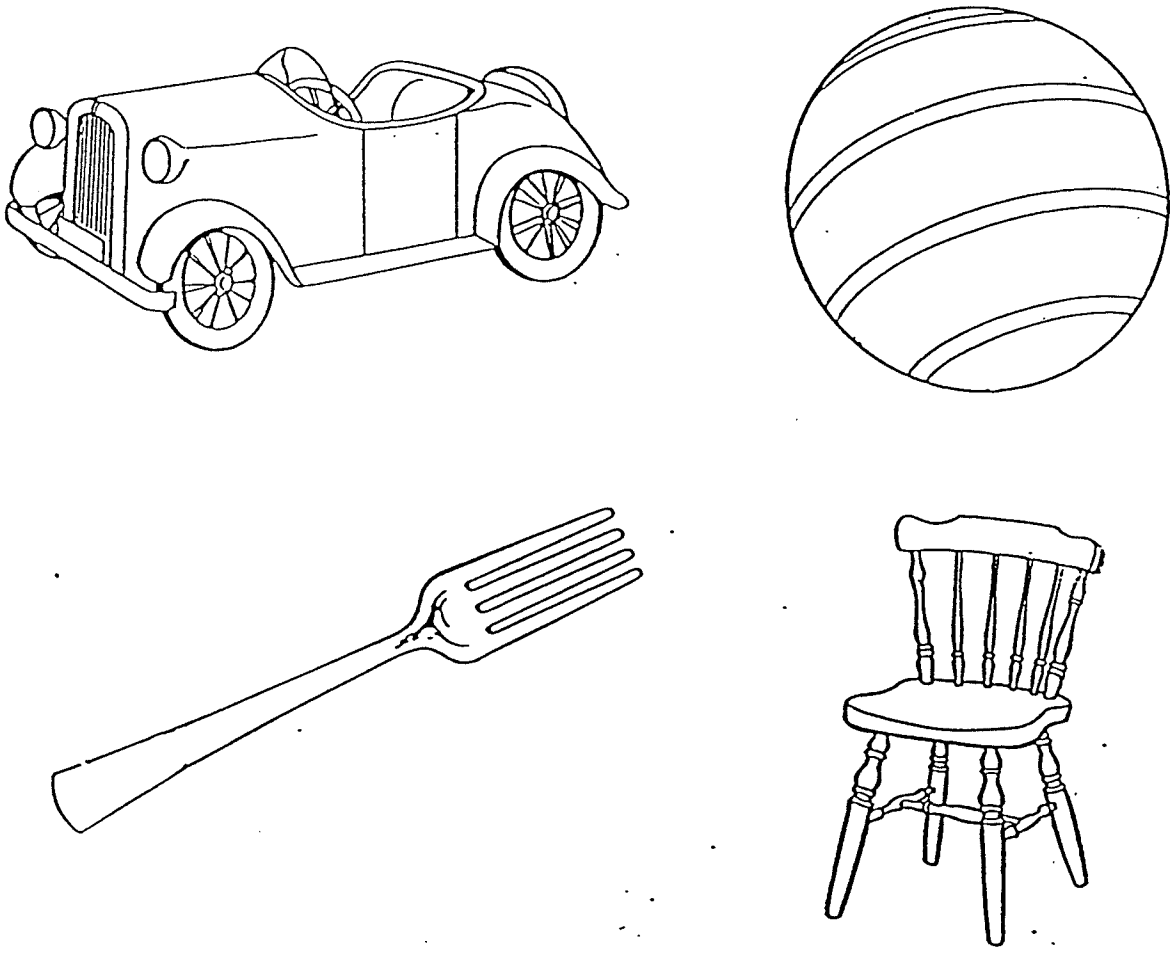

Figure 1. Miniature reproductions of stimuli for Experiment 1.

example, one trial at the difficult level consisted of a small red chair, a small yellow chair, and a large red chair. Here the intended referent was the small red chair, having size and chairness in common with one of the nonreferents, and color and chairness in common with the other. The order of presentation of the trials was randomly determined, with the stipulation that the same intended referent not occur on consecutive trials. The intended referent occurred equally often in each position of the array.

Procedure

Subjects were tested individually in a quiet room in their school. Subject and experimenter sat side by side at a table. A Califone 3420 audio tape recorder was used to record the experimental sessions. The tape recorder was placed at the edge of the table, out of reach of the subject.

Subjects were first given a pretest of their ability to visually discriminate and verbally label the stimuli. The purpose of the pretest was to ensure that subjects possessed the necessary substantive knowledge and enabling skills to adequately perform the task, thus allowing for the focus to be on the role of procedural rules in the development of

referential communication skills. The pretest was followed by practice trials, with the subjects serving as the listener. The 36 experimental trials followed, with subjects serving as the speaker and the experimenter serving as the listener.

In the pretest, each subject was presented with one card depicting each object and asked to name or verbally label the object. Subjects were then shown two colored sheets of paper, one red and one yellow, and asked to identify the color. Finally, subjects were shown two cards, each portraying a red square, one large and one small. They were asked which was the big one, and which was the small one. At this time, they were also pretested for the stimuli used in the transfer task of Experiment 2. Thus, four additional objects (a bell, a shoe, an airplane, and a comb) and two additional colors (blue and green) were presented for labelling. Any subject unable to provide a correct response to any of the stimuli, upon first presentation, was provided with a verbal prompt by the experimenter consisting of the correct label and an opportunity for the subject to repeat the correct answer. Subjects were allowed one subsequent attempt to label the stimuli on their own. Any subject unable to correctly identify any of the stimuli on the second trial was excluded from the study. Two mentally retarded children failed to meet the pretest criterion.

Subjects were then told that they would play a game with the experimenter. They were shown two cards with pictures of different objects on them. The cards used for this practice trial were the same as those used in the experimental session. In the practice trials, card pairs always consisted of different objects which differed in size and color. The experimenter described the intended referent, and the subjects were asked to point to the card they thought the experimenter was talking about. Below the object on each card there was a flap. Subjects chosing the correct card found a colored dot pasted to the card underneath the flap. Subjects were praised if they chose the correct card. Subjects were given the practice listening task until they made three consecutive, correct choices.

Following the practice listening trials, subjects participated in practice speaking trials, where they were to tell the experimenter about the card with the dot. This task gave them practice for the experimental trials and ensured they understood how to determine which card was the designated referent. They were presented with the card pairs used in the practice listening trials, and were told to look under the flap and tell the experimenter about the card with the dot under it. They were instructed on how to lift the flap so only they could see which card had the dot

below it. Subjects were not allowed to use position cues or pointing to identify the intended referent. Subjects continued this task until three consecutive trials were correct.

The subjects then began the 36 experimental trials. They were told that they would have to tell about the cards and the experimenter would have to guess which one they were talking about. After informative messages, the experimenter chose the correct card and said "good". After ambiguous messages, in half of the cases the experimenter chose the correct card and said "good"; in half, the incorrect card was chosen, and the experimenter said "I got it wrong". Although Whitehurst (1976) suggests always choosing the intended referent, regardless of the child's message, when assessing a baseline level of communication skills, it was feared that the subjects might learn that any message resulted in success and therefore reduce their efforts. For this reason ambiguous messages on the part of the subjects were met with incorrect choices by the experimenter on 50% of these trials.

Results

Each subject was given a score based on the total number of informative messages produced during the experimental session. A message was considered informative if it defined the referent uniquely. Messages were evaluated independently by the experimenter and another judge, using the audio recording of performance on the task. Inter-observer reliability was calculated by correlating the scores for each subject provided by the experimenter and the judge using the Pearson product-moment correlation. Inter-observer reliability was $r = .99$.

The number of informative messages produced by each subject at each level of task difficulty was counted. These values were transformed to proportions. Analyses were conducted using both the proportions and their arcsine transformations. An arcsine transformation, given by the formula $Y' = 2 \arcsin\sqrt{Y}$, was used due to the binomial nature of the distribution of proportions (Kirk, 1982). The arcsine transformation normalized the distribution of scores, correcting for the violation of the analysis of variance assumption of normality. The data for Experiment 1 can be found in Tables 2 and 3, Appendix B.

The proportion of informative messages for the mentally retarded and nonretarded subjects on the three levels of

message difficulty were compared across the three MA levels in a 3 (MA level: 5, 8, or 11) x 2 (group: mentally retarded or nonretarded) x 3 (difficulty level: easy, intermediate, or difficult) analysis of variance. MA level was the between-subjects factor, and group and difficulty level were repeated measures. Because mentally retarded subjects were paired with nonretarded subjects on Quick Test scores, these samples could not be considered independent and were therefore treated as dependent in statistical analyses. This was accomplished by analyzing group as a repeated measure. Analysis of variance summary tables are presented for both proportions and arcsine transformed proportions in Tables 4 and 5, Appendix C. The arcsine transformation did not alter the results, and so the results obtained from the analyses of proportions are presented below. Effect sizes were calculated for all main effects using the effect size index f (Cohen, 1977). The cell means are shown in Tables 6 and 7. Significant main effects were found for MA level, $F(2, 66) = 27.29$, $p < .0001$, $f = .60$, group, $F(1, 66) = 35.67$, $p < .0001$, $f = .47$, and difficulty level, $F(2, 132) = 217.39$, $p < .0001$, $f = .84$. These main effects were qualified by two significant two-way interactions. There was a significant interaction between difficulty level and MA level, $F(4, 132) = 15.61$, $p < .0001$, and between group and difficulty level, $F(2, 132) = 26.94$, $p < .0001$.

Table 6

Cell Means for Experiment 1, Proportional Data

	Level of Message Difficulty		
	Easy	Intermediate	Difficult
Nonretarded			
MA Level			
5 (N=26)	.98	.62	.35
8 (N=30)	.99	.88	.66
11 (N=13)	1.00	.99	.88
Mentally Retarded			
MA Level			
5 (N=26)	.99	.26	.04
8 (N=30)	.98	.47	.22
11 (N=13)	.99	.78	.51

Table 7

Cell Means for Experiment 1, Arcsine Transformed Data

	Level of Message Difficulty		
	Easy	Intermediate	Difficult
Nonretarded			
MA Level			
5 (N=26)	3.07	1.88	1.04
8 (N=30)	3.11	2.67	2.03
11 (N=13)	3.14	3.10	2.68
Mentally Retarded			
MA Level			
5 (N=26)	3.06	0.84	0.20
8 (N=30)	3.06	1.45	0.69
11 (N=13)	3.10	2.35	1.52

The means involved in the difficulty level x MA level interaction are shown in Table 8. At the easy level of message difficulty all three MA groups demonstrated virtually error-free performance, and Scheffe S tests, at the .05 alpha level, revealed no significant differences between any of the three groups. At the intermediate level, Scheffe tests revealed that the 11-year MA subjects performed significantly better than the 8-year MA subjects, who in turn performed significantly better than the 5-year MA subjects. For the messages at the difficult level, the Scheffe tests also indicated that the 11-year MA subjects significantly outperformed the 8-year MA subjects, who outperformed the 5-year MA subjects.

Table 8

Mean Proportion of Informative Messages at Each MA Level

MA Level	Level of Message Difficulty			
	Easy	Intermediate	Difficult	M
5 (N=52)	.99	.44	.20	.54
8 (N=60)	.99	.68	.44	.70
11 (N=26)	1.00	.89	.70	.86
M	.99	.63	.40	

For both the 5- and 8-year MA subjects, scores for the easy messages were significantly higher than scores for intermediate messages, which were, in turn, significantly higher than scores on the difficult messages. For the 11-year MA subjects, the differences between easy and intermediate, and intermediate and difficult messages were nonsignificant, however performance on easy messages was significantly better than for difficult messages.

The means involved in the group x difficulty level interaction are shown in Table 9. Both nonretarded and mentally retarded subjects demonstrated near-perfect performance on the easy messages. Scheffe S tests at the .05 alpha level showed that at the intermediate and difficult message levels the nonretarded subjects scored significantly higher than their mentally retarded counterparts. For both groups of children, easy messages yielded significantly more informative responses than intermediate messages, which, in turn, elicited more informative responses than difficult messages.

Table 9

Mean Proportion of Informative Messages for Nonretarded and Mentally Retarded Subjects

Group	Level of Message Difficulty			
	Easy	Intermediate	Difficult	M
Nonretarded (N=69)	.99	.80	.58	.79
Mentally Retarded (N=69)	.99	.45	.21	.55
M	.99	.63	.40	

Discussion

One purpose of the first experiment was to determine whether referential communication skills of nonretarded and mentally retarded individuals improve with increases in mental age. The literature on development of referential communication in nonretarded children shows improvements in these skills between 5 to 10 years of chronological age. In the present study, the same pattern of change was evidenced by mentally retarded and nonretarded individuals compared at mental ages of 5, 8, and 11 years.

Participants at all three MA levels did well on easy messages, where the difference rule was not required for adequate performance. With intermediate messages, which required examining two similar pictures and identifying differences, the 5-year MA group provided significantly fewer informative messages than the 8-year group, who provided significantly fewer informative messages than the 11-year group. At the difficult message level, where three similar pictures must be examined, the 5-year MA group was inferior to the 8-year group, who were inferior to the 11-year group. The performance of 11-year MA participants was high (over 70% informative messages) across all three task difficulty levels, suggesting reliable application of the difference rule. Subjects at the 8-year MA level,

although showing strong evidence of use of the difference rule (68% informative messages) on a moderately difficult task, were less consistent on a more complex task (44%). Participants at the 5-year MA level did not show consistent use of the difference rule at either the moderate or difficult message levels.

The second purpose of Experiment 1 was to compare the performance of mentally retarded individuals with nonretarded children at similar mental age levels. Although mentally retarded subjects did not perform as well as their nonretarded counterparts, they did perform well on easy messages where use of the difference rule was not required. For intermediate and difficult messages, which required making comparisons and reporting differences, mentally retarded participants performed worse than MA-matched nonretarded children. This study demonstrated that mentally retarded individuals lag behind nonretarded children of the same mental age in referential communication skills.

Experiment 1 found that few mentally retarded subjects applied the difference rule to formulate messages in referential communication. Experiment 2 was conducted to determine if mentally retarded individuals are capable of utilizing the difference rule, and whether its use would improve performance.

EXPERIMENT 2

The purpose of Experiment 2 was to determine if perceptual feedback training, used by Whitehurst and Sonnenschein (1981) with nonretarded 5-year-old children, would improve referential communication skills of mentally retarded individuals. Perceptual feedback training was first attempted with the nonretarded 5-year-old subjects from Experiment 1 to verify the effectiveness of this training procedure with the materials used in the present study. Those 5-year-olds from Experiment 1 who consistently failed to provide discriminating messages participated in Experiment 2. Half of the nonretarded 5-year-olds received perceptual feedback training; the other half served as controls, receiving only communication feedback. The effectiveness of the perceptual feedback procedure was evaluated during training, in a posttest one week after training, and in a transfer task also given one week after training. Because Whitehurst and Sonnenschein (1981) found that the effectiveness of training was maintained for at least one week, and transferred to a task utilizing different stimuli, improvements due to training were expected not only during the training task, but also on the posttest and transfer task.

The same procedure was then used with those mentally retarded subjects who had not consistently provided informative messages in Experiment 1. The effects of perceptual feedback training were assessed after one week and on a transfer task with different stimuli. Participants receiving this training were expected to improve their communicative performance, demonstrating that mentally retarded children are capable of using the difference rule, and confirming its relevance to referential communicative interactions.

Method

Subjects

From the original sample of 34 nonretarded 5-year-olds in Experiment 1, 25 participated in Experiment 2. These were subjects who did not reach a competence criterion on at least one level of message difficulty. The competence criterion was 8 or more informative messages on 12 trials, or 67%. Twelve of the mentally retarded subjects reached competence criterion on all three levels of message difficulty, therefore 57 of the original 69 mentally retarded subjects participated in Experiment 2.

Training and Control Task

The materials for the training (or control) task were the same as those used in Experiment 1. That is, pictures of the four different objects (car, ball, fork, and chair) varying along the dimensions of color (red and yellow) and size (large and small) were used.

Each subject received trials at only one level of difficulty, based on his or her performance in Experiment 1. The level of difficulty chosen for training was the lowest level at which the subject did not reach the competence criterion (67% informative messages). Thus a subject who, in Experiment 1, delivered 10 informative messages at the least difficult level, four informative messages at the intermediate level, and two informative messages at the most difficult level received training (or control) trials at the intermediate level of difficulty. For the nonretarded 5-year-olds, 16 of the subjects received training (or control) trials at the intermediate level of message difficulty (8 training, 8 control) and 9 were at the difficult level (5 training, 4 control). Forty-three of the mentally retarded subjects received trials at the intermediate level of difficulty (21 training, 22 control) while 14 received trials at the difficult level (7 training, 7 control). All subjects received 24 trials during the training or control task.

Transfer Task

The transfer task was similar to the referential task used in training, but different cards were used. Once again, the cards depicted four different objects: a bell, a shoe, an airplane, and a comb. Black and white miniature reproductions of the stimuli appear in Figure 2. For each object there were color and size variations, such that a given object was simultaneously large or small, and blue or green. Sixteen trials, all at the same level of difficulty, were given during the training (or control) task.

Procedure

Subjects were tested individually in a quiet room in their school. Subject and experimenter sat side by side at a table. A Califone 3420 audio tape recorder, placed out of reach, was used to record the experimental session.

The 5-year-old nonretarded subjects were randomly assigned to one of two groups. The mentally retarded subjects were also randomly assigned to one of the two groups. The first group, the perceptual feedback group, received perceptual feedback training as described in Whitehurst and Sonnenschein (1981). Each time the subject

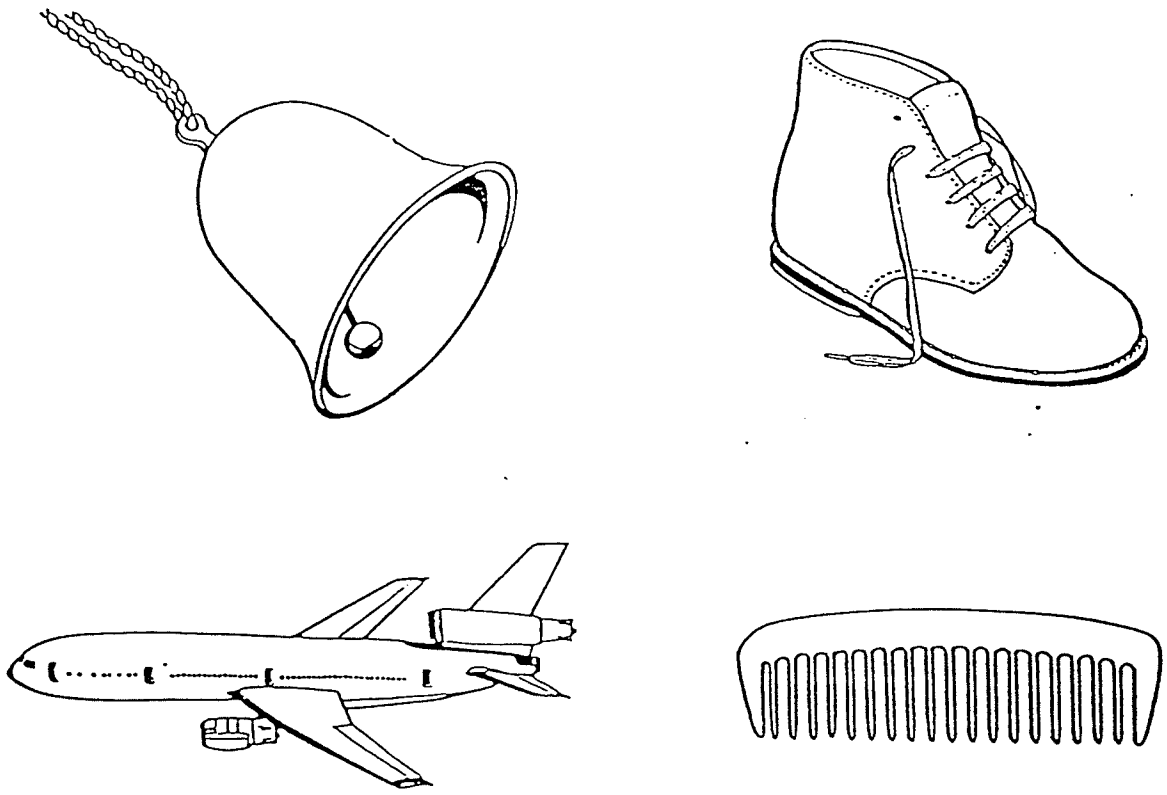

Figure 2. Miniature reproductions of stimuli for transfer task.

delivered a message, the experimenter provided him or her with feedback. If the message was informative, and defined the referent uniquely, the experimenter said: "That's good; you told me how the card with the dot was different from the other(s)." If on the other hand, the message was ambiguous, the experimenter said: "That's wrong; there are two (three) like that. You did not tell me how the card with the dot was different from the other(s)." The control group received the communication feedback described by Whitehurst and Sonnenschein (1981), rather than the perceptual feedback. For informative messages, the experimenter said: "That's good; you told me about the card with the dot. I knew which one you were talking about." In response to ambiguous messages, the experimenter replied: "That's wrong; you did not tell me about the card with the dot. I did not know which one you were talking about."

One week following the training session, the children were given a posttest. The posttest was preceded by a brief reminder of the materials and task instructions. During the posttest all subjects received 16 trials with the same materials used previously, however no feedback was given. The order of the trials was different than the order presented during the training session.

After the posttest, all subjects received a transfer task with 16 trials. No feedback was provided during this task. They were instructed to describe the card with the dot below it so that the experimenter would know which one they were talking about.

Following the transfer task, those mentally retarded subjects serving as controls were given perceptual feedback training using the posttest stimuli. This training was continued until six consecutive responses were correct, or until 24 trials had been presented. This follow-up procedure was implemented as it was considered unethical to withhold potentially beneficial instruction from mentally retarded subjects.

Results

The number of informative messages produced on each task was counted for each subject. As in Experiment 1, a message was considered informative when it defined the referent uniquely. The messages were scored by the experimenter, and independently by another judge. Inter-observer reliability, calculated by correlating the scores for each subject provided by the experimenter and the judge using the Pearson product-moment correlation, was $r = .99$.

The proportion of informative messages was calculated for each subject at each phase (training, posttest, and transfer) and arcsine transformations ($Y' = 2 \arcsin\sqrt{Y}$; Kirk, 1982) were performed on these scores. Data for Experiment 2 can be found in Tables 10 and 11, Appendix D. In cases where arcsine transformed data produced the same results as proportional data, results are reported for the proportional data. Where there was a discrepancy, arcsine transformed data are reported. Proportional and arcsine transformed data analyses for nonretarded 5-year-old and mentally retarded subjects are reported in Tables 12, 13, 14, and 15, Appendix E.

Preliminary Analyses

A number of preliminary analyses were conducted to ensure, for both the nonretarded 5-year-old and mentally retarded subjects, that differences did not exist between the experimental and control groups before training. Separate two-way analyses of variance were conducted for the nonretarded 5-year-old and mentally retarded subjects comparing those receiving training to those not receiving training in Experiment 2 on their performance in Experiment 1. The between-subjects factor was training group (training or control), the within-subjects factor was message level (easy, intermediate, or difficult), and the dependent

variable was the proportion of informative messages in Experiment 1. These analyses revealed no differences in performance between subjects assigned to training and control groups, $F(1,23) = 0.01$, $p = .93$, and $F(1,55) = 0.23$, $p = .64$, for the nonretarded and mentally retarded subjects, respectively.

To investigate possible Quick Test score and chronological age differences between training and control subjects, separate 2 x 2 analyses of variance were conducted for the nonretarded and mentally retarded samples. The independent variables were training (training or control), and level of instruction (intermediate or difficult). These analyses thus broke down the two samples of subjects into four training groups: those trained at the intermediate level, those serving as controls at the intermediate level, those trained at the the difficult level, and those serving as controls at the difficult level. Separate analyses were conducted for Quick Test scores and chronological age. For the nonretarded 5-year-old subjects, all analyses for Quick Test score differences were nonsignificant, $F(1,21) = 0.14$, $p = .72$ for training, $F(1,21) = 0.00$, $p = .95$ for level of instruction, and $F(1,21) = 0.77$, $p = .39$ for the interaction. The analyses for chronological age differences for nonretarded 5-year-olds also yielded nonsignificant values, $F(1,21) = 0.04$, $p = .85$ for training, $F(1,21) = .30$,

p = .59 for level of instruction, and $F(1,21)$ = 0.03, p = .86 for the interaction. Quick Test scores and chronological ages for these groups of subjects are presented in Table 16. Power analyses (Cohen, 1977) for Quick Test score and chronological age data indicated significant power to detect differences if they were present. For mentally retarded subjects, the analyses for Quick Test score differences yielded nonsignificant values for training, $F(1,53)$ = 0.00, p = .99, and the interaction between training and level of instruction, $F(1,53)$ = 0.07, p = .79, however the level of instruction value approached significance, $F(1,53)$ = 3.80, p = .06. None of the values were significant for chronological age differences between mentally retarded subjects, $F(1,53)$ = .79, p = .38 for training, $F(1,53)$ = 0.09, p = .76 for level of instruction, and $F(1,53)$ = 0.04, p = .84 for the interaction. The mean Quick Test scores and chronological ages for these groups of mentally retarded subjects are presented in Table 17. Power analyses (Cohen, 1977) for Quick Test score and chronological age data indicated significant power to detect differences if they were present.

Table 16

Mean Quick Test Scores and Chronological Ages for the Nonretarded 5-Year-Old Subjects

Group	N	Quick Test Mean	Chronological Age Mean
Intermediate - Train	8	29.50	5.38
Intermediate - Control	8	30.75	5.42
Difficult - Train	5	31.80	5.33
Difficult - Control	4	28.75	5.42

Table 17

Mean Quick Test Scores and Chronological Ages for the Mentally Retarded Subjects

Group	N	Quick Test Mean	Chronological Age Mean
Intermediate - Train	21	36.48	15.68
Intermediate - Control	22	37.27	14.94
Difficult - Train	7	43.43	15.57
Difficult - Control	7	42.57	14.40

Nonretarded 5-Year-Olds

A 2 x 2 x 3 analysis of variance was conducted to determine whether training was effective for improving the 5-year-olds' performance on the training, posttest, and transfer phases. The variable of level of instruction was included to determine whether training at one message level was more effective than at another. The between-subject factors were training (training or control) and level of instruction (intermediate or difficult), the within-subject factor was phase (training, posttest, or transfer). The dependent variable was the proportion of informative messages. Analysis of variance summary tables are presented in Tables 12 and 13, Appendix E. Cell means are shown in Tables 18 and 19. Only the main effects for training and phase were significant, $F(1,21) = 12.59$, $p = .002$, $f = .75$, and $F(2,42) = 4.04$, $p = .04$, $f = .11$, respectively. The mean proportion of informative messages produced by those receiving training and those not receiving training were 0.94 and 0.52, respectively. The mean proportion of informative messages produced during the training phase was .68, whereas this value was .77 for posttest and .74 for transfer trials. Although the main effect for phase was significant, Scheffe tests comparing the pairs of means did not reach significance.

Table 18

Cell Means for Nonretarded 5-Year-Old Subjects in Experiment 2, Proportional Data

	Phase		
	Training	Posttest	Transfer
Training Group			
Level of Instruction			
Intermediate (N=8)	.90	.98	.98
Difficult (N=5)	.87	.98	.93
Control Group			
Level of Instruction			
Intermediate (N=8)	.52	.55	.52
Difficult (N=4)	.38	.56	.53

Table 19

Cell Means for Nonretarded 5-Year-Old Subjects in Experiment 2, Arcsine Transformed Data

	Phase		
	Training	Posttest	Transfer
Training Group			
Level of Instruction			
Intermediate (N=8)	2.51	2.99	2.95
Difficult (N=5)	2.59	2.94	2.72
Control Group			
Level of Instruction			
Intermediate (N=8)	1.61	1.68	1.60
Difficult (N=4)	1.39	1.72	1.65

Mentally Retarded Subjects

The scores for the mentally retarded subjects were analyzed by a 2 x 2 x 3 analysis of variance. The between-subjects factors were training (training or control) and level of instruction (intermediate or difficult). The within-subjects variable was phase (training, posttest, or transfer). Results of the analysis using arcsine transformed data differed from the analysis using proportional data, thus results are reported for the analysis performed on the arcsine transformed data, because this data was more normally distributed than the proportional data. Analysis of variance summary tables are presented in Tables 14 and 15, Appendix E. Cell means are shown in Tables 20 and 21. Significant main effects were found for training, $F(1,53) = 31.93$, $p < .0001$, $f = .84$, level of instruction, $F(1,53) = 11.02$, $p = .0016$, $f = .39$, and phase, $F(2,106) = 3.09$, $p = .05$, $f = .09$. None of the interactions were significant. The mean arcsine transformed proportion of informative messages produced by those mentally retarded subjects receiving training was 2.19, whereas this value was only .80 for those serving as controls. Those receiving instruction at the difficult level outperformed those at the intermediate level, with means of 2.09 and 1.29 respectively. On training trials, the mean arcsine transformed proportion of informative

messages was 1.44, whereas this value increased on posttest and transfer trials, with values of 1.53 and 1.49 respectively. Scheffe tests, however, indicated that differences between pairs of these means were nonsignificant.

Table 20

Cell Means for Mentally Retarded Subjects in Experiment 2, Proportional Data

	Phase		
	Training	Posttest	Transfer
Training Group			
Level of Instruction			
Intermediate (N=21)	.71	.69	.66
Difficult (N=7)	.85	.97	.92
Control Group			
Level of Instruction			
Intermediate (N=22)	.17	.18	.19
Difficult (N=7)	.46	.49	.51

Table 21

Cell Means for Mentally Retarded Subjects in Experiment 2, Arcsine Transformed Data

	Phase		
	Training	Posttest	Transfer
Training Group			
Level of Instruction			
Intermediate (N=21)	2.04	2.05	1.96
Difficult (N=7)	2.41	2.93	2.78
Control Group			
Level of Instruction			
Intermediate (N=22)	0.57	0.58	0.63
Difficult (N=7)	1.39	1.54	1.47

Discussion

The results of Experiment 2 demonstrate the effectiveness of perceptual feedback training for increasing performance on a referential communication task. Both 5-year-old children and mentally retarded participants receiving perceptual feedback training performed significantly better than those not receiving training. The absence of an interaction between task and training condition suggests that the perceptual feedback training was effective early in the training session, and the effects were maintained during the posttest and transfer tasks. The significant phase effect appeared to be due to scores on the training phase being lower than scores on the posttest and transfer trials, although this difference was nonsignificant and the phase effect accounted for only a small proportion of the variance. This difference may have been due to some nonspecific practice effects.

Mentally retarded subjects receiving trials at the difficult level produced significantly more informative messages than those receiving trials at the intermediate level. The same trend was not evident with the nonretarded 5-year-old children, however. Two explanations for this difference between nonretarded and mentally retarded children seem plausible. Mentally retarded subjects trained

at the difficult level may have had better developed enabling skills than those at the intermediate level, making it more likely that the former subjects would benefit more from instruction with use of procedural rules. This explanation is supported by somewhat higher Quick Test scores for mentally retarded subjects trained at the difficult level, although the difference between the two groups was not statistically significant ($p = .06$). Alternately, ceiling effects may have prevented finding a significant difference between nonretarded children trained at the intermediate and difficult levels, as all subjects receiving training scored near 90% informative messages or above.

GENERAL DISCUSSION

The present findings shed considerable light on the referential communication skills of mentally retarded children and adolescents. The performance of the mentally retarded subjects in Experiment 1 exposed their deficits in the area of referential communication. The sizable increments in performance resulting from perceptual feedback training, witnessed in Experiment 2, evinced the nature of these deficits.

Experiment 1 confirmed the conclusions of previous investigators (Longhurst, 1974; Reuda & Chan, 1980) that mentally retarded children and adolescents are deficient in referential communication skills in comparison with nonretarded children of similar mental ages. On a simple task, where a mere description of the intended referent sufficed, performance of the mentally retarded individuals was virtually errorless. However, as the task increased in complexity, requiring comparison among stimuli, recognition of differences between stimuli, and descriptions of the perceived differences, performance deteriorated relative to nonretarded children.

Unique to the present investigation was an exploration of the relation between referential communication skills and mental age. On both the intermediate and difficult tasks, nonretarded and mentally retarded participants at the 8- and 11-year MA level outperformed those at the 5-year MA level, suggesting concomitant development of referential skills with increases in mental age.

Experiment 2 offers perspicuity to the nature of the mentally retarded individual's referential communication skill deficit. Whitehurst and Sonnenschein (1981) make a distinction between two categories of skill deficit, depending on whether or not the requisite component skills are already in a person's repertoire of skills. If the skill deficit results from lacking the component skills necessary for successful completion of a task, overcoming such a deficit would presumably require extensive and arduous training and practice. If, on the other hand, the skill deficit results from the lack of knowledge about when or how to organize already existing subskills, such a deficit could be overcome with relative ease. The ease with which performance on the referential communication task was substantially increased by perceptual feedback training suggests the mentally retarded children and adolescents had the necessary subskills, but did not know when or how to use them in an organized fashion.

Perceptual feedback training taught mentally retarded individuals to use the difference rule, suggesting that Whitehurst and Sonnenschein's (1985) model of the development of referential communication applies not only to normally developing children but to individual's with developmental delays as well. The success of the training procedure highlights Whitehurst and Sonnenschein's emphasis on the importance of procedural rules for communicative development. Possessing all the necessary components of referential communication, the substantive knowledge and enabling skills, is not enough to guarantee successful communication. One needs to know how and when to use these components in an organized way.

Research with young nonretarded children (e.g., Whitehurst & Sonnenschein, 1981) demonstrates that the difference rule is a learnable rule, its use increasing dramatically after training. The present investigation indicated that this is also the case for mentally retarded children and adolescents. Considering the importance of communication to both social and cognitive development, the finding that components of referential communication are teachable has important implications for education of mentally retarded individuals. By developing instructional programs involving the appropriate components and rules, communicative competence can be expected to improve.

Taken alone, the findings from Experiment 1 appear to support the difference position on mental retardation (e.g., Ellis, 1963; Ellis & Cavalier, 1982; Milgram, 1969; Spitz, 1963, 1983), which holds that there are fundamental differences in the development of cognitive processes between mentally retarded and nonretarded individuals. Even when matched on mental age, mentally retarded individuals did more poorly on a referential communication task. When the results of Experiment 1 and 2 are taken together, however, it is evident that although the rate of development of referential communication skills in mentally retarded children is delayed, there appears to be similar organization of skills, compared to that of nonretarded children. Both populations of children appear to progress through a stage where they have the subskills necessary for referential communication but do not know when or how to use them. Whitehurst and Sonnenschein (1981) suggest that such a stage is hierarchically dominant to not having the necessary subskills, and subordinate to adequate communication and metacommunication skills. The training in Experiment 2 provided the mentally retarded individuals with a means of using their already developed skills, and performance was subsequently improved. The similar pattern of development for nonretarded children and mentally retarded children and adolescents supports the liberal

version of the developmental position on mental retardation (e.g., Cicchetti & Pogge-Hesse, 1982), which holds that the development of cognitive processes for mentally retarded individuals is similar in sequencing and organization to nonretarded individuals.

Limitations of the present research indicate areas for future investigation. In the current work, the difference rule was instructed only as it pertains to the role of the speaker. Sonnenschein and Whitehurst (1984b) found that training received in the speaker role does not necessarily transfer to improving performance in the listener role. Role-switching experience, in addition to difference rule training, is required for cross-modality transfer (Sonnenschein & Whitehurst, 1984b). Allowing a child to observe and evaluate the communicative interactions of other speakers and listeners and providing feedback regarding the adequacy of the child's evaluation is also a very effective means of fostering understanding and use of the difference rule in both speaker and listener roles (Sonnenschein & Whitehurst, 1984a). Future research should investigate the efficacy of these procedures for enhancing understanding and use of the difference rule by mentally retarded individuals.

Future research should also explore the use of other procedural rules by mentally retarded individuals.

Considering so few of the mentally retarded participants in the current investigation spontaneously used the difference rule, it is likely that other procedural rules, for both speakers and listeners, are also lacking. Although nonretarded children generally acquire these rules without formal instruction, mentally retarded individuals may need to be explicitly taught each rule to improve their communicative competence.

Generalizability of the perceptual feedback training procedure used with the mentally retarded children requires further investigation. Although in the present study new objects and colors were introduced in the generalization task, it would be interesting to investigate the generalization of training effects to an entirely different task. Pratt, McLaren, and Wickens (1984) used a self-regulation training procedure which involved difference rule training to teach children to observe and describe differences among pictures in a referential communication task. The improvement resulting from training generalized to two completely novel referential tasks, one involving blocks of different shapes used to construct a tower and the other using chess pieces on a checkerboard. A similar study implemented with mentally retarded individuals would offer information on the extent of generalization of difference rule training with these individuals.

Emanating from the current work is the question of the kind and amount of feedback mentally retarded children and adolescents are receiving in their everyday interactions. The present results indicate that mentally retarded individuals have the skills necessary for adequate performance in a referential communication task. Their typically poor performance appears to result from a lack of knowledge of how and when to utilize these skills. The dramatic improvement in communicative performance resulting from a relatively simple explicit feedback procedure generates puzzlement as to why the difference rule is not being acquired through everyday interactions. Robinson's (1981b) investigation of the precursors of adequate referential communication performance suggests that, at least for nonretarded children, those receiving some sort of explicit feedback in their preschool years acquire the difference rule sooner than those not receiving such feedback. It will be a challenge for future researchers to establish whether the absence of the use of the difference rule in the referential exchanges of mentally retarded children is due to a lack of explicit feedback contingent on their performance, or some other developmental factor.

In conclusion, it is clear that at least one procedural rule, the difference rule, can be acquired by mentally retarded children and adolescents through a relatively

simple training procedure, involving explicit feedback, and results in significantly improved performance in a referential communication task. These findings offer an exciting challenge to researchers and educators to further explore and implement the findings in an effort to ameliorate the communicative deficits of mentally retarded individuals.

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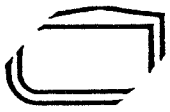
Appendix A

Parental Permission Letter and Consent Form



UNIVERSITY OF MANITOBA DEPARTMENT OF PSYCHOLOGY Winnipeg, Manitoba
Canada R3T 2N2

Dear Parent,

We are conducting research on the development of communication skills in handicapped and nonhandicapped children. Your child's school has kindly agreed to cooperate, and we are writing to request your permission to allow your daughter or son to participate in this research in the near future.

One of the greatest barriers to social interaction and peer acceptance between handicapped and nonhandicapped children is the communication problems experienced by handicapped children. Improving the communication skills of handicapped children should result in enhancing their experiences and opportunities. Previous work with young, nonhandicapped children has led to the development of an instructional procedure to improve communication skills. We feel that this instructional program could be used to improve the communication skills of handicapped children.

The children will take part in a communication task with the researcher, where they will be required to describe pictures of familiar objects. This will allow us to assess their ability to communicate. This initial task will take approximately 30 minutes. Those children who have not yet developed the communication skills necessary to adequately complete the task will be asked to return for the instructional program. The instructional program will take one to three sessions of up to 30 minutes each. One week after its completion, the effectiveness of the instructional program will be assessed with a different communication task. This task will take up to 30 minutes, or less. Thus, in all, children will participate in anywhere from one to five 30-minute sessions. The tasks will be presented to the children as games, and should be enjoyable for them.

Please complete the permission form and return it to the school. If you have any questions, please call Marni Brownell at . Thank you for considering this request.

Sincerely,

John H. Whitelely, Ph.D.
Associate Professor

Marni D. Brownell, M.A.

PERMISSION FORM

Communication Study

Please print.

Child's name: _____

Child's date of birth: _____

Teacher: _____

School: _____

_____ I do consent to let my child participate in the communication study.

_____ I do not consent to let my child participate in the communication study.

Parent or guardian signature: _____

Date: _____

Appendix B

Experiment 1 Data

Explanation for column headings for Tables 2 and 3

OBS - Observation number
ID - Identification number
SEX - Gender of subject 1 = female, 2 = male
AGE - Chronological age of subject
AMSCORE - Score on the Quick Test
AMAGE - Mental age
PAIR - Pair number for subject matching
GROUP - Mental age group 1 = 5, 2 = 8,
3 = 11
EASY - Score out of 12 on the easy message level
INT - Score out of 12 on the intermediate message level
DIFF - Score out of 12 on the difficult message level
P_EASY - Proportional transformation of EASY score
P_INT - Proportional transformation of INT score
P_DIFF - Proportional transformation of DIFF score
T_EASY - Arcsine transformation of EASY score
T_INT - Arcsine transformation of INT score
T_DIFF - Arcsine transformation of DIFF score

Table 2

Data for the Nonretarded Subjects in Experiment 1

OBS	ID	SEX	AGE	AMSCORE	AMAGE	PAIR	GROUP	EASY	INT	DIFF	$\bar{P}_{EASY}$	$\bar{P}_{INT}$	$\bar{P}_{DIFF}$	$\bar{T}_{EASY}$	$\bar{T}_{INT}$	$\bar{T}_{DIFF}$
1	26	2	5.25	21	3.0	1	1	12	12	6	1.00000	1.00000	0.50000	3.14159	3.14159	1.57080
2	10	2	5.00	22	3.0	2	1	12	0	0	1.00000	0.00000	0.00000	3.14159	0.00000	0.00000
3	1	2	5.58	23	3.5	3	1	12	12	11	1.00000	1.00000	0.91667	3.14159	3.14159	2.55591
4	31	1	5.42	23	3.5	4	1	12	10	0	1.00000	0.83333	0.00000	3.14159	2.30052	0.00000
5	3	2	5.33	24	3.5	5	1	12	11	9	1.00000	0.91667	0.75000	3.14159	2.55591	2.09440
6	11	1	5.17	25	3.5	6	1	12	0	0	1.00000	0.00000	0.00000	3.14159	0.00000	0.00000
7	18	2	5.33	25	3.5	7	1	12	7	0	1.00000	0.58333	0.00000	3.14159	1.73824	0.00000
8	19	1	5.17	26	4.0	8	1	12	0	0	1.00000	0.00000	0.00000	3.14159	0.00000	0.00000
9	12	2	5.17	27	4.5	9	1	12	6	0	1.00000	0.50000	0.00000	3.14159	1.57080	0.00000
10	13	1	5.50	27	4.5	10	1	12	7	0	1.00000	0.58333	0.00000	3.14159	1.73824	0.00000
11	2	1	5.17	28	4.5	11	1	12	12	10	1.00000	1.00000	0.83333	3.14159	3.14159	2.30052
12	20	1	4.92	28	4.5	12	1	12	7	1	1.00000	0.58333	0.08333	3.14159	1.73824	0.58569
13	33	2	5.58	29	4.5	13	1	12	8	3	1.00000	0.66667	0.25000	3.14159	1.91063	1.04720
14	14	1	5.50	30	5.0	14	1	7	0	0	0.58333	0.00000	0.00000	1.73824	0.00000	0.00000
15	4	2	5.08	31	5.0	15	1	12	12	10	1.00000	1.00000	0.83333	3.14159	3.14159	2.30052
16	5	1	5.58	31	5.0	16	1	12	12	9	1.00000	1.00000	0.75000	3.14159	3.14159	2.09440
17	6	1	5.33	31	5.0	17	1	12	12	11	1.00000	1.00000	0.91667	3.14159	3.14159	2.55591
18	15	2	5.50	31	5.0	18	1	12	7	0	1.00000	0.58333	0.00000	3.14159	1.73824	0.00000
19	27	1	5.50	31	5.0	19	1	12	11	5	1.00000	0.91667	0.41667	3.14159	2.55591	1.40335
20	7	1	5.17	33	5.5	20	1	11	12	12	0.91667	1.00000	1.00000	2.55591	3.14159	3.14159
21	28	1	5.42	33	5.5	21	1	12	10	5	1.00000	0.83333	0.41667	3.14159	2.30052	1.40335
22	8	1	5.33	34	5.5	22	1	12	12	8	1.00000	1.00000	0.66667	3.14159	3.14159	1.91063
23	23	1	5.75	34	5.5	23	1	12	1	0	1.00000	0.08333	0.00000	3.14159	0.58569	0.00000
24	35	1	7.50	34	5.5	29	1	12	0	0	1.00000	0.00000	0.00000	3.14159	0.00000	0.00000
25	9	1	5.67	35	6.0	24	1	12	12	9	1.00000	1.00000	0.75000	3.14159	3.14159	2.09440
26	24	1	5.58	35	6.0	25	1	12	0	0	1.00000	0.00000	0.00000	3.14159	0.00000	0.00000
27	25	1	5.58	36	6.0	26	2	12	7	1	1.00000	0.58333	0.08333	3.14159	1.73824	0.58569
28	34	1	5.83	38	6.5	27	2	12	11	6	1.00000	0.91667	0.50000	3.14159	2.55591	1.57080
29	36	1	7.25	38	6.5	30	2	12	12	11	1.00000	1.00000	0.91667	3.14159	3.14159	2.55591
30	37	1	6.92	38	6.5	31	2	12	12	11	1.00000	1.00000	0.91667	3.14159	3.14159	2.55591
31	38	1	7.08	39	7.0	32	2	12	12	11	1.00000	1.00000	0.91667	3.14159	3.14159	2.55591
32	30	1	5.17	40	7.0	28	2	12	9	2	1.00000	0.75000	0.16667	3.14159	2.09440	0.84107
33	39	1	7.00	40	7.0	33	2	12	12	12	1.00000	1.00000	1.00000	3.14159	3.14159	3.14159
34	40	1	7.25	40	7.0	34	2	12	12	12	1.00000	1.00000	1.00000	3.14159	3.14159	3.14159
35	41	1	7.42	41	7.0	35	2	12	11	12	1.00000	0.91667	1.00000	3.14159	2.55591	3.14159
36	42	1	7.75	42	7.5	36	2	12	12	12	1.00000	1.00000	1.00000	3.14159	3.14159	3.14159
37	43	2	6.83	42	7.5	37	2	10	7	5	0.83333	0.58333	0.41667	2.30052	1.73824	1.40335
38	44	2	7.42	42	7.5	38	2	12	0	0	1.00000	0.00000	0.00000	3.14159	0.00000	0.00000
39	45	1	7.75	42	7.5	39	2	12	8	0	1.00000	0.66667	0.00000	3.14159	1.91063	0.00000
40	46	2	7.00	42	7.5	40	2	12	12	9	1.00000	1.00000	0.75000	3.14159	3.14159	2.09440
41	47	1	6.58	43	8.0	41	2	12	12	12	1.00000	1.00000	1.00000	3.14159	3.14159	3.14159
42	48	1	7.83	43	8.0	42	2	12	12	12	1.00000	1.00000	1.00000	3.14159	3.14159	3.14159
43	49	1	7.00	44	8.0	43	2	12	12	10	1.00000	1.00000	0.83333	3.14159	3.14159	2.30052
44	53	2	7.00	44	8.0	44	2	12	9	0	1.00000	0.75000	0.00000	3.14159	2.09440	0.00000
45	54	1	7.33	45	8.0	45	2	12	11	1	1.00000	0.91667	0.08333	3.14159	2.55591	0.58569
46	55	1	6.75	46	8.5	46	2	12	12	10	1.00000	1.00000	0.83333	3.14159	3.14159	2.30052

Table 2 (cont'd)

OBS	ID	SEX	AGE	AMSCORE	AMAGE	PAIR	GROUP	EASY	INT	DIFF	$\overline{P}_{EASY}$	$\overline{P}_{INT}$	$\overline{P}_{DIFF}$	$\overline{T}_{EASY}$	$\overline{T}_{INT}$	$\overline{T}_{DIFF}$
47	56	2	7.75	47	9.0	47	2	12	12	11	1	1.00000	0.91667	3.14159	3.14159	2.55591
48	57	2	7.25	47	9.0	48	2	12	9	4	1	0.75000	0.33333	3.14159	2.09440	1.23096
49	58	2	7.08	47	9.0	49	2	12	10	5	1	0.83333	0.41667	3.14159	2.30052	1.40335
50	65	2	9.67	47	9.0	54	2	12	12	12	1	1.00000	1.00000	3.14159	3.14159	3.14159
51	59	1	7.00	49	9.0	50	2	12	12	10	1	1.00000	0.83333	3.14159	3.14159	2.30052
52	60	1	7.50	49	9.0	51	2	12	11	10	1	0.91667	0.83333	3.14159	2.55591	2.30052
53	61	1	7.75	49	9.0	52	2	12	12	11	1	1.00000	0.91667	3.14159	3.14159	2.55591
54	66	1	9.83	49	9.0	55	2	12	12	12	1	1.00000	1.00000	3.14159	3.14159	3.14159
55	68	1	9.92	49	9.0	56	2	12	12	12	1	1.00000	1.00000	3.14159	3.14159	3.14159
56	62	2	7.08	50	9.5	53	2	12	11	2	1	0.91667	0.16667	3.14159	2.55591	0.84107
57	69	2	9.25	51	10.0	57	3	12	12	10	1	1.00000	0.83333	3.14159	3.14159	2.30052
58	70	1	8.83	52	10.0	58	3	12	12	12	1	1.00000	1.00000	3.14159	3.14159	3.14159
59	71	2	9.83	53	10.0	59	3	12	11	3	1	0.91667	0.25000	3.14159	2.55591	1.04720
60	72	2	9.33	53	10.0	60	3	12	12	9	1	1.00000	0.75000	3.14159	3.14159	2.09440
61	75	1	9.58	54	10.5	61	3	12	12	12	1	1.00000	1.00000	3.14159	3.14159	3.14159
62	78	1	9.33	55	11.0	62	3	12	12	10	1	1.00000	0.83333	3.14159	3.14159	2.30052
63	79	2	9.83	55	11.0	63	3	12	12	12	1	1.00000	1.00000	3.14159	3.14159	3.14159
64	80	1	9.75	56	11.0	64	3	12	12	12	1	1.00000	1.00000	3.14159	3.14159	3.14159
65	81	1	9.16	58	11.5	65	3	12	12	11	1	1.00000	0.91667	3.14159	3.14159	2.55591
66	82	1	9.67	59	12.0	66	3	12	12	11	1	1.00000	0.91667	3.14159	3.14159	2.55591
67	83	2	9.83	61	12.0	67	3	12	12	12	1	1.00000	1.00000	3.14159	3.14159	3.14159
68	86	2	9.08	62	12.5	68	3	12	12	12	1	1.00000	1.00000	3.14159	3.14159	3.14159
69	88	2	9.83	64	13.0	69	3	12	12	12	1	1.00000	1.00000	3.14159	3.14159	3.14159

Table 3

Data for the Mentally Retarded Subjects in Experiment 1

OBS	ID	SEX	AGE	AMSCORE	AMAGE	PAIR	GROUP	EASY	INT	DIFF	$\overline{P}_{EASY}$	$\overline{P}_{INT}$	$\overline{P}_{DIFF}$	$\overline{T}_{EASY}$	$\overline{T}_{INT}$	$\overline{T}_{DIFF}$
1	128	2	7.92	21	3.0	1	1	10	2	0	0.83333	0.16667	0.00000	2.30052	0.84107	0.00000
2	129	2	14.92	22	3.0	2	1	12	0	0	1.00000	0.00000	0.00000	3.14159	0.00000	0.00000
3	106	2	19.92	23	3.5	3	1	12	5	0	1.00000	0.41667	0.00000	3.14159	1.40335	0.00000
4	150	2	8.42	23	3.5	4	1	12	10	2	1.00000	0.83333	0.16667	3.14159	2.30052	0.84107
5	107	1	15.16	24	3.5	5	1	12	0	0	1.00000	0.00000	0.00000	3.14159	0.00000	0.00000
6	130	2	14.75	25	3.5	6	1	11	6	1	0.91667	0.50000	0.08333	2.55591	1.57080	0.58569
7	108	1	16.42	27	4.5	7	1	12	0	0	1.00000	0.00000	0.00000	3.14159	0.00000	0.00000
8	109	1	8.83	27	4.5	8	1	12	0	0	1.00000	0.00000	0.00000	3.14159	0.00000	0.00000
9	110	2	16.33	27	4.5	9	1	12	5	0	1.00000	0.41667	0.00000	3.14159	1.40335	0.00000
10	111	1	19.83	27	4.5	10	1	12	0	0	1.00000	0.00000	0.00000	3.14159	0.00000	0.00000
11	131	2	6.92	28	4.5	11	1	12	5	0	1.00000	0.41667	0.00000	3.14159	1.40335	0.00000
12	112	2	6.18	29	4.5	13	1	12	5	0	1.00000	0.41667	0.00000	3.14159	1.40335	0.00000
13	132	1	19.00	29	4.5	12	1	12	0	0	1.00000	0.00000	0.00000	3.14159	0.00000	0.00000
14	113	2	16.16	30	5.0	14	1	12	7	1	1.00000	0.58333	0.08333	3.14159	1.73824	0.58569
15	133	2	17.67	30	5.0	15	1	12	0	0	1.00000	0.00000	0.00000	3.14159	0.00000	0.00000
16	134	2	14.92	30	5.0	16	1	12	0	0	1.00000	0.00000	0.00000	3.14159	0.00000	0.00000
17	114	2	12.75	31	5.0	19	1	11	3	0	0.91667	0.25000	0.00000	2.55591	1.04720	0.00000
18	135	1	15.16	31	5.0	17	1	12	6	0	1.00000	0.50000	0.00000	3.14159	1.57080	0.00000
19	151	2	19.58	31	5.0	18	1	12	11	3	1.00000	0.91667	0.25000	3.14159	2.55591	1.04720
20	115	2	18.00	33	5.5	20	1	12	0	0	1.00000	0.00000	0.00000	3.14159	0.00000	0.00000
21	136	2	13.33	33	5.5	21	1	12	2	0	1.00000	0.16667	0.00000	3.14159	0.84107	0.00000
22	137	2	13.83	34	5.5	22	1	12	0	0	1.00000	0.00000	0.00000	3.14159	0.00000	0.00000
23	157	2	14.83	34	5.5	23	1	12	8	4	1.00000	0.66667	0.33333	3.14159	1.91063	1.23096
24	116	1	20.16	34	5.5	29	1	12	0	0	1.00000	0.00000	0.00000	3.14159	0.00000	0.00000
25	138	1	10.25	35	6.0	25	1	12	0	0	1.00000	0.00000	0.00000	3.14159	0.00000	0.00000
26	158	2	13.08	35	6.0	24	1	12	7	2	1.00000	0.58333	0.16667	3.14159	1.73824	0.84107
27	92	1	18.33	36	6.0	26	2	12	12	8	1.00000	1.00000	0.66667	3.14159	3.14159	1.91063
28	139	2	18.00	37	6.0	30	2	12	0	0	1.00000	0.00000	0.00000	3.14159	0.00000	0.00000
29	93	1	18.92	38	6.5	27	2	12	12	8	1.00000	1.00000	0.66667	3.14159	3.14159	1.91063
30	140	1	13.08	39	7.0	31	2	12	0	0	1.00000	0.00000	0.00000	3.14159	0.00000	0.00000
31	152	2	13.75	40	7.0	28	2	12	11	4	1.00000	0.91667	0.33333	3.14159	2.55591	1.23096
32	141	1	12.00	40	7.0	32	2	12	4	0	1.00000	0.33333	0.00000	3.14159	1.23096	0.00000
33	142	2	19.67	40	7.0	33	2	8	3	0	0.66667	0.25000	0.00000	1.91063	1.04720	0.00000
34	159	1	14.00	40	7.0	34	2	12	10	0	1.00000	0.83333	0.00000	3.14159	2.30052	0.00000
35	117	2	15.00	41	7.0	35	2	12	0	0	1.00000	0.00000	0.00000	3.14159	0.00000	0.00000
36	153	2	19.16	41	7.0	36	2	12	8	1	1.00000	0.66667	0.08333	3.14159	1.91063	0.58569
37	118	1	15.67	42	7.5	37	2	12	6	0	1.00000	0.50000	0.00000	3.14159	1.57080	0.00000
38	119	1	15.83	42	7.5	38	2	12	0	0	1.00000	0.00000	0.00000	3.14159	0.00000	0.00000
39	120	1	18.67	42	7.5	39	2	12	0	0	1.00000	0.00000	0.00000	3.14159	0.00000	0.00000
40	121	2	17.25	42	7.5	40	2	12	0	0	1.00000	0.00000	0.00000	3.14159	0.00000	0.00000
41	143	1	16.00	43	8.0	41	2	12	0	0	1.00000	0.00000	0.00000	3.14159	0.00000	0.00000
42	160	1	14.92	43	8.0	42	2	12	12	7	1.00000	1.00000	0.58333	3.14159	3.14159	1.73824
43	122	2	11.67	44	8.0	43	2	12	1	0	1.00000	0.08333	0.00000	3.14159	0.58569	0.00000
44	94	2	19.50	45	8.0	44	2	12	12	9	1.00000	1.00000	0.75000	3.14159	3.14159	2.09440
45	95	1	10.42	45	8.0	45	2	12	12	12	1.00000	1.00000	1.00000	3.14159	3.14159	3.14159
46	123	1	14.83	46	8.5	46	2	12	5	0	1.00000	0.41667	0.00000	3.14159	1.40335	0.00000

Table 3 (cont'd)

OBS	ID	SEX	AGE	AMSCORE	AMAGE	PAIR	GROUP	EASY	INT	DIFF	PEASY	PINT	PDIFF	TEASY	TINT	TDIFF
47	144	2	17.08	46	8.5	47	2	12	0	0	1.00000	0.00000	0.00000	3.14159	0.00000	0.00000
48	161	2	18.00	46	8.5	48	2	12	8	4	1.00000	0.66667	0.33333	3.14159	1.91063	1.23096
49	124	2	15.42	46	8.5	54	2	12	0	0	1.00000	0.00000	0.00000	3.14159	0.00000	0.00000
50	162	2	13.58	47	9.0	49	2	12	7	0	1.00000	0.58333	0.00000	3.14159	1.73824	0.00000
51	145	2	14.50	49	9.0	50	2	11	2	0	0.91667	0.16667	0.00000	2.55591	0.84107	0.00000
52	125	2	15.33	49	9.0	55	2	12	6	0	1.00000	0.50000	0.00000	3.14159	1.57080	0.00000
53	154	1	16.75	49	9.0	56	2	12	8	4	1.00000	0.66667	0.33333	3.14159	1.91063	1.23096
54	96	2	17.75	50	9.5	51	2	12	12	12	1.00000	1.00000	1.00000	3.14159	3.14159	3.14159
55	97	2	19.08	50	9.5	52	2	12	11	11	1.00000	0.91667	0.91667	3.14159	2.55591	2.55591
56	146	1	21.25	50	9.5	53	2	11	6	0	0.91667	0.50000	0.00000	2.55591	1.57080	0.00000
57	147	2	13.25	51	10.0	57	3	12	5	0	1.00000	0.41667	0.00000	3.14159	1.40335	0.00000
58	148	2	15.67	51	10.0	58	3	12	5	1	1.00000	0.41667	0.08333	3.14159	1.40335	0.58569
59	98	2	18.67	52	10.0	59	3	12	11	9	1.00000	0.91667	0.75000	3.14159	2.55591	2.09440
60	163	2	12.42	53	10.0	60	3	12	11	6	1.00000	0.91667	0.50000	3.14159	2.55591	1.57080
61	99	2	14.00	54	10.5	61	3	12	12	10	1.00000	1.00000	0.83333	3.14159	3.14159	2.30052
62	100	2	17.42	56	11.0	62	3	12	11	11	1.00000	0.91667	0.91667	3.14159	2.55591	2.55591
63	149	2	19.50	56	11.0	63	3	12	2	0	1.00000	0.16667	0.00000	3.14159	0.84107	0.00000
64	101	2	18.00	58	11.5	64	3	12	12	11	1.00000	1.00000	0.91667	3.14159	3.14159	2.55591
65	155	2	17.92	58	11.5	65	3	12	11	2	1.00000	0.91667	0.16667	3.14159	2.55591	0.84107
66	102	2	14.33	59	12.0	66	3	11	12	12	0.91667	1.00000	1.00000	2.55591	3.14159	3.14159
67	126	2	19.92	60	12.0	67	3	12	6	0	1.00000	0.50000	0.00000	3.14159	1.57080	0.00000
68	156	1	13.42	62	12.5	68	3	12	12	6	1.00000	1.00000	0.50000	3.14159	3.14159	1.57080
69	103	1	20.00	64	13.0	69	3	12	11	11	1.00000	0.91667	0.91667	3.14159	2.55591	2.55591

Appendix C

Analysis of Variance Summary Tables for Experiment 1

Table 4

Analysis of Variance Summary Table for Experiment 1, Proportional Data

Between-Subjects Effects

Source	DF	Type III SS	Mean Square	F Value	PR>F
MA Level	2	5.60	2.80	27.29	.0001
Error	66	6.77	0.10		

Within-Subjects Effects

Source	DF	Type III SS	Mean Square	F Value	PR>F
Group	1	5.07	5.07	35.67	.0001
Group * MA Level	2	0.15	0.08	0.53	.5904
Error (Group)	66	9.38	0.14		
Difficulty Level	2	18.22	9.11	217.39	.0001
Difficulty Level * MA Level	4	2.62	0.65	15.61	.0001
Error (Difficulty Level)	132	5.53	0.04		
Group * Difficulty Level	2	2.48	1.24	26.94	.0001
Group * Difficulty Level * MA Level	4	0.15	0.04	0.81	.4970
Error (Group * Difficulty Level)	132	6.09	0.05		

Table 5

Analysis of Variance Summary Table for Experiment 1, Arcsine Transformed Data

Between-Subjects Effects

Source	DF	Type III SS	Mean Square	F Value	PR>F
MA Level	2	51.39	25.69	27.69	.0001
Error	66	61.24	0.93		

Within-Subjects Effects

Source	DF	Type III SS	Mean Square	F Value	PR>F
Group	1	46.63	46.63	36.50	.0001
Group * MA Level	2	1.37	0.68	0.54	.5879
Error (Group)	66	84.31	1.28		
Difficulty Level	2	183.76	91.88	257.74	.0001
Difficulty Level * MA Level	4	23.08	5.77	16.18	.0001
Error (Difficulty Level)	132	47.06	0.36		
Group * Difficulty Level	2	21.41	10.71	26.41	.0001
Group * Difficulty Level * MA Level	4	1.38	0.34	0.85	.4738
Error (Group * Difficulty Level)	132	53.50	0.41		

Appendix D

Experiment 2 Data

Explanation for column headings for Tables 10 and 11

OBS - Observation number
ID - Identification number
SEX - Gender of subject 1 = female, 2 = male
AGE - Chronological age
AMSCORE - Quick Test score
INSTRUCT - Training condition 1 = training, 0 = control
TYPE - Level of training 1 = intermediate, 2 = difficult
TRAIN - Number of informative messages out of 24 on the training task
POST - Number of informative messages out of 16 on the posttest task
TRANSFER - Number of informative messages out of 16 on the transfer task
P_TRAIN - Proportional transformation of TRAIN
P_POST - Proportional transformation of POST
P_TRANS - Proportional transformation of TRANSFER
T_TRAIN - Arcsine transformation of TRAIN
T_POST - Arcsine transformation of POST
T_TRANS - Arcsine transformation of TRANSFER

Table 10

Data for Nonretarded 5-Year-Old Subjects in Experiment 2

OBS	ID	SEX	AGE	AMSCORE	INSTRUCT	TYPE	TRAIN	POST	TRANSFER	$P_{\overline{TRAIN}}$	$P_{\overline{POST}}$	$P_{\overline{TRANS}}$	$T_{\overline{TRAIN}}$	$T_{\overline{POST}}$	$T_{\overline{TRANS}}$
1	18	2	5.33	25	0	1	23	16	16	0.95833	1.0000	1.0000	2.73045	3.14159	3.14159
2	19	1	5.17	26	0	1	14	14	13	0.58333	0.8750	0.8125	1.73824	2.41886	2.24593
3	20	1	4.92	28	0	1	23	16	12	0.95833	1.0000	0.7500	2.73045	3.14159	2.09440
4	21	1	5.42	31	0	1	1	0	0	0.04167	0.0000	0.0000	0.41114	0.00000	0.00000
5	22	1	5.58	31	0	1	5	0	0	0.20833	0.0000	0.0000	0.94797	0.00000	0.00000
6	23	1	5.75	34	0	1	18	12	9	0.75000	0.7500	0.5625	2.09440	2.09440	1.69612
7	24	1	5.58	35	0	1	1	2	1	0.04167	0.1250	0.0625	0.41114	0.72273	0.50536
8	25	1	5.58	36	0	1	15	11	16	0.62500	0.6875	1.0000	1.82348	1.95519	3.14159
9	31	1	5.42	23	0	2	2	14	14	0.08333	0.8750	0.8750	0.58569	2.41886	2.41886
10	32	2	4.83	25	0	2	8	6	4	0.33333	0.3750	0.2500	1.23096	1.31812	1.04720
11	33	2	5.58	29	0	2	2	0	0	0.08333	0.0000	0.0000	0.58569	0.00000	0.00000
12	34	1	5.83	38	0	2	24	16	16	1.00000	1.0000	1.0000	3.14159	3.14159	3.14159
13	10	2	5.00	22	1	1	20	15	15	0.83333	0.9375	0.9375	2.30052	2.63623	2.63623
14	11	1	5.17	25	1	1	20	16	16	0.83333	1.0000	1.0000	2.30052	3.14159	3.14159
15	12	2	5.17	27	1	1	22	16	16	0.91667	1.0000	1.0000	2.55591	3.14159	3.14159
16	13	1	5.50	27	1	1	23	14	15	0.95833	0.8750	0.9375	2.73045	2.41886	2.63623
17	14	1	5.50	30	1	1	20	16	16	0.83333	1.0000	1.0000	2.30052	3.14159	3.14159
18	15	2	5.50	31	1	1	23	16	16	0.95833	1.0000	1.0000	2.73045	3.14159	3.14159
19	16	2	5.58	31	1	1	21	16	16	0.87500	1.0000	1.0000	2.41886	3.14159	3.14159
20	17	2	5.58	43	1	1	23	16	15	0.95833	1.0000	0.9375	2.73045	3.14159	2.63623
21	26	2	5.25	21	1	2	24	16	14	1.00000	1.0000	0.8750	3.14159	3.14159	2.41886
22	27	1	5.50	31	1	2	14	15	13	0.58333	0.9375	0.8125	1.73824	2.63623	2.24593
23	28	1	5.42	33	1	2	23	16	15	0.95833	1.0000	0.9375	2.73045	3.14159	2.63623
24	29	1	5.33	34	1	2	19	15	16	0.79167	0.9375	1.0000	2.19362	2.63623	3.14159
25	30	1	5.17	40	1	2	24	16	16	1.00000	1.0000	1.0000	3.14159	3.14159	3.14159

Table 11

Data for Mentally Retarded Subjects in Experiment 2

OBS	ID	SEX	AGE	AMSCORE	INSTRUCT	TYPE	TRAIN	POST	TRANSFER	PTRAIN	PPOST	PTRANS	TTRAIN	TPOST	TTRANS
1	128	2	7.92	21	0	1	0	0	1	0.000000	0.0000	0.0625	0.00000	0.00000	0.50536
2	129	2	14.92	22	0	1	0	0	0	0.000000	0.0000	0.0000	0.00000	0.00000	0.00000
3	130	2	14.75	25	0	1	12	7	8	0.500000	0.4375	0.5000	1.57080	1.44547	1.57080
4	131	2	6.92	28	0	1	11	8	8	0.458333	0.5000	0.5000	1.48737	1.57080	1.57080
5	132	1	19.00	29	0	1	0	0	0	0.000000	0.0000	0.0000	0.00000	0.00000	0.00000
6	133	2	17.67	30	0	1	0	0	0	0.000000	0.0000	0.0000	0.00000	0.00000	0.00000
7	134	2	14.92	30	0	1	0	0	0	0.000000	0.0000	0.0000	0.00000	0.00000	0.00000
8	135	1	15.16	31	0	1	12	8	8	0.500000	0.5000	0.5000	1.57080	1.57080	1.57080
9	136	2	13.33	33	0	1	4	6	7	0.166667	0.3750	0.4375	0.84107	1.31812	1.44547
10	137	2	13.83	34	0	1	0	0	0	0.000000	0.0000	0.0000	0.00000	0.00000	0.00000
11	138	1	10.25	35	0	1	0	0	0	0.000000	0.0000	0.0000	0.00000	0.00000	0.00000
12	139	2	18.00	37	0	1	0	0	0	0.000000	0.0000	0.0000	0.00000	0.00000	0.00000
13	140	1	13.08	39	0	1	0	0	0	0.000000	0.0000	0.0000	0.00000	0.00000	0.00000
14	141	1	12.00	40	0	1	7	4	8	0.291667	0.2500	0.5000	1.14102	1.04720	1.57080
15	142	2	19.67	40	0	1	0	0	0	0.000000	0.0000	0.0000	0.00000	0.00000	0.00000
16	143	1	16.00	43	0	1	0	0	0	0.000000	0.0000	0.0000	0.00000	0.00000	0.00000
17	144	2	17.08	46	0	1	5	0	5	0.208333	0.0000	0.3125	0.94797	0.00000	1.18640
18	145	2	14.50	49	0	1	0	0	0	0.000000	0.0000	0.0000	0.00000	0.00000	0.00000
19	146	1	21.25	50	0	1	18	15	11	0.750000	0.9375	0.6875	2.09440	2.63623	1.95519
20	147	2	13.25	51	0	1	12	8	5	0.500000	0.5000	0.3125	1.57080	1.57080	1.18640
21	148	2	15.67	51	0	1	8	9	6	0.333333	0.5625	0.3750	1.23096	1.69612	1.31812
22	149	2	19.50	56	0	1	0	0	0	0.000000	0.0000	0.0000	0.00000	0.00000	0.00000
23	157	2	14.83	34	0	2	10	10	12	0.416667	0.6250	0.7500	1.40335	1.82348	2.09440
24	158	2	13.08	35	0	2	7	2	0	0.291667	0.1250	0.0000	1.14102	0.72273	0.00000
25	159	1	14.00	40	0	2	0	0	0	0.000000	0.0000	0.0000	0.00000	0.00000	0.00000
26	160	1	14.92	43	0	2	22	11	15	0.916667	0.6875	0.9375	2.55591	1.95519	2.63623
27	161	2	18.00	46	0	2	0	0	0	0.000000	0.0000	0.0000	0.00000	0.00000	0.00000
28	162	2	13.58	47	0	2	16	16	16	0.666667	1.0000	1.0000	1.91063	3.14159	3.14159
29	163	2	12.42	53	0	2	23	16	14	0.958333	1.0000	0.8750	2.73045	3.14159	2.41886
30	106	2	19.92	23	1	1	16	8	8	0.666667	0.5000	0.5000	1.91063	1.57080	1.57080
31	107	1	15.16	24	1	1	11	8	8	0.458333	0.5000	0.5000	1.48737	1.57080	1.57080
32	108	1	16.42	27	1	1	15	0	2	0.625000	0.0000	0.1250	1.82348	0.00000	0.72273
33	109	1	8.83	27	1	1	15	9	11	0.625000	0.5625	0.6875	1.82348	1.69612	1.95519
34	110	2	16.33	27	1	1	23	13	14	0.958333	0.8125	0.8750	2.73045	2.24593	2.41886
35	111	1	19.83	27	1	1	2	0	0	0.083333	0.0000	0.0000	0.58569	0.00000	0.00000
36	112	2	6.18	29	1	1	21	14	15	0.875000	0.8750	0.9375	2.41886	2.41886	2.63623
37	113	2	16.16	30	1	1	23	13	12	0.958333	0.8125	0.7500	2.73045	2.24593	2.09440
38	114	2	12.75	31	1	1	13	13	13	0.541667	0.8125	0.8125	1.65423	2.24593	2.24593
39	115	2	18.00	33	1	1	15	14	14	0.625000	0.8750	0.8750	1.82348	2.41886	2.41886
40	116	1	20.16	34	1	1	9	8	8	0.375000	0.5000	0.5000	1.31812	1.57080	1.57080
41	117	2	15.00	41	1	1	20	16	14	0.833333	1.0000	0.8750	2.30052	3.14159	2.41886
42	118	1	15.67	42	1	1	21	16	16	0.875000	1.0000	1.0000	2.41886	3.14159	3.14159
43	119	1	15.83	42	1	1	20	9	8	0.833333	0.5625	0.5000	2.30052	1.69612	1.57080
44	120	1	18.67	42	1	1	15	11	8	0.625000	0.6875	0.5000	1.82348	1.95519	1.57080
45	121	2	17.25	42	1	1	15	11	10	0.625000	0.6875	0.6250	1.82348	1.95519	1.82348

Table 11 (cont'd)

OBS	ID	SEX	AGE	AMSCORE	INSTRUCT	TYPE	TRAIN	POST	TRANSFER	P_TRAIN	P_POST	P_TRANS	T_TRAIN	T_POST	T_TRANS
46	122	2	11.67	44	1	1	20	16	16	0.83333	1.0000	1.0000	2.30052	3.14159	3.14159
47	123	1	14.83	46	1	1	17	12	10	0.70833	0.7500	0.6250	2.00057	2.09440	1.82348
48	124	2	15.42	46	1	1	22	16	16	0.91667	1.0000	1.0000	2.55591	3.14159	3.14159
49	125	2	15.33	49	1	1	22	16	10	0.91667	1.0000	0.6250	2.55591	3.14159	1.82348
50	126	2	19.92	60	1	1	21	8	8	0.87500	0.5000	0.5000	2.41886	1.57080	1.57080
51	150	2	8.42	23	1	2	18	15	14	0.75000	0.9375	0.8750	2.09440	2.63623	2.41886
52	151	2	19.58	31	1	2	18	16	16	0.75000	1.0000	1.0000	2.09440	3.14159	3.14159
53	152	2	13.75	40	1	2	20	15	15	0.83333	0.9375	0.9375	2.30052	2.63623	2.63623
54	153	2	19.16	41	1	2	19	15	10	0.79167	0.9375	0.6250	2.19362	2.63623	1.82348
55	154	1	16.75	49	1	2	20	16	16	0.83333	1.0000	1.0000	2.30052	3.14159	3.14159
56	155	2	17.92	58	1	2	23	16	16	0.95833	1.0000	1.0000	2.73045	3.14159	3.14159
57	156	1	13.42	62	1	2	24	16	16	1.00000	1.0000	1.0000	3.14159	3.14159	3.14159

Appendix E

Analysis of Variance Summary Tables for Experiment 2

Table 12

Analysis of Variance Summary Table for Nonretarded 5-Year-Old Subjects in Experiment 2, Proportional Data

Between-Subjects Effects

Source	DF	Type III SS	Mean Square	F Value	PR>F
Training	1	3.09	3.09	12.59	.0019
Level of Instruction	1	0.02	0.02	0.09	.7702
Training * Level of Instruction	1	0.00	0.00	0.00	.9474
Error	21	5.15	0.25		

Within-Subjects Effects

Source	DF	Type III SS	Mean Square	F Value	PR>F
Phase	2	0.13	0.06	4.04	.0418
Phase * Training	2	0.00	0.00	0.02	.9364
Phase * Level of Instruction	2	0.03	0.01	0.79	.4213
Phase * Training * Level of Instruction	2	0.02	0.01	0.74	.4391
Error (Phase)	42	0.67	0.02		

Table 13

Analysis of Variance Summary Table for Nonretarded 5-Year-Old Subjects in Experiment 2, Arcsine Transformed Data

Between-Subjects Effects

Source	DF	Type III SS	Mean Square	F Value	PR>F
Training	1	23.59	23.59	11.68	.0026
Level of Instruction	1	0.06	0.06	0.03	.8689
Training * Level of Instruction	1	0.00	0.00	0.00	.9761
Error	21	42.39	2.02		

Within-Subjects Effects

Source	DF	Type III SS	Mean Square	F Value	PR>F
Phase	2	1.14	0.57	3.47	.0519
Phase * Training	2	0.14	0.07	0.42	.6157
Phase * Level of Instruction	2	0.02	0.01	0.07	.8953
Phase * Training * Level of Instruction	2	0.26	0.13	0.79	.4382
Error (Phase)	42	6.86	0.16		

Table 14

Analysis of Variance Summary Table for the Mentally Retarded Subjects in Experiment 2, Proportional Data

Between-Subjects Effects

Source	DF	Type III SS	Mean Square	F Value	PR>F
Training	1	6.81	6.81	33.83	.0001
Level of Instruction	1	2.27	2.27	11.29	.0014
Training * Level of Instruction	1	0.05	0.05	0.24	.6264
Error	53	10.67	0.20		

Within-Subjects Effects

Source	DF	Type III SS	Mean Square	F Value	PR>F
Phase	2	0.03	0.02	1.39	.2534
Phase * Training	2	0.02	0.01	0.69	.4854
Phase * Level of Instruction	2	0.04	0.02	1.83	.1712
Phase * Training * Level of Instruction	2	0.03	0.01	1.18	.3071
Error (Phase)	106	1.18	0.01		

Table 15

Analysis of Variance Summary Table for the Mentally Retarded Subjects in Experiment 2, Arcsine Transformed Data

Between-Subjects Effects

Source	DF	Type III SS	Mean Square	F Value	PR>F
Training	1	55.96	55.96	31.93	.0001
Level of Instruction	1	19.31	19.31	11.02	.0016
Training * Level of Instruction	1	0.27	0.27	0.16	.6942
Error	53	92.88	1.75		

Within-Subjects Effects

Source	DF	Type III SS	Mean Square	F Value	PR>F
Phase	2	0.65	0.32	3.09	.0543
Phase * Training	2	0.17	0.08	0.81	.4376
Phase * Level of Instruction	2	0.57	0.29	2.75	.0737
Phase * Training * Level of Instruction	2	0.29	0.15	1.40	.2523
Error (Phase)	106	11.09	0.10		