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Procedures for Teaching Appropriate Gestural Communication

Skills to Children with Autism

Dawn M. Buffington

A dissertation submitted to the Graduate Faculty in Psychology in partial fulfillment of the requirements for the degree of Doctor of Philosophy, The City University of New York

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Abstract

PROCEDURES FOR TEACHING APPROPRIATE GESTURAL COMMUNICATION SKILLS TO CHILDREN WITH AUTISM

by

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Children with autism are often deficient in their use of gestural communication. In the current study, four children with autism (ranging in age from 4 to 6 years) were taught to use gestures in combination with oral communication. A multiple-baseline across-responses design was used. An intervention package was introduced successively across three response categories. Each response category contained three gestures considered to be representative of either attention-directing/getting behavior, affective behavior, or descriptive behavior. Although none of the participants displayed any appropriate gestural and verbal responses during baseline, all four participants acquired this skill with the systematic implementation of modeling, prompting, and reinforcement. Generalization of the gestural and verbal responses from stimuli associated with treatment to stimuli not associated with treatment was measured. Generalization of the trained responses was also measured from the training stimuli and setting to novel stimuli presented in a novel setting. All generalization measures indicated that the children learned to use the gestural and verbal responses in the presence of novel stimuli and a novel setting. Social validity measures taken also revealed that the participants' behavior appeared more socially appropriate at the completion of the study than at the start of the

study, and the participants' behavior was indistinguishable from that of their typically developing peers.

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Verbal behavior has been defined as behavior capable of affecting another organism and as "behavior reinforced through the mediation of other persons" (Skinner, 1957, p. 14). As such, verbal behavior includes not only a formalized system of language, but also other audible vocalizations, facial expressions, body postures, and gestures (Bijou & Baer, 1965). In effect, any response that is used to influence another individual's behavior could be described as verbal behavior (Bijou, 1993). Although "nonverbal communication" might be conceived as a class of behavior separate and distinct from verbal behavior, analyses such as Skinner's and Bijou's allow for the application of the basic laws and principles of behavior to instances of both classes of behavior. That is, both spoken language and gesture may be conceptualized as operants that are sensitive to consequences and, therefore, are shaped by the verbal community (Skinner, 1957). In addition, gestural behavior and vocal behavior enter into the three term contingency, allowing for control to be exerted by consequences as well as by antecedent stimuli (Bijou & Baer, 1961.

Gestural behavior, like spoken language, serves a multitude of purposes. The use of gestures can serve as either a complement to, or substitute for, spoken language (Baesler & Burgoon, 1987; Ricks & Wing, 1975). As such, gestures can serve as discriminative stimuli or responses during a social interaction (Skinner, 1957). For example, gestural responses can be used to obtain a desired item (e.g., extending one's hand in the presence of a preferred item), to recruit social responses from others (e.g., raising one's arms after winning an interactive game), or to describe characteristics of an object (e.g., extending one's arms outwards in the presence of a very large item) (Hermelin & O'Connor, 1985;

Koegel & Frea, 1993). In addition, because gestural behavior can be used both to respond to and alter the behavior of others during an interaction, it plays an integral role in the development and maintenance of social relationships (Bijou & Baer, 1965; Eckerman, Davis, & Didow, 1989; Pierce & Schreibman, 1995).

The use of gestures (i.e., hand movements and body movements) is one primary mode of communication that develops early in life and is associated with the later development of language skills (Mundy, Sigman, Ungerer, & Sherman, 1987). By 12 months of age, prior to the onset of speech, children of typical development acquire simple gestures that can be used as reciprocal responses or discriminative stimuli during an interaction (Ricks & Wing, 1975). These gestures include smiling, pointing, waving, and lifting of the arms to communicate a readiness to be picked up. In addition, at approximately the same time, children of typical development learn to use gestures to alter the behavior of others in their environment. An example of this would be pointing to an object which serves as a discriminative stimulus for the social partner to move his/her eyes and head in the direction of the object (Bakeman & Adamson, 1984). The ability to point to an object while making eye contact with another person suggests that infants, as young as 13 months, are able to communicate with others in their environment through gestures (Bijou & Baer, 1965). This type of communication has been termed "intentional" because the response of the child serves to regulate the behavior of the other individual involved in the communicative interaction (Prizant & Wetherby, 1987). Although the use of gestural communication develops prior to the development of speech, it is later used in

coordination with spoken language during communicative interactions (Mirenda & Schuler, 1988; Morford & Goldin-Meadow, 1992).

Gestural communication has been classified as developing from low-level gestures to higher-level, more symbolic gestures (Bates, Camaioni, & Volterra, 1975; McHale, Simeonsson, Marcus, & Olley, 1980). Motoric gestures, gestures that serve mainly to regulate the behavior of another individual to obtain a desired consequence (e.g., reaching towards a desired object) are termed low symbolic gestures and develop first. Gestures that are used to alter the eye contact or orientation of another individual (e.g., looking and pointing) or to describe some characteristic of an object are considered to be representative of a higher symbolic level (McHale et al., 1980). Similarly, Bates et al. (1975) have described two classes of gestural communication. Developing earlier are protoimperatives. These are gestures that represent the needs of infants and are used solely to obtain a desired object (i.e., the adult is used an agent or tool in obtaining some environmental outcome). As such, a protoimperative gesture could be classified as a mand. That is, it is a response that is reinforced by the specified, immediately available consequence and, therefore, under the control of conditions of deprivation (Skinner, 1957). Protodeclaratives, which develop later in life (between 10 and 12 months of age), are gestures that are used to gain the attention of an adult and direct it toward an object in the environment. As such, a protodeclarative gesture could be viewed as the equivalent to a tact. That is, it is a gesture that is used as a label for an object or to describe the characteristics of an object and is reinforced by consequences not immediately implied by

the gesture itself, but rather by consequences applied by the verbal community (Skinner, 1957).

A more extensive gesture classification system was developed by Barten (1979). According to Barten, there are five categories of gestural competence. At the first level are deictic gestures. Included in this level of gestural communication are pointing and indicating gestures. The consequences of these gestures could be either tangible or social in nature. The next level defined includes instrumental gestures. Instrumental gestures are movements that are used primarily to regulate the behavior of others in the environment (e.g., come here). The consequences of instrumental gestures are social in nature. Expressive gestures are representative of the next level of gesture and include gestures that are used to "communicate feeling states" (e.g., covering the face in embarrassment). Behaviorally, these gestures are motor movements that are used to recruit social responses from others in the environment. Next, enactive gestures are defined. This category includes gestures that represent actions that are either performed with an object or on an object. Finally, Barten defined depictive gestures. This category includes gestures that are used to describe a characteristic of an object itself. All of the systems used to define and classify gestural communication suggest that development of gestural communication begins within the first year of life and precedes from responses that are emitted to obtain tangible consequences (i.e., mands) to responses that are emitted to obtain social consequences (i.e., tacts).

Although gestural communication develops early in life and is acquired in a predictable order in typically developing individuals, this is not true of individuals with

autism. Such individuals often have serious deficits in communication (APA, 1994). The communication deficits noted in individuals with autism are extensive and involve deficits in both spoken language and gestural communication. With respect to the development of vocal behavior in individuals with autism, large deficits have been defined in the areas of expressive language, as well as receptive language (Schreibman, Koegel, Charlop, & Egel, 1990). Additionally, numerous studies have identified deficits in the expression and comprehension of gestural communication (Atlas & Blumberg-Lapidus, 1988; Buitelaar, van Engeland, de Kogel, de Vries, & van Hooff, 1991; Attwood, Frith, & Hermelin, 1986; Curcio, 1978; Garfin & Lord, 1986; Kasari, Sigman, Mundy, & Yirmiya, 1990; Landry & Loveland, 1988; Landry & Loveland, 1989; Landry et al., 1988; Loveland & Landry, 1986; McHale et al., 1980; Mundy et al., 1986; Mundy, Sigman, & Kasari, 1990; Sigman, Mundy, Sherman, & Ungerer, 1986; Wetherby & Prutting, 1984).

One area of non-spoken communication that has received much attention is the development and use of gestures in individuals with autism. Interestingly enough, even though individuals with autism have such difficulty speaking, rarely do they use gesture as an alternate means of communication (Loveland, Landry, Hughes, Hall, & McEvoy, 1988; Ricks & Wing, 1976; Wetherby & Prutting, 1984). Numerous studies have been conducted to identify the extent of this deficit in individuals with autism and overall two general conclusions appear to be drawn. First, individuals with autism do not use gesture frequently to communicate and second, when gestures are used by individuals with autism, they differ qualitatively from the gestures that are used by other children (both

typically developing and those with developmental problems). The following brief review of the literature in the area of gestural communication supports this statement.

The initial studies in the area of gestural competence were observational studies conducted during play situations. Curcio (1978) investigated the use of gesture in children with autism who had no expressive language. The children with autism, ranging in age from 5 to 12 years, were observed for 1 hr in their classrooms and the teachers were asked to complete questionnaires about the use of gestures by the children under specific conditions. Curcio found that none of the children with autism used gestures as tacts, such as point and show, but all of the children used gestures that served the function of mands, such as pulling the hand of an adult to a desired item. Because of this differential use of gestures, he concluded that children with autism differ not only quantitatively, but qualitatively, in their use of gesture compared to typically developing individuals. Similarly, McHale et al. (1980) conducted an observational study with children with autism, ranging in age from 4 to 9 years, during free-play sessions, either with a teacher present or absent. The major finding of this study was that approximately 75% of the behavior of the children was not directed towards another individual. They did find, however, that when interactions were observed the primary mode of communication of the children in this study was the motoric-gestural mode. That is, the majority of the small percentage of interactive behavior displayed by the individuals with autism was gestural rather than verbal but that the gestures used were those that primarily used another individual as a tool for obtaining a desired consequence. Such gestures included pushing, pulling, or otherwise physically contacting others.

To ascertain whether the deficits noted in gestural competence were specific to individuals with autism, studies that followed focused on comparing children with autism to children of either normal development or to children with other developmental disabilities (Atlas, 1987; Buitelaar et al., 1991; Attwood et al., 1986; Curcio, 1978; Garfin & Lord, 1986; Kasari et al., 1990; Landry & Loveland, 1988; Landry & Loveland, 1989; Landry et al., 1988; Loveland & Landry, 1986; McHale et al., 1980; Mundy et al., 1986; Mundy et al., 1990; Sigman et al., 1986; Wetherby & Prutting, 1984). These observations of children with autism were conducted under a variety of conditions, including free-play, teacher-directed, and experimenter-directed conditions.

Wetherby and Prutting (1984) compared individuals with autism, ranging in age from 6 to 11 years, to individuals of typical development, ranging in age from 1 to 2 years, under play and structured communication conditions. During the play condition a standard set of five toys was placed in front of the child. During the structured communication condition each child was engaged in a series of eight standard communication situations (e.g., experimenter was eating preferred food or playing with preferred toy, objects were placed out of the child's reach, and familiar social routines were initiated). Although they did not analyze the use of gesture independently of the use of other forms of communication (vocal and verbal), they found that the children with autism, unlike the children of typical development, never used verbal or gestural responses as discriminative stimuli to alter the eye contact or orientation of an adult. Instead, these children used verbal and gestural behavior to regulate the behavior of the adult with the consequence of obtaining some environmental end.

Another comparison group of interest when studying gestural behavior is individuals with developmental language delay. Such individuals often have deficits in verbal behavior that are similar to those seen in individuals with autism. Loveland and Landry (1986) compared these two groups. Children with developmental language delay were matched to children with autism on nonverbal mental age and mean length of utterance and were observed in a structured requesting situation. They found that these two groups of 5 to 6 year old children differed significantly in their use of gesture. That is, children with developmental language delay were more likely to use gestures that served to obtain social consequences (e.g., pointing and showing) than the children with autism. The children with autism, however, were more likely than the children with developmental language delay to use gestures that served to obtain immediately available tangible consequences (e.g., touching and taking).

Studies have also been conducted comparing children with autism, children with mental retardation, and children of typical development. Sigman et al. (1986) compared these three groups of children during play conditions with their caregivers. The children with autism ranged in age from 34 to 74 months. The children with mental retardation were matched to the children with autism on chronological age, whereas the children of typical development were matched to the children with autism on mental age. They found that compared to the children with mental retardation and the children of typical development, the children with autism use fewer indicating and requesting responses (e.g., pointing and giving).

In another study, Mundy et al. (1986) compared children with autism to children with mental retardation and children of typical development using the Early Social Communication Scales. In this procedure, the experimenter presented various items to the child that served as discriminative stimuli for communication (verbal or gestural). For example, the experimenter placed a desired toy out of reach of the child and waited for the child to initiate a request for the item. They found that the children with autism were less likely to initiate requesting gestures or gestures that altered the eye contact and/or orientation of the other individual (e.g., pointing) than the children of normal development or the children with mental retardation. Similar results were founds when Kasari et al. (1990) compared the same three groups using the Early Social Communication Scales. That is, the amount of time that the children with autism were engaged in requesting behavior or behavior that served to alter the orientation and/or eye contact of another individual (e.g., pointing) was significantly less than the amount of time that the children with mental retardation or the typically developing children were engaged in these same responses.

Comparisons of children with autism to children with developmental language delay and to children of typical development have also yielded similar results. In an initial study, Landry and Loveland (1988) compared children with autism (ranging in age from 58 to 155 months) to children with developmental language delay (ranging in age from 36 to 114 months) and to children of typical development (ranging in age from 25 to 37 months). Under experimenter-directed, requesting, and spontaneous conditions, they found that the children with autism used significantly fewer gestures that served to obtain

social consequences, such as pointing and showing, than did either of the other two groups. In another study, Landry et al. (1988) compared the gestural performance of individuals with autism (ranging in age from 58 to 155 months) to children with developmental language delay (ranging in age from 36 to 90 months) and to children of typical development (ranging in age from 25 to 37 months). They found, when comparing these groups in a caretaker-directed, free-play situation, the children with autism used gestures in a significantly lower percentage of the communicative interactions than did either of the other two groups. In an additional study, Landry and Loveland (1989) investigated the use of gestures by these three groups during an experimenter-directed, a requesting, and a spontaneous condition. They also found that, overall, children with autism used fewer gestures that led to social consequences (i.e., show and point) than did the children with developmental language delay or the children of normal development.

Other studies have compared children with autism with differing language abilities on gesture production tasks. Attwood et al. (1986) conducted two experiments investigating the production of gestures under experimenter-directed tasks and the use of spontaneous gestures during free play. They compared three groups of adolescents with autism (those with mild, moderate, and severe mental retardation as determined by full-scale IQ scores on the Wechsler Intelligence Scale) with each other and to two groups of children with Down's syndrome (those with moderate and severe mental retardation). In one part of their study, the adolescents were asked to produce instrumental gestures (i.e., gestures that were used to regulate the behavior of another individual) appropriate for a given

situation. They found that the autistic children with moderate and severe mental retardation had difficulty in producing gestures under such conditions, however, those mildly-retarded individuals with autism performed as well as those individuals with Down's syndrome. In the second experiment, they observed these individuals in natural settings. They found that the individuals with autism, when they interacted with others, used significantly fewer expressive gestures (e.g., covering the face in embarrassment) than children of normal development or children with Down's syndrome. They also found that the individuals with autism were as likely to use instrumental gestures when engaged in a social interaction as the individuals with Down's syndrome. These gestures, however, often served the purpose of terminating social contact.

Additional studies have compared children with autism to children with schizophrenia (Atlas, 1987) and to children with mental retardation who were matched according to mental age and to language level (Buitelaar et al., 1991; Mundy et al., 1990). The results obtained in these studies were similar to the studies already discussed. That is, the children with autism used fewer gestures and were more likely to use gestures as mands (e.g., placing an adult's hand on a desired item) than as tacts (e.g., showing).

In summary, when reviewing the experimental literature on gestural use in children with autism, it is clear that such individuals have extreme difficulties in the area of gestural communication. That is, individuals with autism differ from others both quantitatively and qualitatively in their use of gesture. The number of gestures used by individuals with autism is significantly lower than the number of gestures used by others. More importantly, when individuals with autism do use gesture during social interactions,

the gestures they use are typical of a lower-level of development. That is, individuals with autism tend only to use gesture to obtain an immediate environmental consequence and even these gestures are often not very developmentally advanced (Carr & Kemp, 1989) . Gesture is seldom used as a stimulus to alter another person's orientation or eye contact, to describe objects, or to obtain social consequences. These differences are observed when individuals with autism are compared to normal control subjects, mentally retarded control subjects, and language delayed control subjects. Because these groups were matched to the individuals with autism on a variety of variables (i.e., mental age, language level, chronological age, and mean length of utterance) and the differences remained, it appears that the failure to use a wide variety of gestures is specific to autism.

Individuals with autism are also known to have deficits in the area of social interaction (APA, 1994). Because gestural behavior plays such an important role in the establishment and maintenance of social interactions, difficulties in this area might contribute to some of the difficulties individuals with autism have during social interactions (Garfin & Lord, 1986; Koegel & Frea, 1993). Because individuals with autism do not use conventional gestures as responses or discriminative stimuli during social interactions, they (as well as their social partners) have difficulty in participating in a reciprocal social situation (Prizant & Wetherby, 1987). Gestural responses are integral components of reciprocal social interaction in that they serve to alter the behavior of others and to obtain both social and tangible consequences (Carr & Durand, 1985; Shah & Wing, 1986). According to Koegel and Frea (1993) the responses that accompany verbal communication are the social aspects of language and thereby allow "the

communicator successful, appropriate, and normally perceived conversation" (p. 369). Gestures are an important component of this social aspect of communication Deficits in this area, therefore, make social interaction difficult for individuals with autism as well as for their social partners (Attwood et al., 1988; Buitelaar et al., 1991; Mundy et al., 1986).

The difficulties that individuals with autism have using gestures for communicative purposes can be viewed as a learning failure. That is, it is likely that individuals with autism have not learned to use conventional forms of gestural communication and, therefore, lack the skills needed to engage in reciprocal social interactions (Landry & Loveland, 1988). Cross-cultural differences in gestural communication suggest that at least some forms of gestural communication are learned (Hermelin & O'Connor, 1985). It is well known that individuals with autism have difficulty in learning through observation and imitation (Schreibman, 1988; Smith & Bryson, 1994). In one study conducted to assess the imitation of gestures, Sigman and Ungerer (1984) found that individuals with autism performed significantly more poorly than individuals with mental retardation or individuals of typical development on the Uzigiris-Hunt vocal and gestural imitation subtests. This deficit in imitation skills may contribute to the difficulties individuals with autism have in using gestural communication (Wetherby & Prutting, 1984). Additionally, individuals with autism may not learn to use gestures that lead to social consequences, because social consequences may not often serve as reinforcers for them in the same way that they do for individuals of typical development. Because of the above-mentioned issues, it seems important that language intervention efforts with children with autism include the teaching of gestural communication (Mirenda &

Schuler, 1988). Such intervention efforts should focus on teaching gestures that serve as discriminative stimuli for the behavior of others in the environment (Mundy et al., 1990), more appropriate requesting skills (Carr & Kemp, 1989), and gestures that can be used to obtain social consequences and express affect (Attwood et al., 1989; Gena, Krantz, McClannahan, & Poulson, in press). For individuals with autism, the acquisition of these skills can only serve to provide them with additional communicative responses. The acquisition of these response would lead to a more reliable communication system and, thereby, facilitate social interaction skills (McIlvane, Dube, Green, & Serna, 1993).

Although extensive research has defined the extent of the impairment in gestural communication, little research to date has demonstrated that gestural communication can be taught to individuals with autism. Stokes, Baer, and Jackson (1974) used prompting and reinforcement to teach a greeting response to four individuals with mental retardation. The teaching procedure used demonstrated that a single greeting response could be taught to such individuals. In a study conducted by Koegel and Frea (1993), a self-management treatment procedure was introduced to increase appropriate "nonverbal mannerisms" in a high-functioning male with autism. In this study, they found that the treatment package, which consisted of teaching the discrimination of appropriate and inappropriate behavior and self-monitoring of behavior, led to an increase in appropriate "nonverbal mannerisms." Strain and Timm (1974) and Strain, Shores, and Kerr (1976) measured changes in "motor-gestural behavior" after the implementation of a treatment procedure that consisted of the contingent delivery of adult attention for such behavior. They found increases in "motor-gestural behavior" as a function of the delivery of

contingent adult attention. Another study, conducted by Cooke and Apolloni (1976), demonstrated an increase in "positive physical contacting" (e.g., patting, rubbing, hugging, stroking, or grasping in a positive fashion) on the part of four learning-disabled students as a result of the introduction of instructions, modeling, and contingent adult praise. Finally, in a recent study conducted by Pierce and Schreibman (1995) two children with autism showed increases in "joint attention" as a result of peer-implemented pivotal response training, even though this was not one of the targeted responses.

Although the above studies measured changes in a variety of "nonverbal responses," all of the studies except for the one conducted by Baer et al. (1974), included numerous responses in the dependent measure and/or did not evaluate the effect of the intervention on specific gestural responses that could be used as responses or discriminative stimuli during social interaction. That is, in the study conducted by Koegel and Frea (1993) the positive change observed in "nonverbal mannerisms" included changes in all gestures or mannerism that were related to the conversational topic. In the studies conducted by Strain and his colleagues (1974; 1976), changes in "motor-gestural behavior" included responses such as waving, hugging, kissing, holding hands, and other cooperative responses involved with the sharing of a toy. In the study conducted by Cooke and Apolloni (1976), the positive change observed in "positive physical contacting" included changes in responses such as patting, rubbing, hugging, stroking, or grasping in a positive fashion. In the study conducted by Pierce and Schreibman (1995) changes in "joint attention" were evidenced as a result of the pivotal response training procedure that was applied to other response classes, but not specifically applied to the response class of

"joint attention." Additionally, the subjects that participated in the studies had a variety of handicaps. Some children were diagnosed as "mentally retarded" (Stokes et al., 1974), "behaviorally disordered" (Strain & Timm, 1974), "behaviorally handicapped" (Strain et al., 1976), and "learning disabled" (Cooke & Apolloni, 1976). Only the one subject in the study conducted by Koegel and Frea (1993) and the two subjects in the study by Pierce and Schreibman (1995) were diagnosed with autism.

Due to the paucity of research in the literature on the systematic teaching of gestural communication to children with autism, the current study focused on teaching three gestural response categories to these children. The three responses categories were chosen to contain gestures that would be appropriate for requesting tangible consequences or directing the behavior of another individual, for obtaining social consequences, and for describing characteristics of objects. A multiple-baseline-across-responses design was used to demonstrate that with the application of an intervention package, which consisted of modeling, prompting and reinforcement, children with autism could learn to use gestures in the presence of naturally occurring discriminative stimuli. Generalization of the gestural responses from training stimuli to untrained stimuli was assessed by the presentation of non-trained discriminative stimuli. Generalization of training from the treatment setting to a new setting was also assessed. These measures of generalization were crucial in demonstrating the functional value of this skill (Sailor, Guess, & Baer, 1973).

# Method

## Participants

Four children with autism participated in this study. All of the children attended educational classes at the Princeton Child Development Institute (PCDI) and had previously received diagnoses of autism by independent agencies. The children who participated in the study used little or no gesture to communicate with others, although all of the children had some oral language.

Anne was 6 years old at the start of the study. Prior to the onset of the study, she had participated in educational classes at PCDI for 4 years. Anne was a verbal child, often using speech to request desired items or activities (e.g., "Can I have tickle?"), to greet others (e.g., "Hi, Dawn"), or to talk about preferred upcoming events (e.g., "Today is special lunch"). The majority of her speech was prompted by her activity schedule (MacDuff, Krantz, & McClannahan, 1993) or others in her environment, although she did sometimes display spontaneous speech. Anne never used gesture to direct attention, to request items, to express emotion, or to describe characteristics of objects. Prior to the start of the study, Anne's age-equivalent score on the Peabody Picture Vocabulary Test-Revised (PPVT-R) was 3-0 yr.

Oscar was 6 years old at the start of the study. He had received 3 years of educational training at PCDI prior to the onset of the study. Oscar was also a verbal child. He used speech to request items (e.g., "Can I have a donut?") and to greet others (e.g., "Hi, Dawn"). Most of his speech, however, was prompted by others in his environment or his activity schedule (MacDuff et al., 1993) and rarely did he use language spontaneously.

At the start of the study, Oscar rarely used gesture to communicate in any way. He was never observed using gestures to direct the behavior of others, to obtain tangible or social consequences, or to describe characteristics of objects. He received an age-equivalent score of 3-2 yr on the PPVT-R administered prior to the onset of the study.

Nick was 4 years old at the start of the study. He had attended educational classes at PCDI for 1.5 years prior to the onset of the study. Nick had limited speech. He used speech when prompted by others in his environment or his activity schedule (MacDuff et al, 1993), although his vocabulary was limited and his articulation was rather poor. Nick sometimes used one word phrases to express his needs (e.g., cookie). Prior to the study, Nick sometimes used a pointing response to obtain items in his environment, although he never used this response to alter the eye contact or head-orientation of another individual. Often, Nick pushed or pulled people in his environment to obtain desired toys and foods and also often grabbed items he was interested in. Rarely, did he use gestures appropriately to alter the behavior of others in his environment, to obtain social consequences, or to describe characteristics of objects. Prior to the study, he received an age equivalent score of 3-5 yr on the PPVT-R.

Kevin was 4 years old at the start of the study. He had attended educational classes at PCDI for 3 months prior to the onset of the study. Kevin had limited verbal skills. He uttered 1-2 word phrases spontaneously (e.g., "yellow car") and when prompted by others in his environment. His vocabulary was rather limited and his articulation was quite poor. Kevin rarely used gestures to alter the behavior of others in his environment, to obtain tangible or social consequences, or to describe characteristics of objects in his

environment. He received an age-equivalent score of 2-0 yr on the PPVT-R, administered prior to the onset of the study.

All of the children displayed low to moderate levels of stereotypic and disruptive behavior, such as finger manipulations (including rubbing and measuring), eye gazing, toe-walking, crying and tantruming. They all were accustomed to learning in both a discrete-trial format and under incidental teaching conditions. The majority of the daily teaching sessions in school for Kevin and Nick were individual sessions, however they did work in group settings for 1-2 sessions per day. Oscar and Anne spent approximately half of their day in individuals sessions and the other half of their day in group sessions. All of the participants followed teacher directions, and were accustomed to using a monetary motivational system. Prior to the onset of the study, all of the parents of the participants gave informed consent for their children to participate in the study.

Setting and Apparatus

All sessions took place in a small classroom at PCDI where the children attended educational classes. The classroom was 10 ft long by 9 ft wide with beige walls and a gray-carpeted floor. There was a large gray chair (31 in high by 17 in wide), one desk (25.5 in wide by 16.5 in long by 22 in high), two small chairs (23.5 in high by 11.5 in wide), and a colored box (21.25 in long by 15 in wide by 15.5 in high) in the room. The desk was placed in the center of the room. The two small chairs were placed next to the desk, one for the therapist and one for the child. The large gray chair and the colored box were placed at the periphery of the session area. The monetary motivational system and the data sheets were placed on the desk in the center of the classroom. The stimulus

materials were also placed on this desk or on one of the items (e.g., gray chair or box) found at the periphery of the room, depending upon the response being trained. Two video recording cameras were also in the room. One video camera (Panasonic IQ Palmcorder, model PV-IQ204) was placed at the side and behind the therapist. This video camera was used primarily to record the responses of the child and the interaction between the therapist and the child. A second video camera (GE VHS movie system, model 9-9609) was placed behind the child. This video camera was used to record the behavior of the therapist. To assess generalization of trained responses to a new setting, pre- and post-intervention measures were taken in the children's regular classrooms at PCDI. These classrooms were larger in size and were occupied by 1 to 3 additional children and 1 to 3 additional therapists.

Therapist

The primary therapist was a doctoral student in psychology with training in applied behavior analysis. She conducted all of the baseline, treatment, and regular-classroom generalization sessions.

Response Definitions

The dependent measure consisted of two components, a gestural and verbal response (e.g., pointing and saying "Look!"). The gestural and verbal responses are presented in Table 1. Responses were scored immediately following the first presentation of the discriminative stimuli during a session. The responses were scored by independent observers and were scored correct only if they occurred within 5 s of the therapist-presented discriminative stimuli that signaled the start of each interactive episode. The target responses were the same for both training and probe trials.

Table 1

Gestural and Verbal Response Definitions for Each Target Response

| Response Name | Gestural Response Definition | Verbal Response Definition |
|---|---|---|
| | Attention Directing/Getting Gestures | |
| Point | Participant extends arm and index finger towards object. | Look! |
| Hand request | Participant extends arm towards other with palm facing upward and without contacting object. | Can I have that? Can I see? |
| Raise hand | Participant extends arm over head with palm facing therapist. | I do! |
| | Affective Gestures | |
| Arms up | Participant extends both arms over his/her head. | I won! |
| Shake head | Participant moves head from side to side. | No way |
| Hands on face | Participant places palms of hand on his/her cheeks with arms bent at elbow. | Uh oh |
| | Gestures of Reference | |

Table 1 (continued)

| | | |
|---|---|---|
| Tiny | Participant extends thumb and index finger with fingers facing but not touching or extends thumb, index and middle fingers with fingers touching. Remaining fingers are curled down. | It's tiny<br>Tiny |
| Huge | Participant extends arms outwards as wide as possible. | It's huge!<br>Huge! |
| Fast | Participant extends one arm, other arm is bent at elbow. Fingers are extended and palms are facing each other. Participant moves bent arm towards other rapidly, with palms rubbing together. | It was fast!<br>It moved fast!<br>Fast |

Stimulus Materials

Nonverbal Stimuli. A total of 144 nonverbal stimuli were used. These stimuli were an assortment of food items, toys, common objects, and activities that were appropriate discriminative stimuli for each target response. Examples of these stimuli include a globe, a bag of candy, a book, a bowling game, mustard, spilled candy, a tiny gun, a huge crayon, and a racing car. A complete listing of the nonverbal stimuli can be found in Table 2. These stimuli were arranged in four stimulus sets, each of which contained 36 items. Within a stimulus set, four stimuli were assigned to each target response. Three of these items were designated as training stimuli and one of these items was designated as a probe stimulus. Training stimuli were associated with treatment, whereas the probe stimuli were never associated with treatment. All stimuli for a specific target response were randomly assigned to stimulus sets, as well as to the training and probe categories.

Verbal Stimuli. A total of 36 verbal stimuli were used. These statements were appropriate discriminative stimuli for each target response. Examples of the verbal stimuli include "Who wants this," "You won!," "Wow, this is a big crayon." As shown in Table 2, there were four verbal discriminative stimuli assigned to each target response. Three of these discriminative stimuli were randomly assigned as training discriminative stimuli (associated with treatment) and one was randomly assigned as a probe discriminative stimulus (never associated with treatment).

Table 2

Nonverbal and Verbal Discriminative Stimuli Presented During Training and Probe Trials. Probe Stimuli Are Designated by (P).

| Response | Verbal Stimuli | Nonverbal Stimuli |
|---|---|---|
| | Attention Directing / Getting Gestures | |
| Point | Try to find something new on the ___<br>Let's talk about something new on the ____<br>Do you see anything new on the _____<br>Find something new on the _____ (P) | maraca, pig, tractor, flower, cow, pinwheel gumball machine,bee, baby dino, beetle, grapes, watermelon, slinky (P), boat (P), baby doll (P), globe (P) |
| Hand request | Check out this ____<br>Look at this<br>Look at what I have<br>See what I have (P) | Gold Fish, squeeze monster, silly hammer, elephant book, clown hammer, spin toy, Robin Hood toy, animal cracker |

Table 2 (continued)

| | | |
|---|---|---|
| | | bus, frog, pinwheel, fish, book (P), lion (P), sparkle gun (P), planet frisbee (P) |
| Raise hand | Who wants ____<br>Who would like _____<br>Does anyone want ____<br>Anyone want _____ (P) | dinosaur, accordion, clown horn, mini-sketch board, walking dino, Silly Putty, troll, spring, microphone, mini-sketch, triangle, clacker, M & M's (P), xylophone (P),Pez (P) harmonica (P) |
| | Affective Gestures | |
| Arms up | Super, you got it<br>You're the winner<br>Wow, you won<br>Wow, you did it (P) | pinball, pick #, Go-Fish, bowling, egg match, basketball, Tiddly Winks, fishing game, dart ball, Barrel |

Table 2 (continued)

| | | |
|---|---|---|
| | | of Bears, memory match, pop bowling, dart game (P), Woody Darts (P), pick a witch (P), pick a cup (P) |
| Shake head | You can have<br>Want this _____<br>Would you want _____<br>Do you want ____ (P) | pop balloon, water gun, mustard, lemon juice, pepper, tobasco, axe, ugly bug, soy sauce, pop ball gun, snapping dino, plastic pear, clapping hands (P), buzzer (P), drinking bubbles (P), rice cakes (P) |
| Hands on Face | Oh boy<br>Look what happened<br>Oh, look what I did<br>Oh, no (P) | break crayon, spill candy, blocks fall, pop fist, break pencil, shape puzzle, drop |

Table 2 (continued)

| | | |
|---|---|---|
| | | folder, spools fall, break chalk, drop cracker, break phone, drop puzzle (P), Pogs fall (P), deck of cards fall (P), balloon flies away (P) |
| | Gestures of Reference | |
| Tiny | Look at this little _____<br>Tell me about this little ____<br>What do you think of this little _____<br>Check out this little ____ (P) | clown, card, sock, pan, orange juice, cereal, panda, bird, book, airplane, troll, baseball hat, gun (P), Little Hen book (P), spoon (P), tree (P) |
| Huge | Check out this big ____<br>Look at this big _____<br>What do you think of this big ____<br>Wow, this is a big ____ (P) | spoon, crayon, dollar bill, coloring book, flag, bug, balloon, candy bar, popcorn, flower, candy corn, |

Table 2 (continued)

| | | |
|---|---|---|
| | | Gold Fish, sponge (P), pencil (P), glasses (P), Coca Cola glass (P) |
| Fast | Tell me how that moved<br>Tell me about the way ___ moved<br>What do you think about how ____ moved<br>How did ____ move (P) | helicopter, airplane, music top, scooter, car, spin top, motorcycle, spin saucer, dump truck, 4- wheeler, see through copter, boat (P), exploder (P), snake car (P), dog (P) |

Experimental Design

A multiple-baseline-across-responses design was used. Three response categories were trained. These categories were attention-directing/getting responses, affective responses, and reference responses. Within each response category, three gestural and verbal responses were trained. In the attention category the responses "point," "hand request," and "raise hand" were trained. In the affect category the responses "arms up," "shake head," and "hands on face" were trained. In the reference category the responses "tiny," "huge," and "fast" were trained. These gestures were selected as a result of two observational strategies. A listing of gestural responses was created after observing preschool and kindergarten-age children in their school classroom and at home. In addition, gestural responses were defined after requesting preschool and kindergarten-age children to show the therapist specific responses with their hands (e.g., the therapist said "show me fast with your hands"). In total, 12 children were observed between the ages of 4 and 6 years. During the classroom observations the children were engaged in a number of activities including art, snack, circle time, and free play. During the in-home observations the children were engaged in play activities that included the therapist and two to three other children.

Intervention was introduced successively across the legs of the design after the mastery criterion was met. This criterion required that accurate gestural and verbal responses remained at 89% or higher for four consecutive training sessions. The order of introduction of treatment across response categories was varied for each child to control for order effects. The order used with Anne was attention, affect, and reference. The

order used with Oscar was affect, reference, and attention. The order used with Nick was reference, affect, and attention. The order used with Kevin was reference, attention, and affect.

Procedure

General Format. At the start of each session, the child was seated in front of a desk across from the therapist. The therapist instructed the child that it was time to talk together. The therapist then held her hand in front of the child. This served as a trial-start signal in the presence of which the child learned to sit tall and look at the therapist. Once the child was attending to the therapist, a nonverbal and verbal discriminative stimulus was presented by the therapist. For example, the therapist held up a tiny water gun and said "what do you think of this little gun?"

Each session contained 36 trials. A trial consisted of the therapist presenting a nonverbal and a verbal discriminative stimulus to initiate the interactive episode and waiting for a maximum of 5 s for a gestural and verbal response to occur. Each trial was terminated by the therapist removing the nonverbal stimulus from the desk and putting it away. Within each session, there were 27 training trials and 9 probe trials. Sessions lasted approximately 20 minutes and sessions were conducted 5 days per week. Ten orders of trial presentation were prepared for each stimulus set to avoid order effects. These orders were prepared using a controlled-randomized procedure. That is, the stimuli were randomly assigned to trial position in session with the exceptions that 1) a session never started or ended with a probe trial, 2) not more than one presentation of a particular

response occur consecutively, and 3) not more than one probe trial occurred consecutively.

Baseline. During baseline sessions, the therapist initiated the interactive episode by presenting the nonverbal and verbal stimuli. If the correct verbal and gestural target response occurred within 5 s of the start of the interactive episode, the therapist provided verbal feedback (i.e., "yes, that is a tiny water gun"). If an incorrect response or no response occurred within 5 s of the start of the interactive episode, the nonverbal stimulus was removed from the desk by the therapist and placed in a box. The next trial was presented after the therapist obtained the next stimulus item. Both the nonverbal and verbal stimuli designated as training stimuli and probe stimuli were presented during baseline sessions. Token reinforcement was provided along with verbal praise for on-task behavior after approximately every third trial. The token, however, was only provided after 5 s had elapsed from the last incorrect response so that incorrect responses were not inadvertently reinforced.

Treatment sessions. During treatment sessions, the therapist initiated the interactive episode by presenting the nonverbal and verbal discriminative stimuli. Two types of trials were presented during treatment sessions. Training trials were associated with treatment and probe trials were not associated with treatment. For training trials, if the correct response occurred within 5 s of the start of the interactive episode, the therapist provided token reinforcement and verbal praise to the child. If, however, an incorrect response occurred or no response occurred within 5 s of the start of the interactive episode, the therapist modeled the correct gestural and verbal response. If the child

imitated both components of the response, the therapist said "good." If the child did not imitate both components of the response, the therapist physically prompted him/her to emit the gestural response and verbally prompted him/her to emit the verbal response. Once both components of the response were present simultaneously, the therapist said "good." Following this correction procedure, the trial was presented again. If the child made the correct gestural and verbal response, token reinforcement was provided along with verbal praise and the trial was terminated by the therapist removing the stimulus from the desk. If, again, an incorrect response occurred or no response occurred with 5 s of the start of the interactive episode, the correction procedure was introduced again. This process continued until the child independently emitted the correct gestural and verbal response within 5 s of the start of the interactive episode. This repetitive correction sequence was used to ensure that the gestural and verbal responses produced by the child immediately followed the experimenter-presented discriminative stimuli and, therefore, came to be controlled by the presentation of the discriminative stimuli and not the teacher's manual and verbal prompts.

A modified training procedure was used for three sessions with Anne (sessions 6-8), four sessions with Kevin (sessions 6-9), and one session with Oscar (session 8). During this training procedure each training trial was presented a maximum of two times, even in the absence of correct responding. The procedure was changed to the one outlined above to establish independent responding in the presence of the therapist-presented discriminative stimuli and not the experimenter-presented prompts. This change was made after an initial evaluation of the data that indicated the target responses were not

being acquired rapidly enough for the baseline data to be useful in evaluating a treatment effect.

Within-session generalization of the trained gestural and verbal responses from the training stimuli to a novel set of verbal and nonverbal stimuli was measured by the presentation of probe trials. During these probe trials, the nonverbal and verbal stimuli that were used to initiate the interactive episode were never associated with the teaching procedure or reinforcement, however, the target responses were the same as those trained during teaching trials. During the probe trials, the therapist initiated the interactive episode, waited for a response to occur (for a maximum of 5 s) and terminated the trial by removing the stimulus materials and getting the stimulus materials for the next trial. Reinforcement (tangible or verbal) was never provided for correct responses and the correction procedure (i.e., modeling and prompting) was never used.

Across Setting and Stimuli Generalization: Regular classroom probes. Generalization of the trained gestural and verbal responses to a different setting and in the presence of novel, verbal and nonverbal discriminative stimuli presented by the therapist was assessed by the presentation of the regular classroom probes. During these probes, the child followed his/her regularly scheduled activities. In addition, other children and therapists were present in this classroom. A novel set of stimuli was used during these probes. The set contained nine nonverbal and nine verbal discriminative stimuli that had never been associated with treatment (one novel nonverbal and verbal stimulus per response). The nonverbal and verbal stimuli that were used during the regular classroom

probes are listed in Table 3. The therapist waited for the child's attention (a trial signal was not used) and then the therapist initiated an interactive episode by presenting the discriminative stimuli. No reinforcement or teaching (modeling and prompting) was provided in the classroom setting. The trials were interspersed, however, throughout other academic events so that reinforcement for other responses was available. Three such generalization probes were conducted in the children's regular classrooms during baseline conditions and three were conducted in the children's regular classrooms immediately after treatment was completed for the final response category.

Social Validity

Two social validity measures were obtained to ensure that 1) the participants had more appropriate gestural and vocal skills after intervention than before intervention, and that 2) the gestural and verbal responses taught to the children in this study were appropriate for typically developing children in the same age range.

Measure 1. To assess the change in the students' communication skills from baseline to treatment, the first measure of social validity consisted of presenting 72 videotaped interactive episodes (9 baseline and 9 treatment episodes for each of the 4 children in the study) to a group of 11 graduate students enrolled in a course in Applied Behavior Analysis. Two episodes for each target response were presented, one was a baseline episode and one was a treatment episode. This was done for each of the four children in the study. The baseline episodes for each child were randomly selected from probe trials in the first four baseline sessions. The treatment episodes were then selected from the last

Table 3

Nonverbal and Verbal Discriminative Stimuli Presented During Regular Classroom Generalization Trials.

| Target Response | Verbal Stimuli | Nonverbal Stimuli |
|---|---|---|
| | Attention Directing / Getting Gestures | |
| Point | Show me something new on the _____ | pumpkin |
| Hand request | Look at this cool toy | Press-n-Go truck |
| Raise hand | Does anyone like ____ | Vanilla Wafers |
| | Affective Gestures | |
| Arms up | Great, you won the game | Tic-Tac-Toe |
| Shake head | Would you like to eat ___ | Plastic cookie |
| Hands on Face | Whoops! | Knock over cup |
| | Gestures of Reference | |
| Tiny | See this little ____ | Etch-A-Sketch |
| Huge | Can you believe how big this is? | Hammer |
| Fast | Wow, did you see that move! | Airplane |

four sessions of treatment before criterion performance was achieved to match the baseline episodes. That is, the stimuli that were presented by the therapist during the interactive episodes were the same in both the baseline and treatment episodes. For each child, the order of the interactive episodes was randomly determined. All trials for a child were presented in succession and each graduate student was asked to answer the following question: "In which of the two interactive episodes (A or B) did the child appear more expressive in his/her communication."

Measure 2. For the second social validity measure, the same group of 11 graduate students was presented with 72 videotaped interactive episodes to assess whether the gestures used by the children in this study were similar to those used by their age-matched peers. These interactive episodes contained the four children in the study and four typically developing children (matched on chronological age) engaging in the nine targeted responses. For the children in the study, the interactive episodes were randomly selected from the probe trials in the last four sessions of treatment, prior to achievement of criterion performance. The trials for the typically developing children were obtained by presenting the same stimuli as those in the trials selected for the children in the study. First, the children of typical development were asked to show the therapist how they would describe all nine of the target responses with their hands and language. For example, the therapist asked the child "How would you show me fast with your hands and what might you say?" The therapist then presented the trials to the children of typical development in the same way that the trials were presented to the children in the study during the experimental conditions. The order of the presentation of the interactive

episodes to the graduate students was randomly determined. Each graduate student was asked to evaluate each scene and answer the following question: "Was an appropriate gesture and verbalization used by the student."

Both of these social validity measures were obtained during an evening meeting of the Applied Behavior Analysis course. The graduate students were not informed of the purpose of the study prior to viewing the videotaped episodes. The graduate students were told the following "You will be presented with a series of videotaped interactive episodes between a teacher and a student. In each episode the teacher will present some toy or activity to the child and say something to the child. When the child responds to the teacher please answer the question below." The graduate students were then presented with four practice trials to acquaint them with the general format and structure of the videotapes. The therapist did not provide any information about whether the child's response was correct during these practice trials. After this, the therapist asked if there were any questions and then proceeded with the social validity measures. The graduate students were first asked to rate the Measure 2 (comparison of the subjects to typically developing peers). After completion of this task, the graduate students were asked to rate Measure 1 (comparison of baseline to treatment episodes).

Data Analysis

For baseline and treatment sessions, the percentage of trials that contained an appropriate gestural response, an appropriate verbal response, and an appropriate gestural and verbal response was calculated for both training and probe trials. For generalization sessions conducted in the children's regular classrooms, the percentage of trials that

contained an appropriate gestural response, an appropriate verbal response, and an appropriate gestural and verbal response was calculated. The data on social validity Measure 1 were summarized as the percentage of treatment videotaped scenarios scored as more socially appropriate than the baseline videotapes scenarios. The data on social validity Measure 2 were summarized as the percentage of videotaped scenarios scored as containing an appropriate gesture and verbalization. This percentage was calculated for both the scenarios of the typically developing children and the children with autism. Data were also collected to ensure the integrity of the independent variable. That is, data were collected on the correct presentation of the nonverbal discriminative stimuli, on the correct presentation of the verbal discriminative stimuli, on the correct presentation of modeling, and on the contingent delivery of consequences. For the above measures, the percentage of trials correctly administered was calculated by dividing the number of trials scored as correct by the total number of trials presented for the sessions in each experimental condition.

Interobserver Agreement

The primary therapist and one other therapist working at PCDI, with a BA in psychology and training in Applied Behavior Analysis, independently scored a minimum of 40% of the sessions in each of the baseline, treatment, and regular-classroom generalization conditions. Interobserver agreement was obtained on the percentage of trials containing an appropriate gestural response, an appropriate verbal response, and an appropriate gestural and verbal response. Interobserver agreement was also calculated on the number of training trials presented. Finally, to ensure the integrity of the independent

variable, interobserver agreement was calculated for the accurate presentation of the nonverbal discriminative stimuli, the verbal discriminative stimuli, the modeling procedure, and the reinforcement contingencies.

The therapists were trained to 80% accuracy before scoring the videotapes. This training was conducted prior to the onset of the study. Videotapes from a pilot study were used as training stimuli. Each observer was provided with a written definition of the target gestural and verbal responses. In addition, examples of possible variations in responding were provided along with a discussion of whether they were acceptable. Training was then conducted by reviewing each trial scored differently by the observers and refining the definitions for the target responses. Interobserver agreement was calculated on a point by point basis. The number of agreements was divided by the number of agreements plus disagreements and multiplied by 100 to obtain the percentage of interobserver agreement for correct responses.

For the dependent measures, the mean percentage of interobserver agreement was maintained at 94% or better throughout all conditions of the study. The mean percentage of interobserver agreement for training trials, as shown in Table 4, was at least 95% during baseline and treatment conditions for each child. As shown in Table 5, the mean percentage of interobserver agreement for probe trials was maintained at 94% during baseline and treatment conditions for each child. As shown in Table 6, the mean percentage of interobserver agreement for the regular-classroom generalization probes was maintained at 95%. In summary, the percentage of interobserver agreement on Anne's combined gestural and verbal responses was invariably 100% during baseline conditions. During treatment conditions the mean percentage of interobserver agreement

Table 4

Mean Percentage of Interobserver Agreement for Gestural Responses (Gest), Verbal Responses (Verb), and Combined Gestural and Verbal Responding (G+V) During Training Trials for Each Participant in Each Response Category During Baseline (Bl) and Treatment (Tr) Sessions.

| | | Attention | | | Affective | | | Reference | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Subj | Cond | Gest | Verb | G+V | Gest | Verb | G+V | Gest | Verb | G+V |
| Anne | Bl | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 |
| | Tr | 98 | 100 | 98 | 98 | 100 | 99 | 97 | 98 | 95 |
| Oscar | Bl | 97 | 98 | 94 | 100 | 100 | 100 | 100 | 100 | 100 |
| | Tr | 97 | 100 | 97 | 98 | 100 | 98 | 99 | 100 | 99 |
| Kevin | Bl | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 |
| | Tr | 99 | 98 | 97 | 98 | 100 | 98 | 99 | 100 | 99 |
| Nick | Bl | 96 | 99 | 95 | 100 | 99 | 99 | 100 | 100 | 100 |
| | Tr | 99 | 100 | 99 | 98 | 100 | 99 | 99 99 | 100 | 100 100 |

Table 5

Mean Percentage of Interobserver Agreement for Gestural Responses (Gest), Verbal Responses (Verb), and Combined Gestural and Verbal Responding (G+V) During Probe Trials for Each Participant in Each Response Category During Baseline (Bl) and Treatment (Tr) Sessions.

| | | Attention | | | Affective | | | Reference | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Subj | Cond | Gest | Verb | G+V | Gest | Verb | G+V | Gest | Verb | G+V |
| Anne | Bl | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 |
| | Tr | 95 | 100 | 95 | 100 | 100 | 100 | 95 | 98 | 93 |
| Oscar | Bl | 98 | 100 | 98 | 100 | 100 | 100 | 100 | 100 | 100 |
| | Tr | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 |
| Kevin | Bl | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 |
| | Tr | 96 | 98 | 95 | 100 | 100 | 100 | 97 | 100 | 97 |
| Nick | Bl | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 |
| | Tr | 97 | 100 | 97 | 94 | 98 | 94 | 100 | 100 | 100 |

Table 6

Mean Percentage of Interobserver Agreement for Gestural Responses (Gest), Verbal Responses (Verb), and Combined Gestural and Verbal Responding (G+V) for Each Participant in Each Response Category During Regular-Classroom Generalization Sessions.

| | Attention | | | Affective | | | Reference | | |
|---|---|---|---|---|---|---|---|---|---|
| Subj | Gest | Verb | G+V | Gest | Verb | G+V | Gest | Verb | G+V |
| Anne | 100 | 95 | 95 | 100 | 100 | 100 | 100 | 100 | 100 |
| Oscar | 100 | 95 | 95 | 100 | 100 | 100 | 100 | 100 | 100 |
| Kevin | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 |
| Nick | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 |

was 97%, with a range of 83 to 100%. During the regular-classroom generalization probes, the mean percentage of interobserver agreement on combined gestural and verbal responding was 98%. For Oscar, the percentage of interobserver agreement on combined gestural and verbal responses varied from 83 to 100% during baseline conditions, with a mean of 98%, and from 92 to 100% during treatment conditions, with a mean of 98%. During the regular-classroom generalization probes, the mean percentage of interobserver agreement on combined gestural and verbal responses was 98%. The percentage of interobserver agreement on Kevin's combined gestural and verbal responses varied from 92 to 100% during baseline conditions, with a mean of 99%, and from 83 to 100% during treatment conditions, with a mean of 97%. During the regular-classroom generalization probes, interobserver agreement on combined gestural and verbal responding was invariably 100%. Finally, the percentage of interobserver agreement on Nick's combined gestural and verbal responses varied from 92 to 100% during baseline conditions, with a mean of 98%, and from 83 to 100% during treatment conditions, with a mean of 96%. During the regular-classroom generalization probes, interobserver agreement on Nick's combined gestural and verbal responses was invariably 100%.

Interobserver agreement on the number of training trials presented during treatment sessions was calculated for each child. The mean percentage of interobserver agreement on the number of training trials presented to Anne was 94% (range of 67 to 100%). For Oscar, the mean percentage of interobserver agreement on the number of training trials presented was 99% (range of 80 to 100%). The mean percentage of interobserver agreement on the number of training trials presented to Kevin was 97% (range of 75 to

100%). Finally, the mean percentage of interobserver agreement on the number of training trials presented to Nick was 97% (range of 75 to 100%).

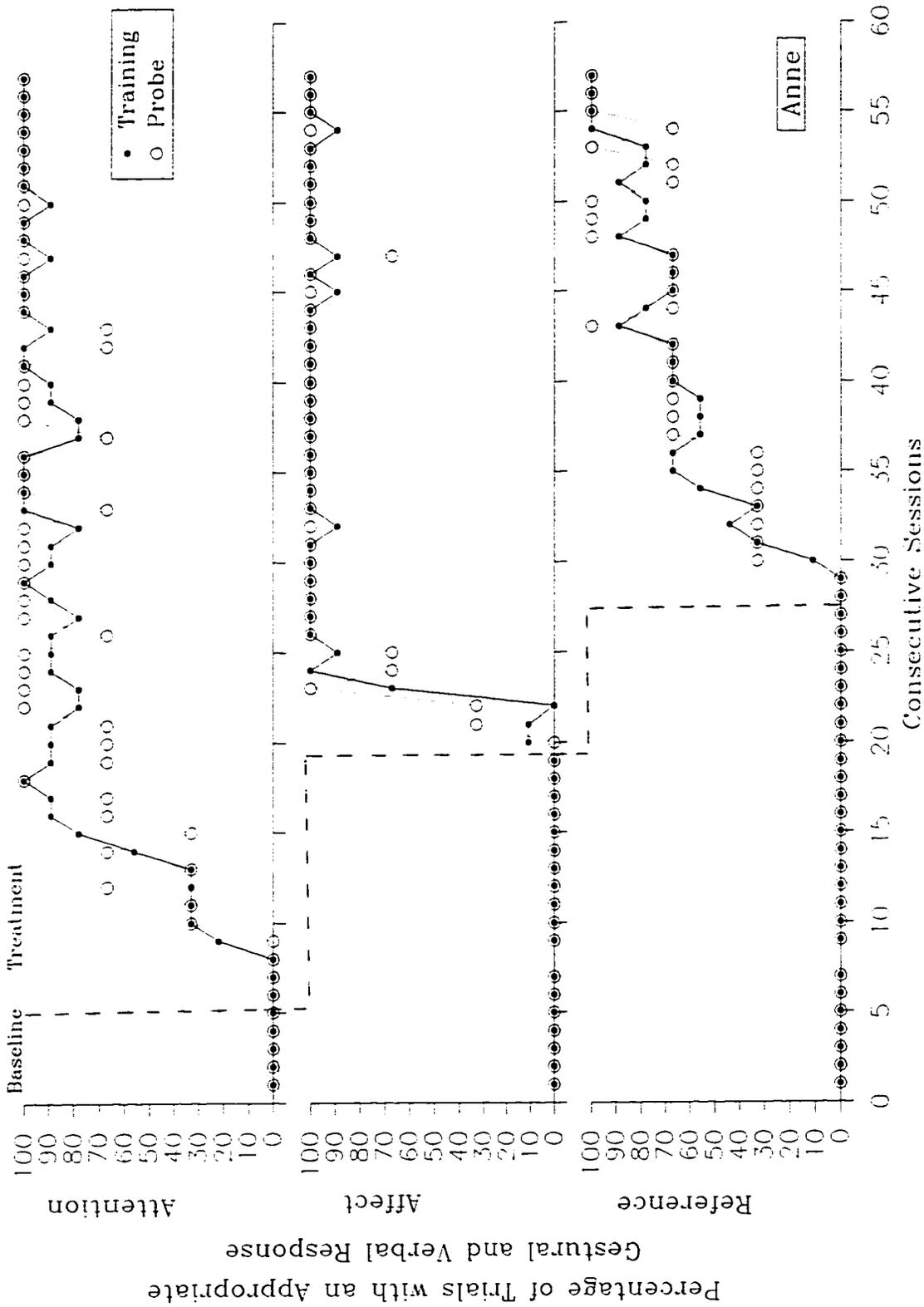
Interobserver agreement was also collected on the independent variable. The percentage of interobserver agreement on the correct delivery of the nonverbal and verbal discriminative stimuli, on the contingent use of the modeling procedure, and on the contingent delivery of reinforcement was invariably 100% across all conditions and all children.

## Results

The individual results for each participant are graphically presented in Figures 1 through 16. For each figure, the dashed vertical line represents the point at which treatment was introduced for each response category. Also in each figure, the closed circles represent the data obtained during training trials and the open circles represent the data obtained during probe trials.

The percentage of training and probe trials in which Anne produced an appropriate gestural and verbal response is presented in Figure 1 by session for all three response categories. During the baseline conditions for all three response categories, the percentage of trials containing a correct gestural and verbal response was 0% throughout all sessions. With the successive introduction of treatment across the three response categories, systematic increases in correct responding in the presence of both the

Figure 1. Percentage of training and probe trials in which Anne produced a correct verbal and gestural response. Training trials are represented by the closed circles and probe trials are represented by the open circles.



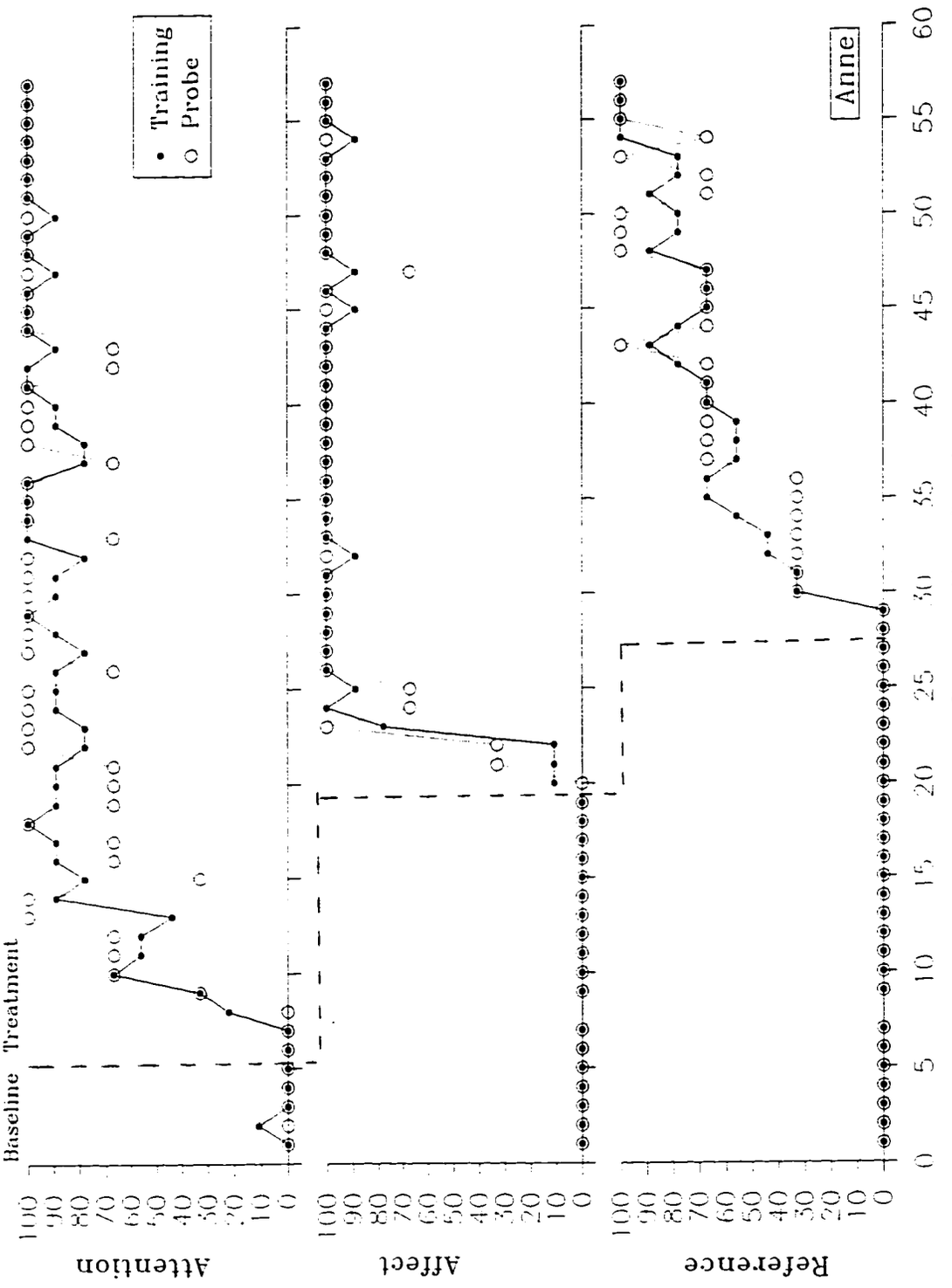
training and probe stimuli were observed. The increases in the percentage of trials containing an appropriate gestural and verbal response were observed only in the response category under treatment. Specifically, the percentage of training trials in which Anne produced an appropriate attention getting/directing gestural and verbal response increased from 0% during baseline to an average of 100% during the last four sessions of treatment. A similar increase was seen in the probe trials for the attention category. That is, the percentage of probe trials in which Anne produced an appropriate gestural and verbal response increased from 0% during baseline to an average of 100% during the last four sessions of treatment. For the affect category, the percentage of training trials in which Anne produced an appropriate gestural and verbal response increased from 0% during baseline to an average of 97% during the last four sessions of treatment. Again, this increase in appropriate responding was also observed during the probe trials with the percentage of appropriate gestural and verbal responding increasing from 0% during baseline to an average of 100% during the last four sessions of treatment. Finally, for the reference category, the percentage of training trials in which Anne produced an appropriate gestural and verbal response increased from 0% during baseline to an average of 100% during the last four sessions of treatment. During probe trials in the reference category, the percentage of trials in which Anne produced an appropriate gestural and verbal response increased fro 0% during baseline to an average of 92% during the last four sessions of treatment.

An interesting measure of acquisition of the gestural and verbal responses can be obtained from the number of sessions required to meet a mastery criterion. The mastery

criterion established in the current study was four consecutive sessions with 89% accurate gestural and verbal responding during training trials. When using this measure of response acquisition, it was found that Anne's rate of acquisition of the gestural and verbal responses varied across response category with the rate of acquisition being slowest in the reference category. To establish criterion performance, 8 sessions were conducted in the affect category, 14 sessions were conducted in the attention category, and 30 sessions were conducted in the reference category. Generalization of the gestural and verbal responses from the training stimuli to novel stimuli, measured during the probe trials, followed a similar pattern with two sessions of 100% accurate responding occurring first in the affect category, next in the attention category, and last in the reference category. In all response categories, once responding reached criterion level (i.e., 89% accurate responding to training stimuli for four consecutive sessions) very little variability in the accuracy of responding was observed.

To assess the acquisition of the individual components of the combined gestural and verbal response, the percentage of trials containing one component of the response (i.e., gestural or verbal) was calculated. To assess acquisition of the gestural response alone, the percentage of training and probe trials during which Anne produced an appropriate gestural response was calculated and is presented in Figure 2. During baseline conditions for all three response categories, low, stable levels of accurate gestural responding were observed. With the successive introduction of treatment across the three response categories, systematic increases in the percentage of trials during which an accurate gestural response occurred were observed for both the training and probe trials. The pattern of acquisition for the gestural response very closely followed the pattern of

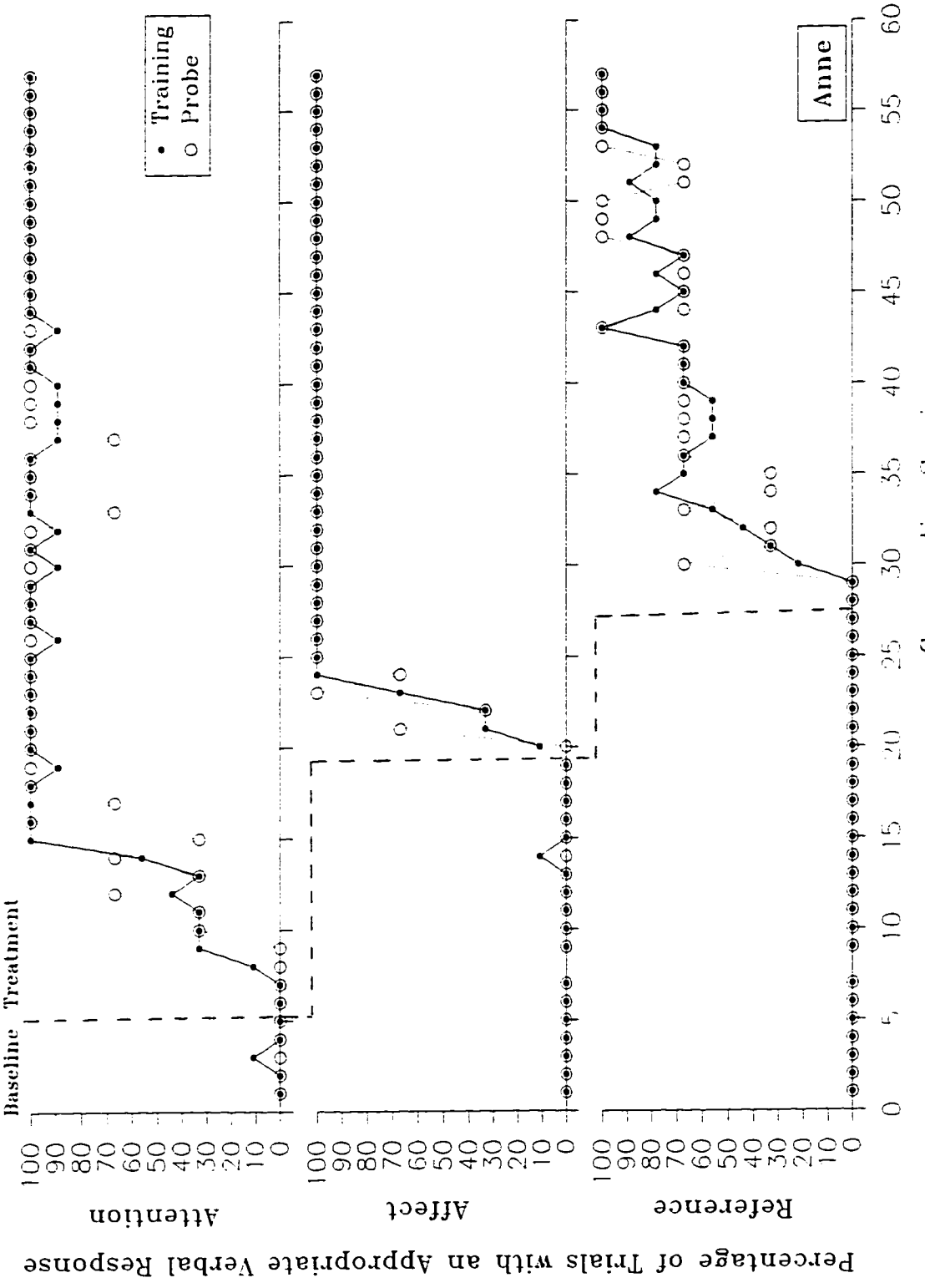
Figure 2. Percentage of training and probe trials in which Anne produced a correct gestural response. Training trials are represented by the closed circles and probe trials are represented by the open circles.



acquisition for the combined gestural and verbal responses. Acquisition rate for training trials varied across response category with acquisition being fastest in the affect category, then the attention category, and finally the reference category. Eight treatment sessions were required in the affect category before criterion performance was achieved. Similarly, 12 treatment sessions were required for the attention category, and 30 treatment sessions were required for the reference category. Generalization of the gestural responses to untrained stimuli followed a similar pattern with 100% accurate responding during two sessions occurring first in the affect category, second in the attention category, and third in the reference category.

To assess acquisition of the second component of the combined response, the percentage of trials during which an appropriate verbal response was produced was calculated. The percentage of trials in which Anne produced an accurate verbal response during the training and probe trials is presented in Figure 3. As can be seen in this figure, low, stable rates of verbal responding were observed during baseline conditions for all three response categories. Again, with the successive introduction of treatment across the response categories, systematic increases in the percentage of trials containing an accurate verbal response were observed for both training and probe trials. The pattern of acquisition of verbal responses alone for all three response categories was similar to the pattern of acquisition for the combined gestural and verbal responses, as well as for the gestural responses alone. That is, acquisition of verbal responses for both training and probe trials occurred first in the affect category, second in the attention category, and last in the reference category. The number of treatment sessions conducted prior to the achievement of criterion performance was as follows: 8 sessions for the affect category,

Figure 3. Percentage of training and probe trials in which Anne produced a correct verbal response. Training trials are represented by the closed circles and probe trials are represented by the open circles.

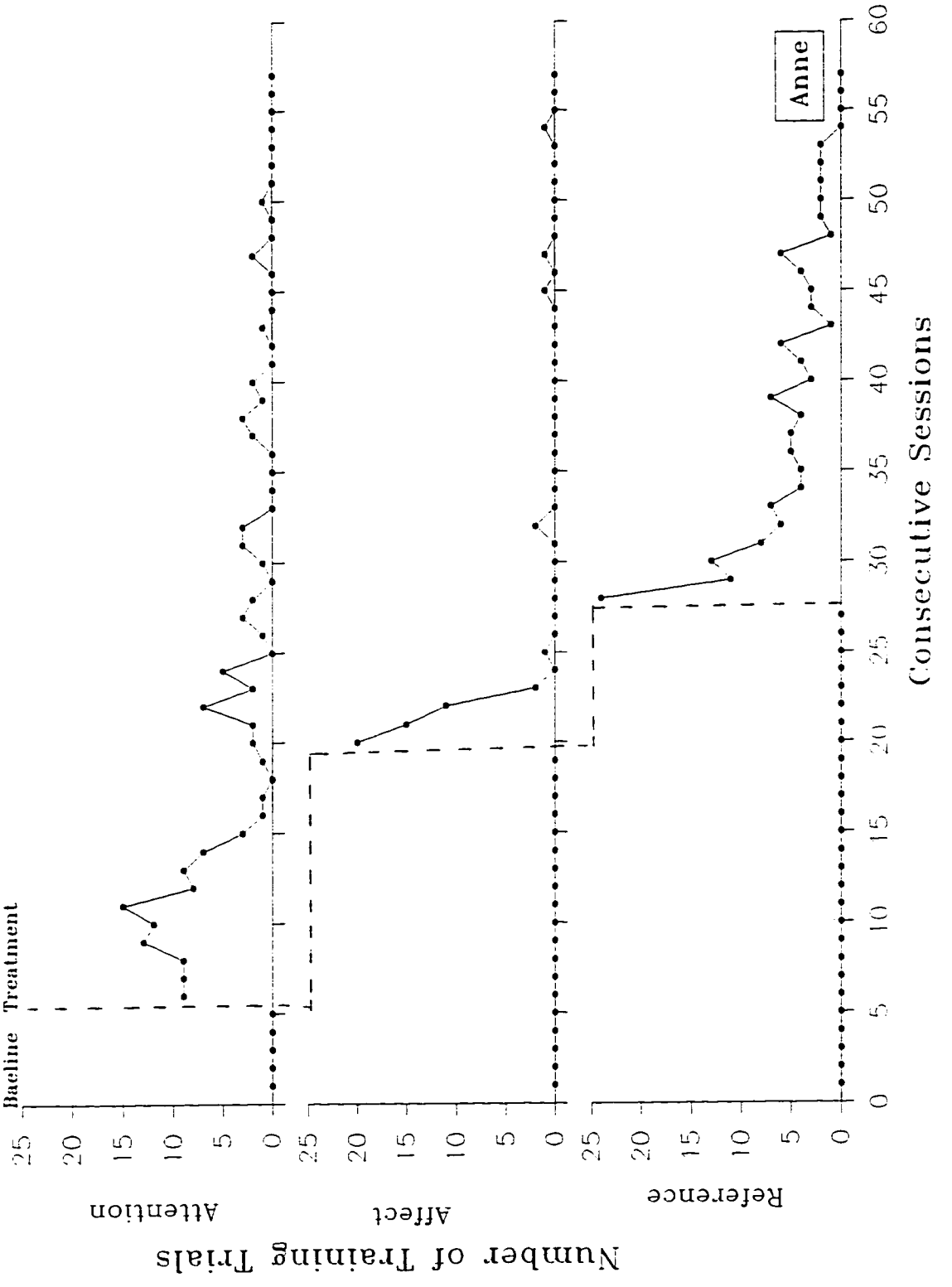


13 sessions for the attention category, and 30 sessions for the reference category. Similarly, two sessions of 100% accurate verbal responding to the probe stimuli occurred within 7 treatment sessions for the affect category, 14 treatment sessions for the attention category, and 22 treatment sessions for the reference category.

Another measure of the rate of acquisition of the gestural and verbal responses is the number of training trials that were presented during treatment. A training trial was defined as each presentation of the verbal and nonverbal discriminative stimuli by the therapist that was not immediately followed by an accurate, unprompted gestural and verbal response. That is, each training trial was followed by the presentation of the model and/or the prompting of the gestural and verbal responses. The number of training trials presented to Anne for each response category is shown in Figure 4. As can be seen in this figure, the number of training trials decreased most rapidly across sessions in the affective category. Although the number of training trials initially presented during the reference category training was quite high (i.e., 23 trials presented during the first treatment session), the number of training trials required in this response category decreased at approximately the same rate as the number of training trials required in the attention category.

The above findings were replicated with three additional children. That is, for Oscar, Kevin, and Nick low, stable rates of gestural, verbal, and combined gestural and verbal responding were observed in all three response categories during baseline. With the successive introduction of treatment across each response category, systematic increases in the percentage of training and probe trials containing an appropriate gestural, verbal,

Figure 4. The number of training trials presented to Anne before an independent response was produced in the presence of the discriminative stimuli.



and combined gestural and verbal response were observed for each student. These increases were observed only in the response category under treatment.

The rate of acquisition of the gestural and verbal responses for each response category, however, varied by child. As can be seen in Figure 5, acquisition of Oscar's gestural and verbal responses was fastest in the attention category, then the affect category, and then the reference category. Prior to meeting the mastery criterion for training trials, 13 treatment sessions were conducted for the affect category, 39 treatment sessions were conducted for the reference category, and 10 treatment sessions were conducted for the attention category. A similar pattern of responding was observed in the presence of the probe stimuli. That is, generalization of responding from trained stimuli to novel stimuli occurred first in the presence of stimuli in the attention category, second in the presence of stimuli in the affect category, and third in the presence of stimuli in the reference category. These findings were replicated when acquisition of the individual components of the response was assessed (see Figures 6 and 7).

Kevin's rate of acquisition of the gestural and verbal responses also varied across response category, as shown in Figure 8. Prior to criterion performance, 9 treatment sessions were conducted in the affective category, 15 treatment sessions were conducted in the reference category, and 28 treatment sessions were conducted in the attention category. Similarly, the pattern of generalization of gestural and verbal responses from trained stimuli to novel stimuli varied across response category. The number of treatment sessions conducted until two sessions of 100% accurate responding during probe trials occurred was as follows: 7 sessions for the affect category, 21 sessions for the reference

Figure 5. Percentage of training and probe trials in which Oscar produced a correct verbal and gestural response. Training trials are represented by the closed circles and probe trials are represented by the open circles.

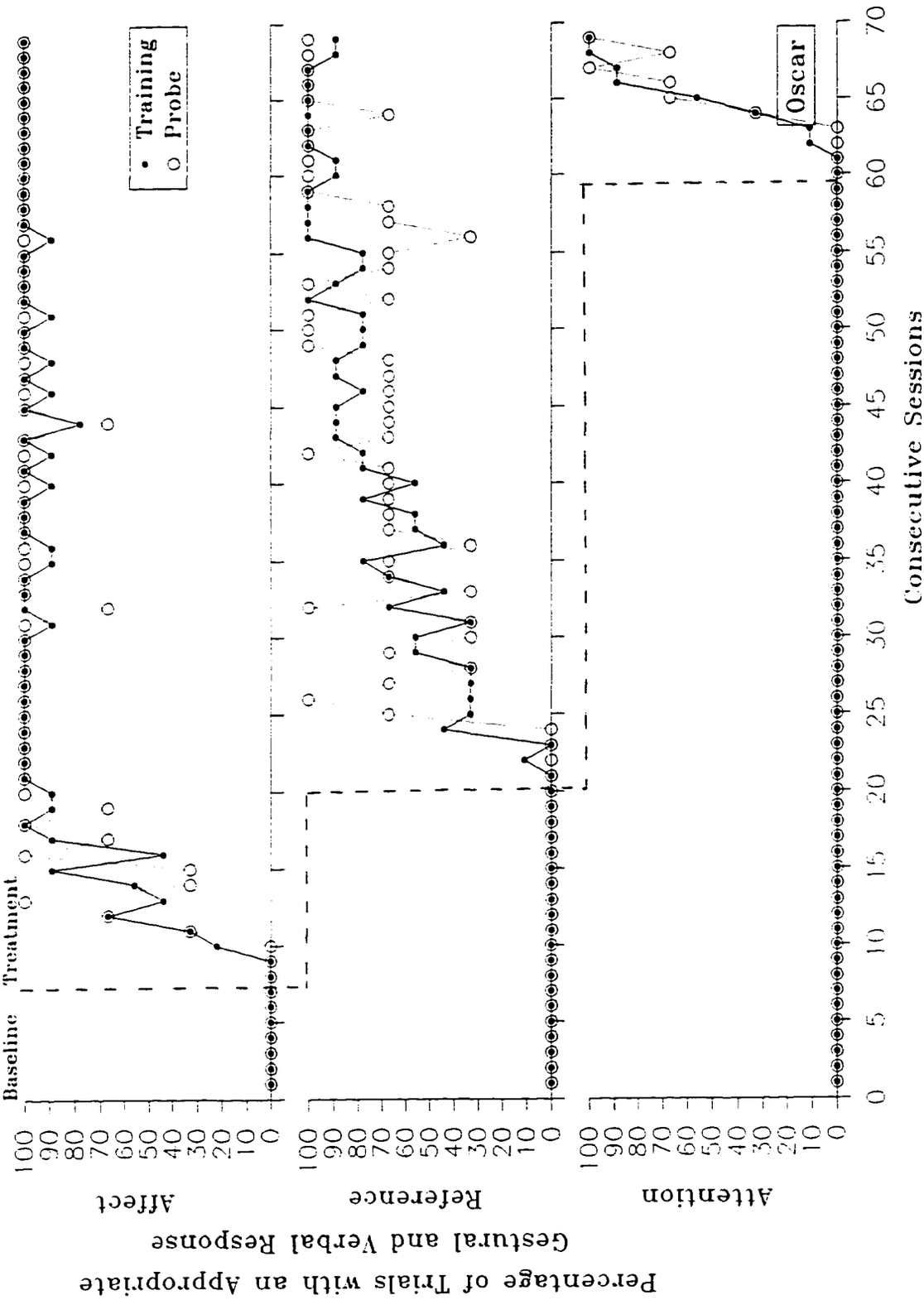


Figure 6. Percentage of training and probe trials in which Oscar produced a correct gestural response. Training trials are represented by the closed circles and probe trials are represented by the open circles.

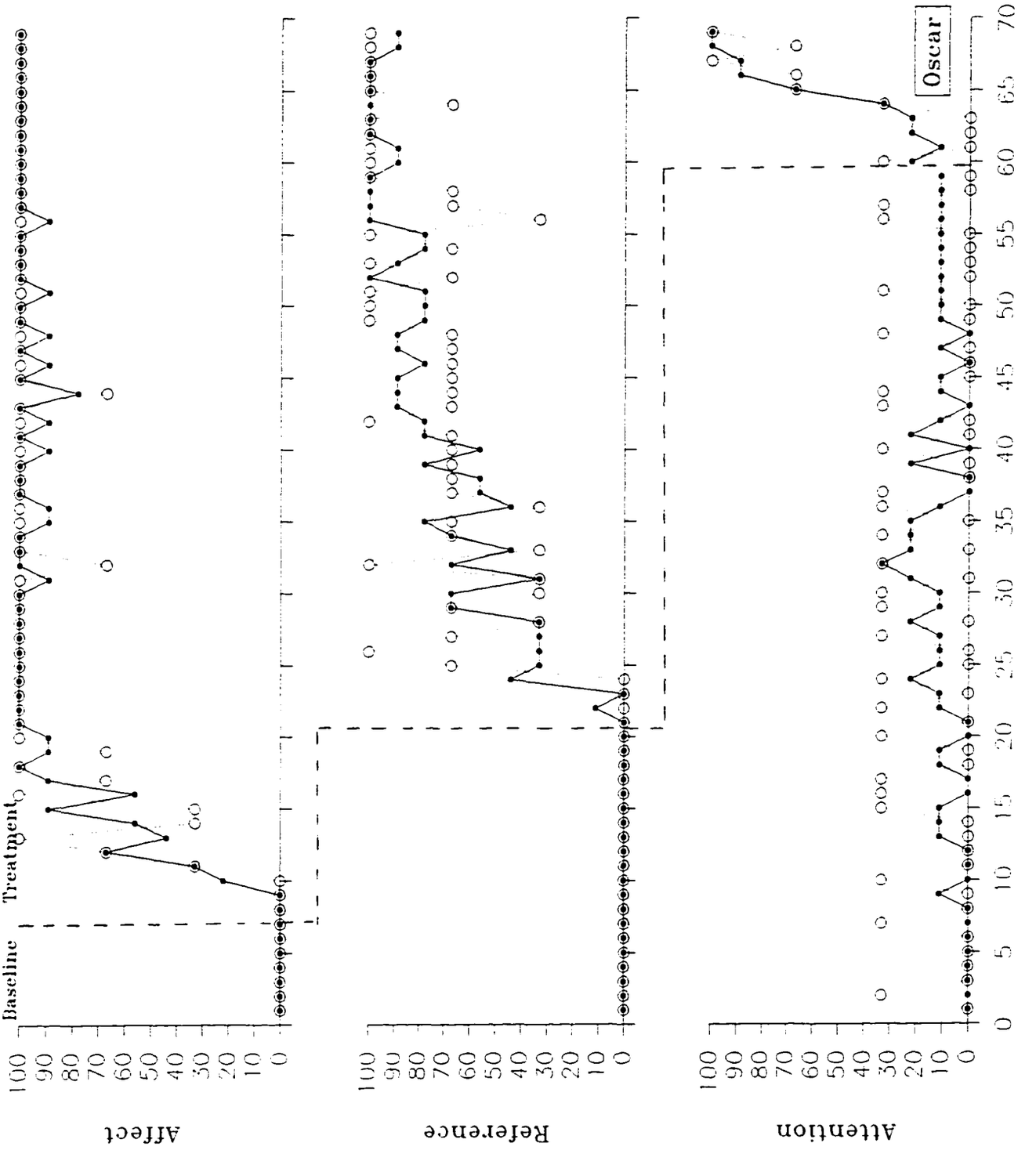


Figure 7. Percentage of training and probe trials in which Oscar produced a correct verbal response. Training trials are represented by the closed circles and probe trials are represented by the open circles.

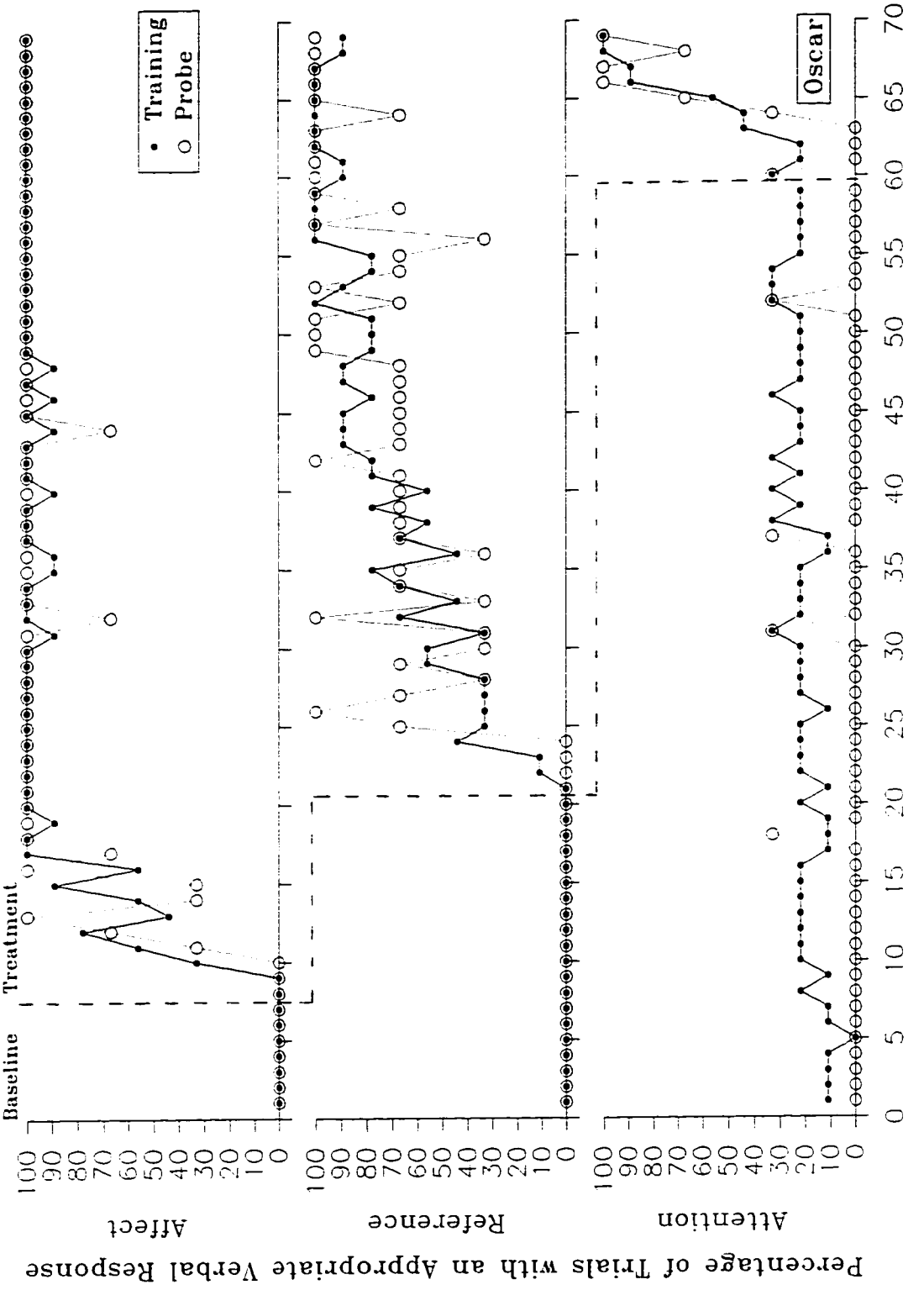
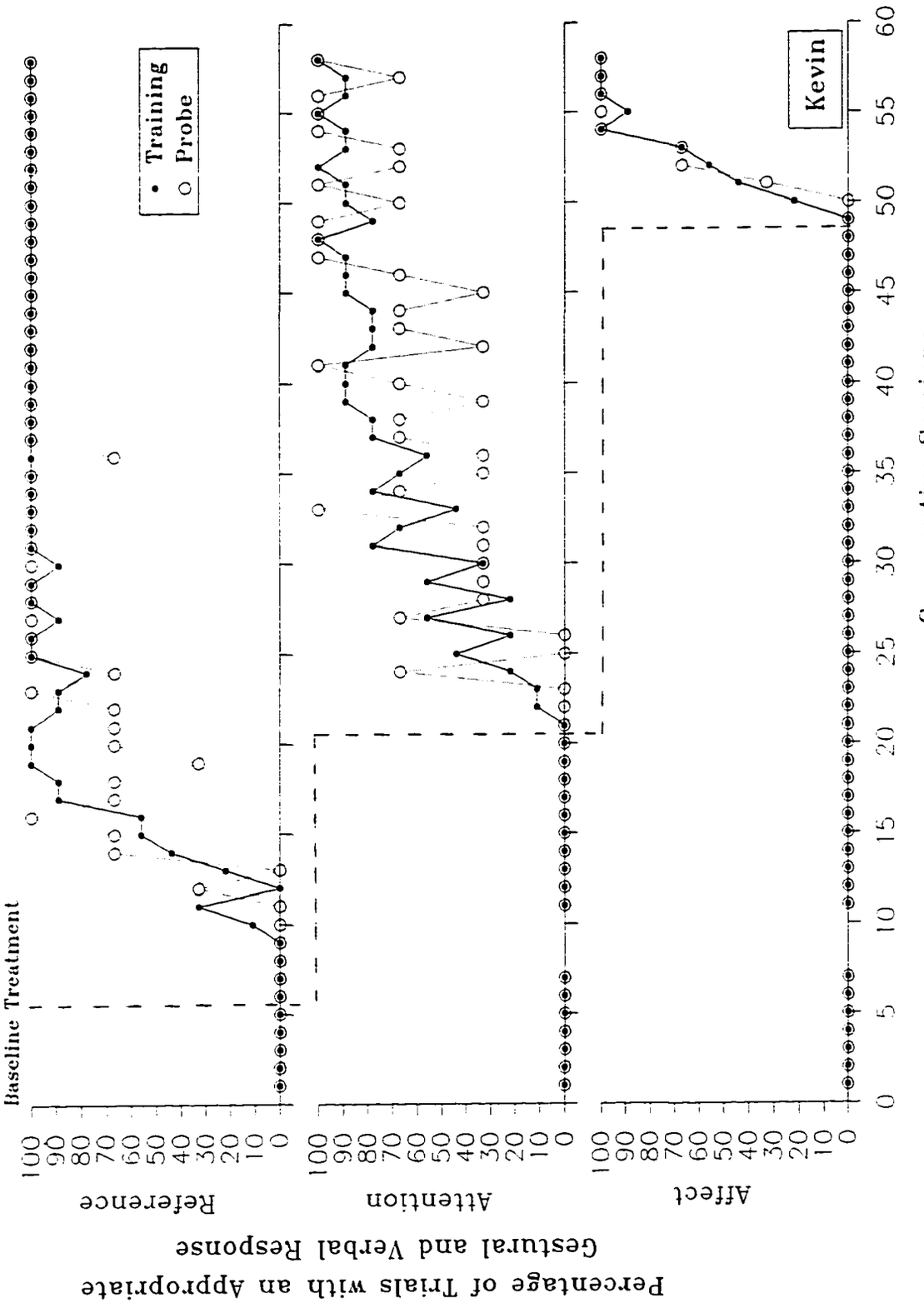


Figure 8. Percentage of training and probe trials in which Kevin produced a correct verbal and gestural response. Training trials are represented by the closed circles and probe trials are represented by the open circles.



category and 28 sessions for the attention category. These findings were replicated when acquisition of the individual components of the response was assessed (see Figures 9 and 10).

Finally, as seen in Figure 11, acquisition of Nick's gestural and verbal responses varied across response category with acquisition being slowest in the attention category. The number of treatment sessions needed to meet the mastery criterion was as follows: 13 sessions for the reference category, 14 sessions for the affect category, 25 sessions for the attention category. A similar pattern of responding was observed during the probe trials. That is, the number of treatment sessions conducted prior to the acquisition of 100% accurate responding during the probe trials varied across response category. Stable levels of generalization were observed after 10 treatment sessions for the reference category, 11 treatment sessions for the affective category, and 25 sessions for the attention category. These findings were replicated when acquisition of the individual components of the response was assessed (see Figures 12 and 13).

Individual differences in the rates of acquisition of the gestural and verbal responses were also observed in the number of training trials presented to each student. The number of training trials for Oscar are presented in Figure 14 for all three response categories. The number of training trials was highest in the affect category, then the reference category, and finally the attention category. The decrease in the number of training trials across sessions, however, occurred first for the attention category, second for the affect category, and third for the reference category.

Figure 9. Percentage of training and probe trials in which Kevin produced a correct gestural response. Training trials are represented by the closed circles and probe trials are represented by the open circles.

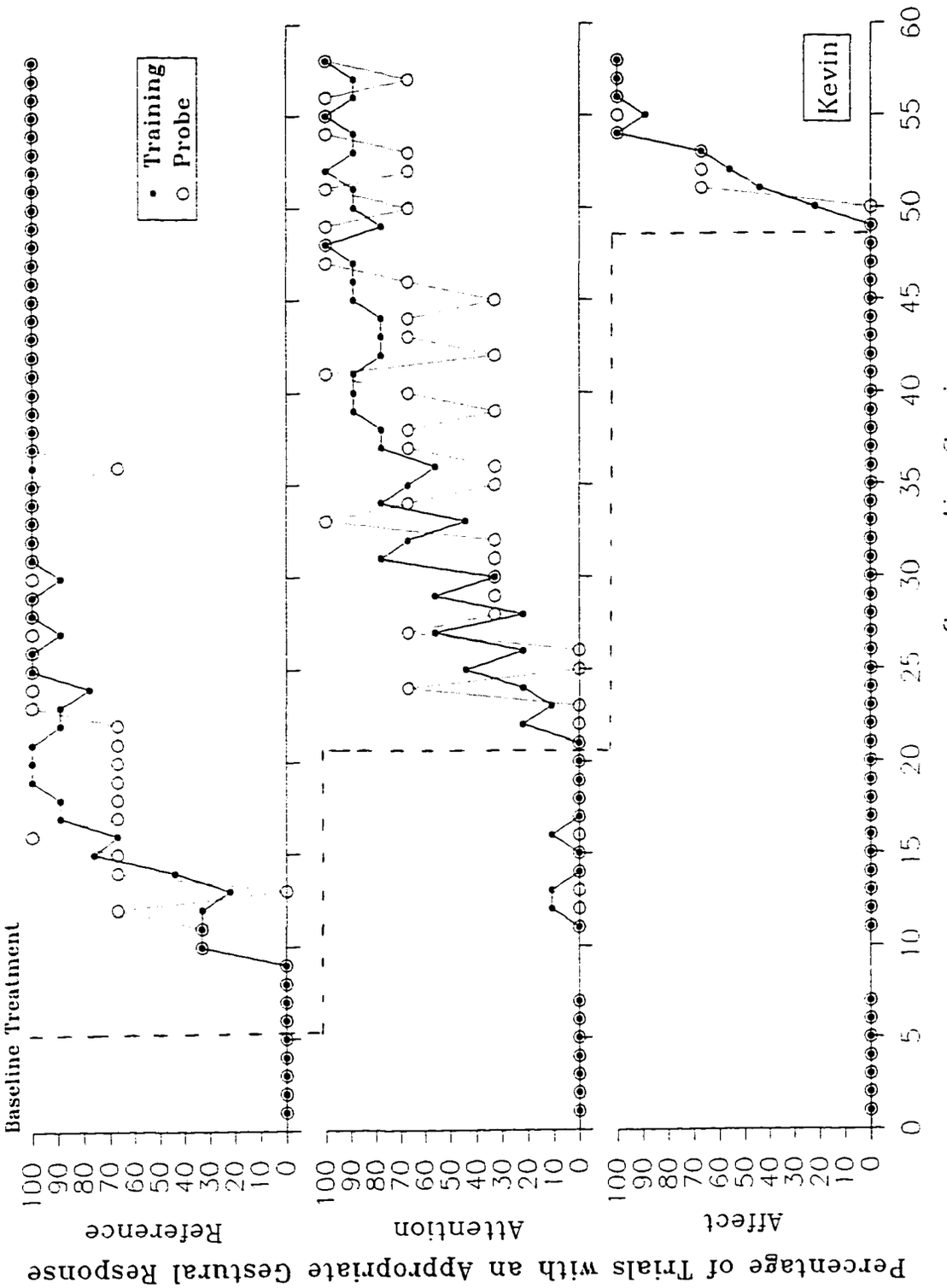


Figure 10. Percentage of training and probe trials in which Kevin produced a correct verbal response. Training trials are represented by the closed circles and probe trials are represented by the open circles.

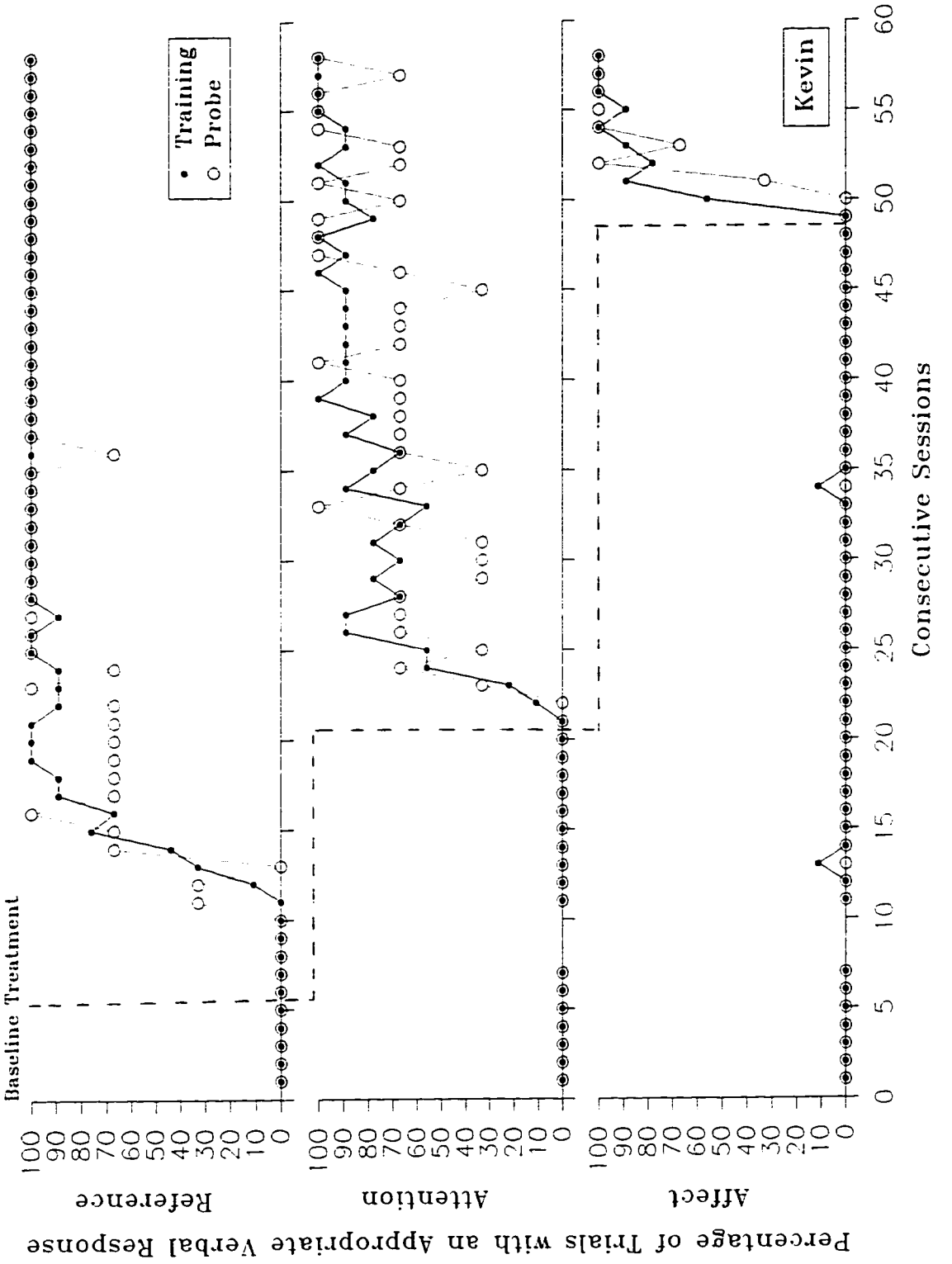


Figure 11. Percentage of training and probe trials in which Nick produced a correct verbal and gestural response. Training trials are represented by the closed circles and probe trials are represented by the open circles.

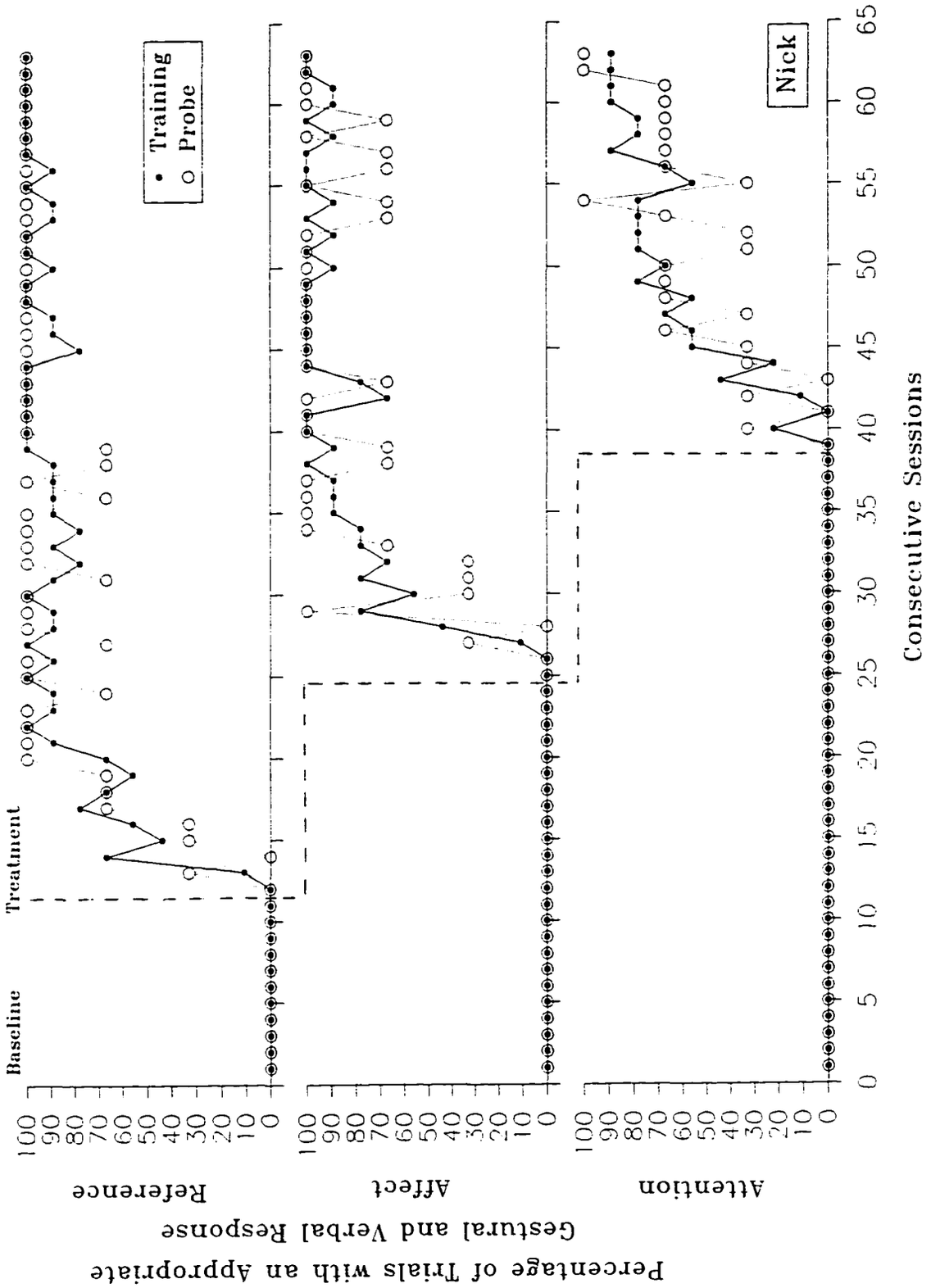


Figure 12. Percentage of training and probe trials in which Nick produced a correct gestural response. Training trials are represented by the closed circles and probe trials are represented by the open circles.

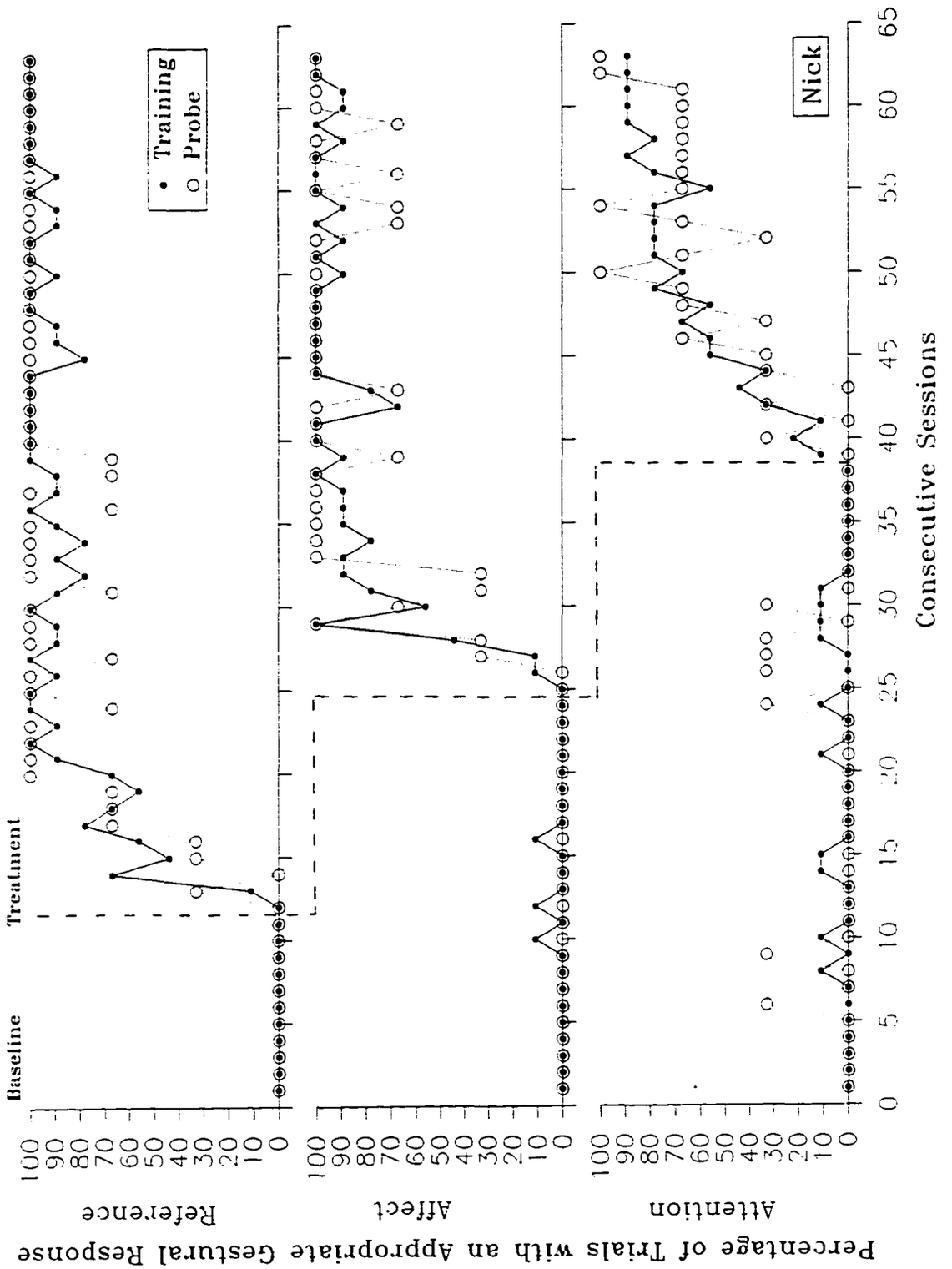


Figure 13. Percentage of training and probe trials in which Nick produced a correct verbal response. Training trials are represented by the closed circles and probe trials are represented by the open circles.

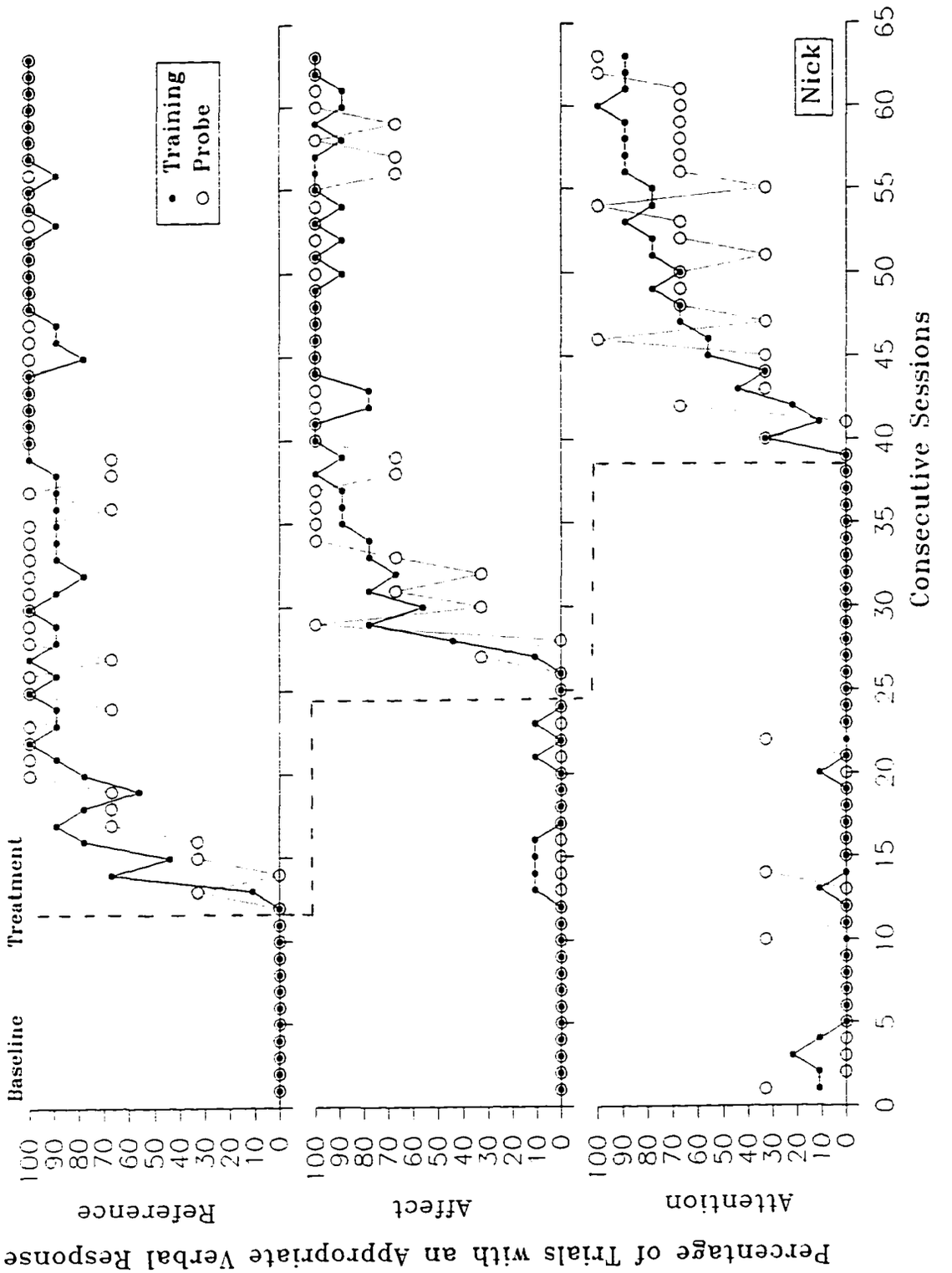


Figure 14. The number of training trials presented to Oscar before an independent response was produced in the presence of the discriminative stimuli.

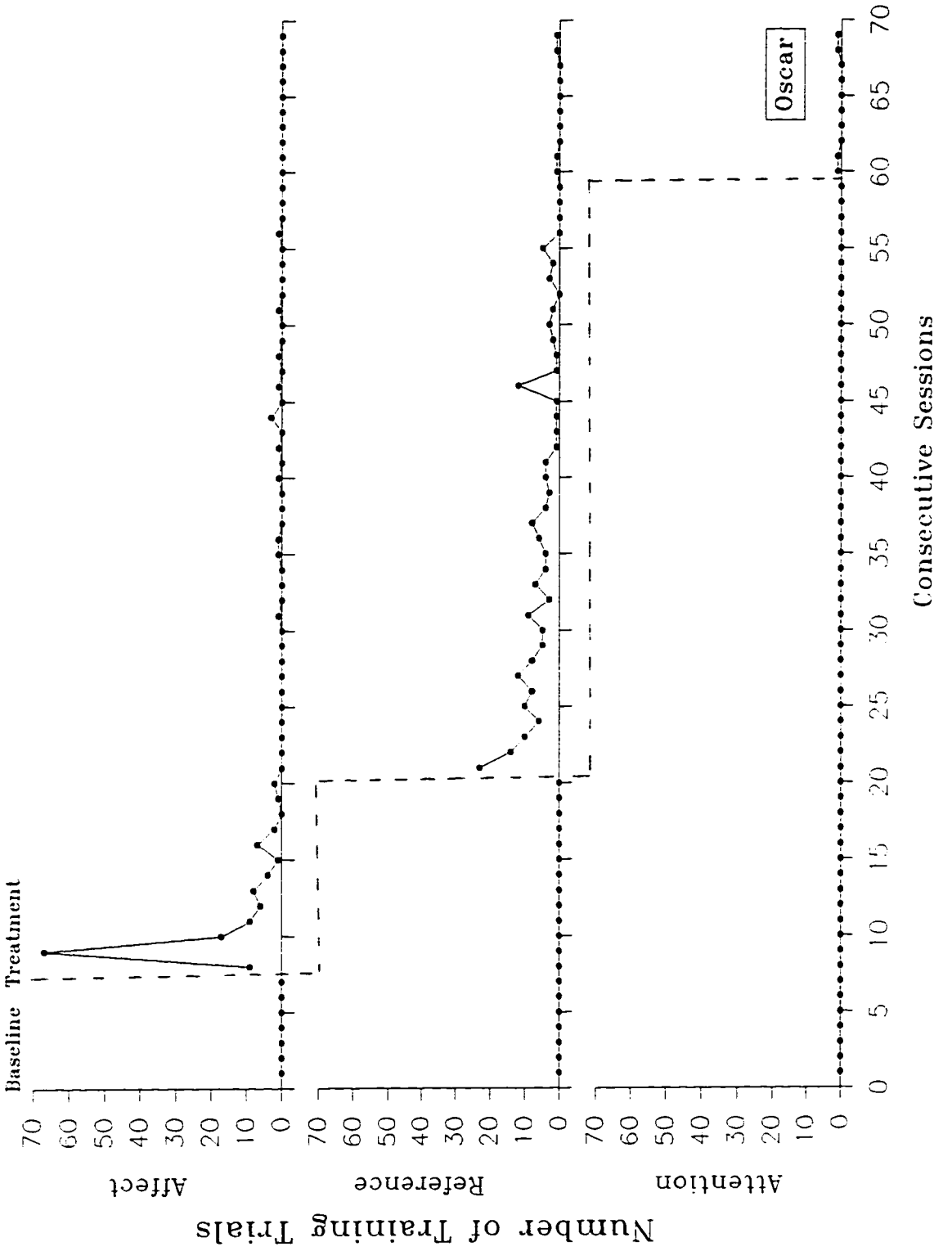


Figure 15. The number of training trials presented to Kevin before an independent response was produced in the presence of the discriminative stimuli.

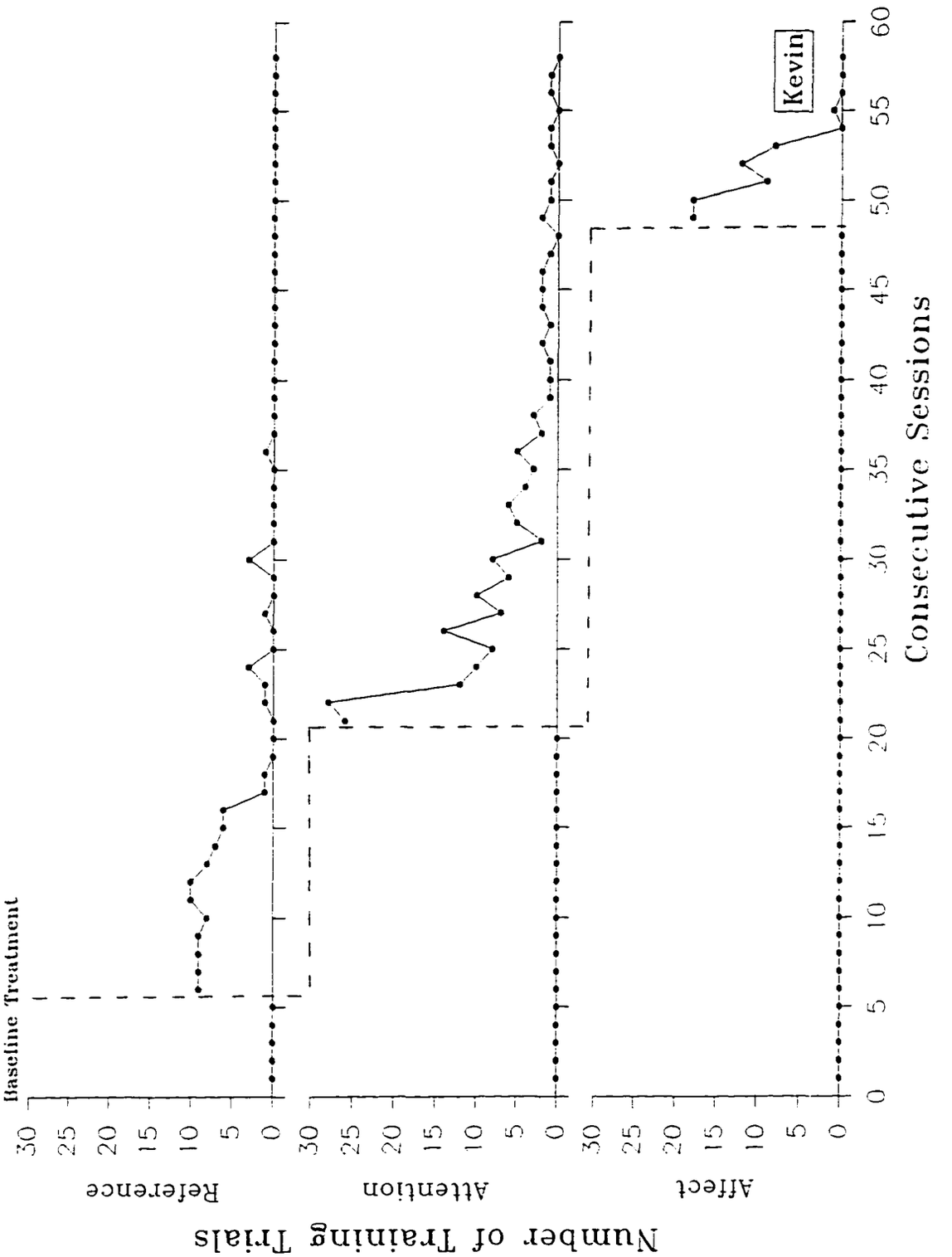
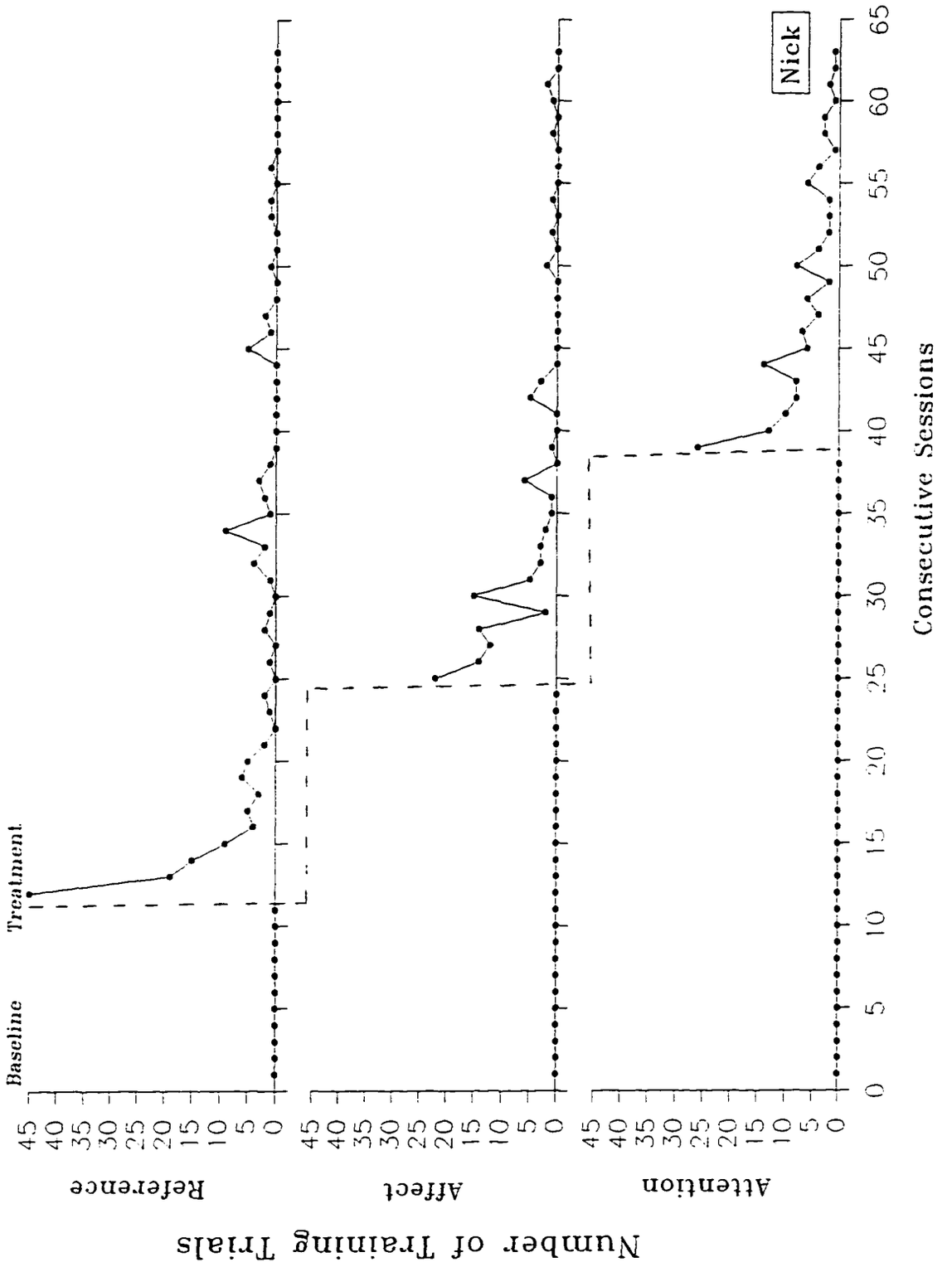


Figure 16. The number of training trials presented to Nick before an independent response was produced in the presence of the discriminative stimuli.



The number of training trials presented to Kevin can be seen in Figure 15 for each response category as a function of session. The decrease in the number of training trials provided followed a systematic pattern, with the decrease occurring most rapidly in the affect category, then the reference category, and finally the attention category.

The number of training trials presented to Nick in each response category is presented in Figure 16 as a function of session. The number of training trials presented was greatest for the reference category, although similar decreasing trends were observed across the three response categories.

To assess generalization of the gestural and verbal responses from the stimuli presented during training in the training setting to the presentation of novel stimuli in a novel setting, generalization probes were conducted in the children's classrooms. The percentage of trials in which an accurate gestural, verbal, and combined gestural and verbal response was observed during the regular-classroom generalization sessions is presented for each student in Table 7. The sessions conducted prior to teaching are indicated by the prefix "pre" (e.g., Pre1 was the first pre-treatment generalization session conducted in the regular classroom) and the sessions conducted at the completion of the study are indicated by the prefix "post" (e.g., Post1 was the first post-treatment generalization session conducted in the regular classroom). During the pre-treatment sessions, none of the students demonstrated accurate gestural, verbal, or combined gestural and verbal responding in any of the response categories. Following the teaching conducted in the study, the percentage of accurate gestural, verbal, and combined gestural and verbal responding increased in the presence of untrained stimuli in a different setting.

Table 7

Percentage of Regular-Classroom Trials with An Appropriate Gestural (G), Verbal (V) and Combined Gestural and Verbal(G+V) Response During Pre- and Post-Treatment Probes. Generalization Probes Conducted Prior To The Introduction of Treatment Are Indicated By the Prefix "Pre" and Probes Conducted After the Completion of Treatment Are Indicated By the Prefix "Post."

| | | Attention | | | Affect | | | Reference | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Subj | Sess | G | V | G+V | G | V | G+V | G | V | G+V |
| Anne | Pre 1* | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | Pre 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | Pre 3 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | Post 1** | 100 | 100 | 100 | 100 | 100 | 100 | 67 | 67 | 67 |
| | Post 2 | 100 | 100 | 100 | 100 | 100 | 100 | 67 | 100 | 67 |
| | Post 3 | 100 | 100 | 100 | 100 | 100 | 100 | 67 | 67 | 67 |
| Oscar | Pre 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | Pre 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | Pre 3 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | Post 1 | 33 | 33 | 33 | 100 | 100 | 100 | 67 | 67 | 67 |
| | Post 2 | 67 | 67 | 67 | 100 | 100 | 100 | 67 | 67 | 67 |
| | Post 3 | 67 | 67 | 67 | 100 | 100 | 100 | 100 | 100 | 100 |

Table 7 (continued)

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Kevin | Pre 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | Pre 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | Pre 3 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | Post 1 | 67 | 67 | 67 | 67 | 100 | 67 | 100 | 100 | 100 |
| | Post 2 | 67 | 67 | 67 | 67 | 67 | 67 | 100 | 100 | 100 |
| | Post 3 | 67 | 67 | 67 | 100 | 100 | 100 | 100 | 100 | 100 |
| Nick | Pre 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | Pre 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | Pre 3 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | Post 1 | 100 | 67 | 67 | 67 | 67 | 67 | 67 | 67 | 67 |
| | Post 2 | 100 | 100 | 100 | 67 | 67 | 67 | 67 | 67 | 67 |
| | Post 3 | 67 | 67 | 67 | 100 | 100 | 100 | 100 | 100 | 100 |

* Pre indicates measures taken before treatment occurred.

** Post indicates measures taken after treatment was completed.

By the end of the third post-treatment generalization session, each student made at most one error. For Kevin, Oscar and Nick 100% accurate verbal and gestural responding was observed in the affect and reference categories, and one error was made in the attention category. For Anne, 100% accurate verbal and gestural responding was observed in the attention and affect categories, and one error was made in the reference category.

To assess changes in gestural and verbal responding that occurred as a result of treatment, social validity Measure 1 was calculated. The mean percentage of treatment episodes that were rated as more expressive than the baseline episodes for Anne was 98%, with a range of 89% to 100%. The mean percentage of treatment episodes that were rated as more expressive than the baseline episodes for Oscar was 98%, with a range of 89% to 100%. The mean percentage of treatment episodes that were rated as more expressive than the baseline episodes for Kevin was 98%, with a range of 89% to 100%. Finally, the mean percentage of treatment episodes that were rated as more expressive than the baseline episodes for Nick was 96%, with a range of 89% to 100%.

To ascertain whether the gestural and verbal performances of the children in this study were typical of the gestural and verbal performances of children in their peer group, social validity Measure 2 was collected. The mean percentage of Anne's videotaped episodes scored as containing an appropriate gesture and verbalization was 91%, with a range of 56% to 100%. The mean percentage of her age-matched peer's episodes scored as containing an appropriate gesture and verbalization was 100%. An independent-t test (Ramsey & Ramsey, 1993) conducted to assess whether the rating for these two individuals was different revealed that there was no significant difference between the

number of videotaped episodes scored as appropriate between these two individuals ($t$ (20) = -2.043, $p$>.025). The mean percentage of videotaped episodes scored as containing an appropriate gesture and verbalization for Oscar was 93%, with a range of 78 to 100%. The mean percentage of episodes scored as containing an appropriate gesture and verbalization for his age-matched peer was 96%, with a range of 89 to 100%. There was no significant difference between the number of episodes rated as appropriate between these two individuals ($t$(20) = -1.074, $p$>.025). The mean percentage of Kevin's episodes rated as containing an appropriate gesture and verbalization was 100%. The mean percentage of episodes rated as containing an appropriate gesture and verbalization was 97% for his age-matched peer. There was no significant difference between the number of videotaped segments rated as appropriate between these two individuals ($t$(20) = 1.936, $p$>.025). Finally, the mean percentage of videotaped episodes scored as containing an appropriate gesture and verbalization for Nick was 91%, with a range of 67 to 100%. The mean percentage of videotaped episodes scored as containing an appropriate gesture and verbalization for his age-matched peer was 89%, with a range of 56 to 100%. There was no significant difference between the number of episodes rated as appropriate for these two individuals ($t$(20) = .363, $p$>.025).

To assure the integrity of the independent variable the following measures were taken 1) the percentage of trials during which the appropriate nonverbal stimulus was presented, 2) the percentage of trials during which the appropriate verbal stimulus was presented, 3) the percentage of trials during which modeling was contingently provided, and 4) the percentage of trials during which reinforcement was contingently delivered.

To assess the accurate presentation of the discriminative stimuli data were collected on the presentation of both the nonverbal and verbal discriminative stimuli and are presented in Tables 8 and 9 for the training and probe stimuli, respectively. In summary, invariably, the nonverbal discriminative stimuli were presented by the therapist accurately on 100% of the training and probe trials during all baseline and treatment sessions across all children. Although some slight deviation in the accuracy of the presentation of the verbal discriminative stimulus was observed, the accurate verbal discriminative stimulus was presented on a minimum of 96% of the trials during the baseline and treatment conditions for all children.

To assess the accurate use of the teaching procedure, the contingent use of modeling and reinforcement was assessed. As seen in Tables 10 and 11, modeling and reinforcement were withheld during all training and probe trials in baseline for all children. During treatment, the modeling procedure was presented contingently on 100% of the training trials in which a correct gestural and verbal response did not occur and withheld on 100% of the probe trials. This was true for all children. During treatment, contingent reinforcement was provided on 100% of the training trials during which an independent gestural and verbal response was produced. This was true for all children. Contingencies were withheld on a minimum of 99% of the probe trials during treatment for each child.

Table 8

Mean Percentage of Training Trials in Which a Correct Nonverbal Discriminative Stimulus and a Correct Verbal Discriminative Stimulus Were Presented By the Therapist for Each Participant During Baseline (Bl) and Treatment (Tr) Conditions.

| | | Attention | | Affective | | Reference | |
|---|---|---|---|---|---|---|---|
| Subj | Cond | Nonverbal | Verbal | Nonverbal | Verbal | Nonverbal | Verbal |
| Anne | Bl | 100 | 99 | 100 | 100 | 100 | 100 |
| | Tr | 100 | 100 | 100 | 100 | 100 | 100 |
| Oscar | Bl | 100 | 100 | 100 | 99 | 100 | 100 |
| | Tr | 100 | 100 | 100 | 99 | 100 | 100 |
| Kevin | Bl | 100 | 99 | 100 | 99 | 100 | 96 |
| | Tr | 100 | 100 | 100 | 100 | 100 | 100 |
| Nick | Bl | 100 | 100 | 100 | 99 | 100 | 99 |
| | Tr | 100 | 100 | 100 | 100 | 100 | 100 |

Table 9

Mean Percentage of Probe Trials in Which a Correct Nonverbal Discriminative Stimulus and a Correct Verbal Discriminative Stimulus Were Presented By the Therapist for Each Participant During Baseline (Bl) and Treatment (Tr) Conditions.

| | | Attention | | Affective | | Reference | |
|---|---|---|---|---|---|---|---|
| Subj | Cond | Nonverbal | Verbal | Nonverbal | Verbal | Nonverbal | Verbal |
| Anne | Bl | 100 | 100 | 100 | 100 | 100 | 100 |
| | Tr | 100 | 100 | 100 | 100 | 100 | 100 |
| Oscar | Bl | 100 | 100 | 100 | 100 | 100 | 100 |
| | Tr | 100 | 100 | 100 | 100 | 100 | 100 |
| Kevin | Bl | 100 | 100 | 100 | 100 | 100 | 100 |
| | Tr | 100 | 100 | 100 | 100 | 100 | 100 |
| Nick | Bl | 100 | 100 | 100 | 100 | 100 | 100 |
| | Tr | 100 | 100 | 100 | 100 | 100 | 100 |

Table 10

Mean Percentage of Training Trials During Which Modeling Was Provided Contingent Upon Incorrect Responding and Reinforcement Was Contingently Provided for Correct Independent Responding During Baseline (Bl) and Treatment (Tr) Sessions.

| | | Attention | | Affective | | Reference | |
|---|---|---|---|---|---|---|---|
| Subj | Cond | Model | Reinforce | Model | Reinforce | Model | Reinforce |
| Anne | Bl | 0 | 0 | 0 | 0 | 0 | 0 |
| | Tr | 99 | 100 | 100 | 100 | 100 | 100 |
| Oscar | Bl | 0 | 0 | 0 | 0 | 0 | 0 |
| | Tr | 100 | 100 | 100 | 100 | 100 | 100 |
| Kevin | Bl | 0 | 0 | 0 | 0 | 0 | 0 |
| | Tr | 100 | 100 | 100 | 100 | 100 | 100 |
| Nick | Bl | 0 | 0 | 0 | 0 | 0 | 0 |
| | Tr | 100 | 100 | 100 | 100 | 100 | 100 |

Table 11

Mean Percentage of Probe Trials During Which Modeling Was Provided Contingent Upon Incorrect Responding and Reinforcement Was Contingently Provided for Correct Independent Responses During Baseline (Bl) and Treatment (Tr) Sessions.

| | | Attention | | Affective | | Reference | |
|---|---|---|---|---|---|---|---|
| Subj | Cond | Model | Reinforce | Model | Reinforce | Model | Reinforce |
| Anne | Bl | 0 | 0 | 0 | 0 | 0 | 0 |
| | Tr | 0 | <1 | 0 | <1 | 0 | 0 |
| Oscar | Bl | 0 | 0 | 0 | 0 | 0 | 0 |
| | Tr | 0 | <1 | 0 | <1 | 0 | 0 |
| Kevin | Bl | 0 | 0 | 0 | 0 | 0 | 0 |
| | Tr | 0 | <1 | 0 | 0 | 0 | <1 |
| Nick | Bl | 0 | 0 | 0 | 0 | 0 | 0 |
| | Tr | 0 | <1 | 0 | 0 | 0 | 0 |

## Discussion

The four children with autism who participated in this study used little or no gestural communication prior to the present intervention. With the introduction of an intervention package that contained modeling, prompting, and reinforcement, all four of the children learned to use gestural and verbal responses in the presence of nonverbal and verbal discriminative stimuli presented by the therapist during an interactive episode. In addition, generalization of their gestural and verbal responses was observed in the presence of non-trained discriminative stimuli and in their regular classroom settings.

The results of this study suggest that children with autism can learn to use gesture. That is, gesture is a class of operant behavior that is sensitive to both consequences and antecedent stimuli (Skinner, 1957). When an interactive episode was initiated during baseline conditions by the therapist's presentation of the nonverbal and verbal discriminative stimuli, the children in this study exhibited very little verbal or gestural behavior, and absolutely no responding that combined the two types of responses. The verbal responses that were produced by the children in the presence of the stimuli included some previously taught responses such as "I do" and "I won." The only instances of gestural communication that were produced in the presence of the stimuli were a few instances of pointing and a few instances of Nick shaking his head. All of these responses were, however, weak in that the verbal responses were produced with very little intonation or inflection and the pointing responses were often non-differentiated pointing responses in that the arm was not fully extended towards the object. With the introduction of treatment, the existing responses were strengthened and

the children learned all of the remaining gestural and verbal responses. Most importantly, the children learned to combine the gestural and verbal responses, a rather difficult task for these children. This increase in responding was the direct result of the implementation of the treatment procedure. That is, correct responses were modeled and prompted by the therapist until independent responding occurred in the presence of the discriminative stimuli presented by the therapist during an interactive episode. The independent responses were then immediately followed by the delivery of contingent verbal and tangible consequences. The arrangement of contingencies between the therapist-presented discriminative stimuli and reinforcement led to the stimulus control exerted by the discriminative stimuli at the end of the experiment. This demonstrates this type of gestural behavior is an operant class of behavior (Skinner, 1957). Such an account of gestural behavior allows us to study the functional relationship between gestural behavior and antecedent stimuli and consequences. This analysis would then lead to the development of specific teaching strategies to remediate the deficit observed in gestural communication among children with autism rather than to declare it a life-long deficit predicted by the diagnosis of autism.

Not only did fluently combined gestural and verbal responses occur in the presence of the training stimuli, but they also occurred in the presence of the probe stimuli. This is an important finding, showing that the effects of treatment on training trials generalized to probe trials. A large number of nonverbal and verbal discriminative stimuli were presented by the therapist during each interactive episode. More importantly, these stimuli had several features in common. For example, the nonverbal discriminative

stimuli used to teach the "I won" response included a series of games and activities in which the child needed to make a response that led to winning a competitive game. The actual games used varied by specific type (e.g., dart gun game, picking a winning number, selecting a cup with a ball underneath it from among three cups, selecting one of two egg shells that matched one the therapist held, etc.) but all required the child to make a correct response that led to the outcome of winning. In addition, the verbal discriminative stimuli varied in form (e.g., "You won," "Wow, you did it," "Great you won the game," etc.) but all were similar in that they described the outcome of the game (i.e., that the student won). During training, reinforcement was delivered contingently when correct, independent gestural and verbal responses occurred in the presence of a number of training stimuli. What the students learned was that reinforcement followed certain gestural and verbal responses when these stimuli were presented. That is, these stimuli set the occasion for reinforcement. The occurrence of responding in the presence of probe stimuli suggests that the gestural and verbal behavior of the children was not only under the control of the training discriminative stimuli but also under the control of other stimuli that resembled those stimuli (Bijou & Baer, 1961; Catania, 1992). This is an example of operant stimulus generalization. Such generalization is often facilitated by the use of many stimuli during training that are similar along some dimension (Bijou, 1993; Stokes & Baer, 1977; Stokes, Baer, & Jackson, 1974).

Although all of the children acquired all nine of the gestural and verbal response combinations, individual variability in the speed at which they were acquired was observed. Interestingly, both Anne and Oscar (the 6 yr old children) had the most

difficulty in learning the gestures in the reference category. Nick and Kevin (the 4 yr old children), however, had the most difficulty learning the gestures in the attention category. The differences noted above were probably the result of difficulty in discriminating some of the stimuli presented during the interactive episode and, perhaps, these difficulties resulted from prior discrimination training in their educational history. Specifically, both Anne and Oscar had difficulty discriminating when to use the gesture for "huge" versus when to use the gesture for "tiny." The errors in responding that occurred in this category were most often the result of using one of these two gestures in the presence of the discriminative stimuli for the other response. They never, however, used the gesture for "fast" (i.e., the third response in the reference category) in the presence of the stimuli associated with the gestures of "tiny" and "huge." This suggests that these children discriminated that one of the "size" gestures was appropriate, however, the finer discrimination of which gesture to use (i.e., "tiny" or "huge") was more difficult for them. Nick and Kevin had a similar difficulty, but in the attention category. That is, these two children would often use the "hand request" and "raise hand" gestures interchangeably. Neither of these children used the "point" gesture (the third response in the attention category), however, in the presence of the stimuli associated with the gestures of "raise hand" or "hand request." The "hand request" and "raise hand" responses were occasioned by similar setting variables (i.e., the therapist presenting a desired item) but were differentially occasioned by changes in the verbal discriminative stimuli presented by the therapist. That is, the verbal discriminative stimuli for the "hand request" gesture consisted of statements (e.g., "look at this" and "check out this toy"), whereas the verbal

discriminative stimuli for the "raise hand" gesture consisted of questions (e.g., "Does anyone want this?" and "Does anyone like these?"). Again, this suggests that these children were able to discriminate that one of the two "requesting" gestures be used, however, the finer discrimination of which "requesting" gesture to use was more difficult to acquire. These differences were observed in the presence of both the training and probe stimuli.

Generalization of the gestural and verbal responses from the training setting to a novel setting was also assessed in the current experiment. The findings suggest that generalization of the trained responses did occur to some extent in the presence of novel stimuli presented in a novel setting. For the most part, by the final generalization probe in the regular classroom, only one error occurred in one response category for each child. The generalization results from the classroom setting were consistent with the findings in the training setting. That is, the greatest level of generalization of the trained responses from the discriminative stimuli presented by the therapist in the training setting to novel discriminative stimuli presented by the therapist in a different setting occurred for those responses that the children had the least difficulty acquiring. Anne made one error in the reference category (i.e., the "huge" response, one of the responses she had difficulty acquiring). Kevin and Nick both made one error in the attention category (i.e., the category that presented the most difficulty during training). What was interesting, however, about Kevin, Nick and Oscar was that although the children responded incorrectly during some of the generalization probes, they often used some gesture/verbalization combination that was not the targeted response combination. That

is, both Kevin and Oscar used the "tiny" response in the presence of a small toy that the therapist presented, saying "Look at this cool toy." Although "tiny" was not the target response, most likely it would not have been viewed as an inappropriate gesture or vocalization by an observer. During the final generalization probe conducted in Nick's regular classroom, he used the "hand request" gesture instead of the "raise hand" gesture. Again, this response did not look inappropriate in the presence of the specific discriminative stimuli presented by the therapist. The level of generalization in the presence of both a novel setting and novel discriminative stimuli combined with the types of errors that occurred suggests that the skills acquired by the children in this study did transfer to other contexts in which no teaching or reinforcement contingencies were provided. Other teachers and therapists reported that Oscar, Nick and Kevin used the gestures they learned during training in other non-training settings including group and individual teaching sessions. The gestures used most frequently by these children, as reported by the other teachers and therapists, included the "hand request," "raise hand," and "arms up" gestures. It was also reported that Nick and Kevin were observed on a few occasions using the "fast" and "hands on face" gestures.

Two social validity measures were obtained in this study. To determine if there was a noticeable change in the nature of the child's communication after teaching was conducted, social validity Measure 1 was determined by asking raters to compare baseline videotaped episodes to treatment videotaped episodes. The data indicated that the children's responses in the treatment episodes were much more expressive than those in the baseline episodes. The consistent ratings across the graduate students indicated

that the change measured from baseline to treatment was clearly socially valid. That is, naive observers consistently agreed that the children appeared more expressive in their communication after the introduction of treatment for the gestural and verbal responses.

The second measure of social validity was obtained by asking raters to rate videotaped episodes of typically developing children and of the participants in this study according to whether or not an appropriate gesture and verbalization was used. The data collected on this measure indicated that there was no significant difference between the gestural and verbal responding of the children in the study and typically developing peers. This was a consistent finding across all participants.

The social validity measures taken in this study suggest that the participants' behavior appeared more socially appropriate after treatment. Graduate students consistently rated post-treatment video scenes as being more socially appropriate than baseline video scenes. In addition, the ratings that were obtained from comparison of typical children to the participants in this study suggest that the children with autism were indistinguishable from their peers in their use of appropriate gestures and verbalizations in the scenarios presented.

The responses trained in this study were representative of various levels of gestural competence. That is the gestures that the children learned in this study could be used to obtain tangible consequences in a socially appropriate way, to obtain social consequences, to display affective behavior, and to describe characteristics of objects. According to the classification scheme developed by Barten (1979) the gestures that the children acquired in this study were representative of the deictic (i.e., pointing),

instrumental (i.e., gestures that regulate the behavior of others), expressive (i.e., gestures associated with affect), and depictive (i.e., gestures used to describe objects) levels of gestural communication. Using the analysis presented by Skinner (1957) the children in this study acquired gestures that function as mands (i.e., gestures that result in the specified consequence) and as tacts (i.e., gestures that are used to obtain social consequences or to describe objects).

By teaching the gestures in the attention category, the children learned to request items in a more appropriate manner and alter the orienting behavior of others in their environment (Kasari et al., 1990; Loveland & Landry, 1986; Mundy et al., 1990). By teaching these children to use requesting gestures (e.g., "hand request" and "raise hand") that are more socially acceptable than those gestures often used by individuals with autism (e.g., grabbing, pulling, and reaching), it increases the probability of their gaining access to reinforcers in their environment (Carr & Kemp, 1989; Prizant & Wetherby, 1987). In addition, by teaching children with autism to point and say "look" rather than to only label an object, it is more probable that others in their environment will respond to them (Bijou & Baer, 1965). It is also more likely that this response would generalize to a situation in which a novel stimulus is present, and thereby, provide the children with a response that would lead to the attainment of new knowledge (Taylor & Harris, 1995).

The gestures that the children learned in the affective category provided the children with behavior that could recruit social responses from others in their environment. The "arms up" and "hands on face" gestures could serve as discriminative stimuli for individuals in their environment to attend to and respond socially to behavior exhibited

by children with autism. The "shake head" gesture could lead to both the removal of an unwanted stimulus and/or the presentation of social responses from others in their environment. Because children with autism have such serious deficits in social interaction skills, teaching them to use gestures to recruit social responses from others is a useful way to increase the probability of successful social interactions between themselves and others in their environments (Loveland et al., 1988; McHale et al., 1980; Mundy et al., 1986; Ricks & Wing, 1975; Sigman et al., 1986; Wetherby & Prutting, 1984; Wetherby, 1986) . These gestures were considered to be affective responses because they are so often associated with the description of affective states, another large deficit area for children with autism (Attwood et al., 1988; Kasari et al., 1990).

Finally, the gestures that the children learned in the reference category provided them with responses to describe objects (i.e., tact). This skill is often deficient in individuals with autism, with the majority of their vocal and gestural behavior serving only the purpose of requesting items (Landry & Loveland, 1988; Partington, Sundberg, Newhouse, & Spengler, 1994; Shah & Wing, 1986; Wetherby & Prutting, 1984). Tacting responses, however, provide additional opportunities for children with autism to recruit social responses from other individuals in their environment, and thereby, strengthen their overall communication skills.

All of the gestural responses taught in the current study enabled the children to make more clear communicative responses. That is, for a child whose verbal skills were weak, the addition of a gestural response helps the listener involved in the social interaction discriminate and respond to the child's behavior. In the case of a child with articulation

difficulties, for example, a verbal response such as "ast" alone may not be understood by the listener as "fast." With the addition of the gestural response, however, the behavior on the part of the speaker is much easier to identify. The combined gestural and verbal responses will more likely result in a more immediate consequence, and thereby lead to the strengthening of communicative behavior (Bijou, 1993).

Vocal and gestural behavior are two important contributors to social behavior (Bijou & Baer, 1965; Garfin & Lord, 1986; Prizant & Wetherby, 1987). Children with autism have deficits in all three of these areas (Schreibman et al., 1990; Shah & Wing, 1986). By teaching use of gesture, alone or in combination with vocal behavior, children with autism will acquire another skill that is a needed component of social interaction. Teaching children with autism to use gesture as a communicative tool can help provide them with new responses that can be used during social interactions. More importantly, teaching gesture in the presence of varying nonverbal and verbal discriminate stimuli should help to provide the context in which gestural communication should be used (Shah & Wing, 1986). With the addition of gestural behavior under the control of appropriate social stimuli, to the communication repertoires of individuals with autism, hopefully these individuals will appear more "typical" in their social interactions and in turn become more reinforcing to their social partners (Koegel & Frea, 1993).

The results of this study suggest that language programs for children with autism should include nonverbal communication. The children in this study were between 4 and 6 years old and exhibited little or no gestural communication prior to treatment, not even gestures that typical 1 and 2 year-old children exhibit. With the systematic application of

modeling, prompting and reinforcement, these children were able to learn to use gestures in combination with verbal communication in the training situation, as well as in the natural environment. Future research efforts should be aimed at defining the most efficient way to teach use of gesture to communicate and at using more natural teaching paradigms (e.g., incidental teaching) to facilitate generalization of the gestural skills from training situations to novel situations. It would also be interesting to determine whether early intervention efforts that include gestural communication training will produce generalized imitation of gesture. If not, it would be important to learn how one could teach this. Young children with autism have been shown to acquire generalized imitation skills in a variety of areas. An interesting area to investigate would be that of spontaneous imitation of novel gestures.

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