STIMULUS CONTROL OBTAINED WITH TWO DIFFERENT PROPERTIES OF THE SAME MODELED RESPONSES THROUGH GENERALIZED IMITATION TRAINING WITH INFANTS AND A YOUNG CHILD

by

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Abstract

The present study investigated whether stimulus control, first established according to one property of modeled motor responses, could be transferred to another property of the same modeled motor responses, by training imitative responses with each property separately. Three children of typical development, two infants and a six-year-old, participated in two experiments each. In each experiment, each child experienced reinforcement according to a different property of the same modeled responses, either an object-manipulation property, or a visibility property. The object-manipulation property consisted of motor-with-toy modeled response types, and motor-without-toy modeled response types. The visibility property consisted of visible to imitate modeled response types, and invisible to imitate modeled response types. Reinforcement consisted of social praise and tokens or edibles, and was presented contingent upon matching of training models. Matching of probe models was never reinforced. In Experiment 1, the sequential implementation of reinforcement for imitation of the training models of both response types according to the first modeled response property, resulted in a systematic increase in imitation of the training models and the probe models of similar type. These results provided a demonstration of generalized imitation within each modeled response type, and response class formation according to the first modeled response property. The sequential, implementation of a DRO 0-second procedure during the training trials of both modeled response types, resulted in a systematic decrease in imitation of the training and probe models of similar type. During Experiment 2, the sequential implementation of reinforcement for imitation of the training models of both response types according to the second modeled

response property, resulted in a systematic increase in imitation of the training and probe models of similar type. These results provided a second demonstration of generalized imitation and response class formation now according to the second property of the same modeled responses. A change in the reinforcement contingencies resulted in the transfer of stimulus control from one property of the modeled responses to a second property of the same modeled responses without interference of prior training. This finding adds valuable information to the existing body of research about how imitative response classes are formed.

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Well papa, I did it!

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Introduction

Imitation as a response repertoire has long been recognized as being important, even during early infancy (Guillaume, 1926/1971; Bridges, 1933; Valentine, 1930; Piaget, 1962). Imitation in infants was investigated in 1962 by Piaget who observed, in great detail, the acquisition of imitation of various types of models presented to each of his three children (Piaget, 1962). Imitation of the behavior of a model by children has since been extensively investigated in the psychological literature (for a review see Poulson, Nunes, & Warren, 1988; and Kymissis & Poulson, 1990).

What constitutes imitative behavior? First, as Skinner stated in 1989, there must be both a model and a potential imitator. Without the potential imitator there cannot be a model and without the model there cannot be imitation. In addition, an imitative response must temporally follow the behavior of a model. The potential imitator must observe the demonstrated response. And the topography of the model's response must control the topography of the imitator's response. Therefore, as Bijou and Baer pointed out, imitation may also be referred to as a "Discriminative operant" (Bijou and Baer, 1978, pg. 82). A model's response serves as the discriminative stimulus for a similar response, the imitation, which is in turn strengthened by some subsequent event, the reinforcer (McCuller and Salzberg, 1982).

In 1964, Baer and Sherman first demonstrated the operant control of imitation. They presented preschool children of typical development with four different responses modeled by a puppet. The imitation of mouthing, nodding, and nonsense verbalizations (referred to as the training models), was followed by social reinforcement delivered by the puppet. Imitation of bar pressing (a probe model) interspersed among the training model presentations, was never followed by reinforcement. They found that imitation of the three training models increased, as did imitation of the bar press model. In addition, with the introduction of an extinction procedure and a non-contingent reinforcement procedure in which the training models were no longer presented, imitation of the training models decreased, as did imitation of the probe model.

Therefore it was found that children of typical development imitated models when this imitative behavior was directly reinforced, and as a result they also imitated other models, interspersed among the training models, when matching these other models was not directly reinforced. This phenomenon was described as generalized imitation by Baer and Sherman (1964) and Baer Peterson and Sherman (1967).

Generalized imitation has been demonstrated in other studies with children of typical development (Sherman, Clark, & Kelly, 1977; Hursh & Sherman, 1973; Baer and Deguchi, 1985; and Kymissis & Poulson, 1996), as well as with other populations such as children with mental retardation (Baer, et al., 1967; & Garcia, Baer & Firestone, 1971); and children with autism (Metz, 1965; Young, Krantz, McClannahan, & Poulson, 1994; Lovaas, Berberich, Perloff, & Schaeffer, 1966). In addition, generalized imitation has also been demonstrated with infants, using motor models (Poulson & Kymissis, 1988; Poulson, Kyparisos, Andreatos & Reeve, 1991), and using vocal models (Poulson, Kymissis, Reeve, Andreatos & Reeve, 1991; Poulson, Kyparisos, Andreatos, & Kymissis, 1993).

In 1985, Baer and Deguchi summarized the generalized imitation literature to date. In their paper they described in detail what constitutes generalized imitation. They listed three characteristics that have lead to the description of the generalization of imitation as a response class. These three characteristics are the following:

> "1. Nonreinforced imitations are maintained as long as other imitations are reinforced, but decrease when reinforcement is no longer contingent on other imitations (Baer, et al., 1967; Lovaas et al., 1966; Waxler and Yarrow, 1970).
>
> 2. Nonreinforced imitations persist despite continuous differential reinforcement (Baer et al., 1967; Steinman, 1970a; 1970b).
>
> 3. Accuracy of nonreinforced imitations increases when other imitations are reinforced in the course of developing generalized imitative skill (Brigham & Sherman, 1968; Lovaas, et al., 1966; and Schroader & Baer, 1972).
>
> Thus, these covariations of two sets of behaviors (reinforced and nonreinforced imitations) in both quantity and quality allow the description of imitation as a functional response class." (p. 103)

Gewirtz and Stingle (1968), suggested that generalized imitation was the result of intermittent reinforcement. Thus these investigators viewed the generalized imitation procedure as an intermittent reinforcement procedure. This interpretation is not adequate in explaining generalized imitation however, because there is a difference between the generalized imitation procedure and an intermittent reinforcement procedure With a generalized imitation procedure, all the models presented are different from eachother. Each functions as its own discriminative stimulus. Whereas in a typical intermittent reinforcement procedure all the responses are the same, but are reinforced according to an intermittent schedule of reinforcement.

Another attempt to explain generalized imitation has focused on the "failure to discriminate" hypothesis. Bandura and Barab (1971) suggested that the reason matching of models not correlated with reinforcement occurred along with reinforced matching of other models was that the subjects failed to discriminate between the models correlated with reinforcement and the models not correlated with reinforcement, especially when both sets of models were topographically similar. Bandura and Barab (1971) showed that subjects will imitate only models correlated with reinforcement when these and models not correlated with reinforcement are easily distinguished. They presented children with two experimenters, one experimenter modeled only responses correlated with reinforcement and the other experimenter modeled only responses not correlated with reinforcement. They found that the children were more likely to produce reinforced imitations than nonreinforced imitations.

Other studies have shown however, that children can, in fact, discriminate between the models correlated with reinforcement and those not correlated with reinforcement. Steinman (1970a) and Steinman and Boyce 1971) presented children of typical development with two different types of trials. One type of trial consisted of two sets of models presented concurrently, one set correlated with reinforcement and the other not correlated with reinforcement. The other type of trial consisted of single-model presentations. They found that during the concurrent-model presentation trials, in which the children were presented with a choice, they imitated the models correlated with reinforcement. During the single-model presentation trials, with no choice, the children matched all the models presented regardless of differential reinforcement. These findings indicated that the children could in fact discriminate between models correlated with reinforcement and models not correlated with reinforcement, but even given this discrimination, imitation of all models persisted during the single presentation trials.

In another experiment, Steinman (1970a) presented different children of typical development with either single-model presentation trials, or concurrent-model presentation trials. The models correlated with reinforcement and the models not correlated with reinforcement were either similar in topography (hand movements), or dissimilar in topography, (hand movememnts and leg movements). They found that all the models were imitated during the single-model presentation trials, whereas, fewer of the model were imitated during the concurrent-model presentation trials. Steinman suggested that "social setting conditions" (p. 160), may have been responsible for this result.

Steinman proposed that various environmental events determine whether a model functions as a discriminative stimulus for reinforcement. The experimental procedure is one in which reinforcement of an imitation in the presence of a specific model was conditional upon the presence of another stimulus. A procedure in which reinforcement of a response in the presence of a stimulus is conditional upon the presence of another stimulus has been described as a conditional discrimination (Catania, 1992). This explanation has receive some support in the imitation research literature. Steinman (1970b) presented children of typical development with instructions not to imitate models not correlated with reinforcement. The introduction of this instruction resulted in a decrease in imitation of these models which was previously occurring at high levels..

Peterson and Whitehurst (1971) also provided data that supported the conditional discrimination hypothesis. They found that experimenter presence versus absence also controlled the extent to which imitation generalized to nonreinforced models. In addition, Furnell and Thomas (1976) showed that previously neutral stimuli can come to function as conditional discriminative stimuli. They trained children with mental retardation to imitate certain models in the presence of a large ball and not in the presence of a small ball, by providing reinforcement for imitation of responses modeled in the presence of a large ball and not reinforcing imitation of responses modeled in the presence of a small ball.

Baer and Deguchi (1985) proposed a different explanation of generalized imitation. They proposed that the similarity between the model's behavior and the imitator's behavior becomes a conditioned reinforcer by virtue of being paired with the primary reinforcer delivered contingently for matching of the training models. This similarity is what functions as a reinforcer for matching of probe models, because the similarity is present in every instance if imitation even if the primary reinforcement is not.

One question that arises in generalized imitation research is the extent of the generalization of imitation, and what governs that generalization. Garcia, Baer and

Firestone, in 1971, investigated generalized imitation, across responses of different types: Small-motor; large motor; and short-vocal, in a multiple-baseline-across-responses design Their subjects were children with mental retardation. In their study, generalized imitation was demonstrated within small motor, large-motor and short-vocal response types, but not across the different response types. For example, when reinforcement was introduced for matching of small motor training models, matching of small-motor training models increased as did matching of small motor probe models never directly reinforced. This effect did not generalize to large-motor training and probe models or short-vocal training and probe models. This was the first demonstration of response-class formation within generalized imitation training with modeled responses of different types.

In 1993, Poulson et al., replicated this finding using motor-with-toy, motor-without-toy and vocal responses with infants. In 1994, Young, Krantz, McClannahan and Poulson, replicated the Garcia et al., study using toy-play, vocal responses, and pantomime with children with autism. All these studies used a multiple-baseline-across-responses design.

Other studies, in which multiple-baseline-across-responses designs have not been used, have also reported the generalization of imitation only among models of similar type, even without the differential reinforcement correlated with modeled responses of different types. Baer et al., 1967 had difficulty obtaining generalization of imitation to vocal imitation in previously non imitative children with mental retardation. And Steinman (1970a) reported that generalized imitation was more likely to occur within modeled responses of similar types, using hand and leg movements as models with children of typical development, when the reinforced and non reinforced models of similar types were presented concurrently. It was surmised that generalized imitation was obtained only within topographically similar modeled responses, and that response topography alone might define the boundaries of generalized imitation. One may consider the response types as functioning as discriminative for reinforcement, or as conditional discriminative stimuli, and therefore an increase in matching of the model types correlated with reinforcement would be expected.

With the demonstration of stimulus control using modeled-responses of different types, i.e. motor-with-toy and motor-without-toy, the question becomes, can this stimulus control be manipulated? If a property of the modeled responses correlated with reinforcement is changed, will imitative behavior change along with the new reinforcement contingencies, and will this lead to the formation of new response classes?.

The present study is similar to other generalized imitation studies in that it shows generalized imitation and response-class formation within each modeled response type in a multiple-baseline-across-responses design. It differs from other generalized imitation studies, however, in that it was an attempt to show two different instances of stimulus control and response-class formation established by using different properties of the same modeled responses, obtained as a result of two separate experiments with the same children and with the same modeled responses. The study was conducted with two normally developing infants and replicated with a normally developing six-year-old child.

Every modeled response has multiple properties that can be measured. Two of these properties are visibility and whether they involve the manipulation of objects (object-manipulation). These two response properties were selected for measurement and manipulation because of their special interest in the study of infant and child behavior. The visibility property (whether the response is within the field of vision of the person producing it or not) was chosen because Piaget (1962) strongly suggested that it was a variable influencing the probability of imitation by infants and children.

The property of object-manipulation was chosen because manipulation of objects (i.e. toys) by infants has been demonstrated to influence the probability of imitation by infants (McCall, Parke, & Kavanaugh, 1977; Poulson and Nunes, 1988; Poulson et al., 1993; and Young et al., 1994;). The Poulson et al., 1988, the Poulson et al., 1993, and the Young et al., 1994 studies have demonstrated generalized imitation using motor-with-toy and motor-without-toy (or pantomime), models.

Modeled responses can be said to be of similar type according to shared properties. Using the object-manipulation property, the modeled responses can be either motor-with-toy response types (those involving the manipulation of an object), or motor-without-toy response types (those involving only motor movement of limbs and face). Using the visibility property, modeled responses can be either visible response types (those within the field of the person producing them), or invisible response types (those outside the field of vision of the person producing them). These two properties simultaneously apply to each modeled response chose for the present study. For example: picking up a brush and running it over the top of one's head would be an invisible motor-with-toy responses; rubbing one's hand over the top of ones' head would be an invisible motor-without-toy responses; pushing a hammer across a desk would be a visible , motor-with-toy responses; and clasping one's hands together infant of one's torso would be a visible, motor-with-toy response. In addition, the modeled responses chosen were those judged that the children were capable of producing, but which they did not produce during pre-test sessions.

It was expected that stimulus control would be established in both Experiments 1 and 2. This would be accomplished by training a discrimination during each experiment between the two modeled response types (i.e. motor-with-toy and motor-without-toy, visible or invisible) in a sequential fashion according to one of the two modeled response properties, the object-manipulation property, or the visibility property. During Experiment 1, involving training according to the first modeled response property, it was expected that generalized imitation would be demonstrated within each modeled response type, and stimulus control would be demonstrated between the two modeled response types. In Experiment 2, involving training according to the second modeled response property, generalized imitation was expected to be demonstrated within each of the newly trained modeled response types, and stimulus control was expected to be demonstrated between the two modeled response types. Therefore, it was expected that the results of Experiment 1, training using the first modeled response property, would be replicated in Experiment 2 training using the second modeled response property.

Method

Subjects

The subjects of this study were three children of typical development. Two were infants, one boy and one girl, between the ages of 13 and 26 months, and one was a 6-year-old boy. The infants were Min and Winnie. Min was 13 months old at the beginning of the study and 18 months old at the completion of her participation. Winnie was 16 months old at the beginning of the study and 26 months old at the completion of his participation. The 6-year-old was a boy named Will. He was five years, 11 months at the beginning of his participation and six years, 3 months at the end.

All three children were tested with the Bayley Scales of Infant Development. Min and Winnie were tested during their participation in the present study, and Will had been tested five years prior to his participation in the present study. All three children scored within the normal range.

Setting and Apparatus

The study took place in an infant laboratory of a university psychology facility. The experimental room was furnished with a 51-cm tall infant high chair, a 60-cm tall table that served as a substitute for the high chair tray, and a chair for the experimenter to sit in, facing the high chair on the other side of the table. For the six-year-old boy, the high chair was replaced with a chair high enough to place the child at the same height as the infants. Both experimenter and child were videotaped with two tripod-mounted color video cameras (Panasonic model WV-3260/8AF). The camera filming the child stood 270 cm from the child's face and was located behind and to the left of the experimenter. The camera filming the experimenter stood 180 cm from the experimenter's face and was located behind and to the left of the child. Both cameras were connected to a special effects generator (Panasonic model WJ-3500) that served as a system switcher. This allowed for a vertically split image to be recorded from a television monitor (Panasonic model CTJ-2062R) to a video cassette recorder (Panasonic model AG1820), that enabled both visual and auditory information from both the experimenter's and children's behavior to be incorporated in the scoring by two independent observers.

Stimulus Materials.

The stimuli presented to the children were a total of 18 motor models as shown in Tables 1 through 3. The stimuli involved either movement with an object or movement without an object. These motor models were grouped according to two modeled response properties, either the object-manipulation property or the visibility property, and were age appropriate responses chosen separately for the two age groups. According to the object-manipulation property, the 18 models were divided into two types: nine were those involving the manipulation of an object, referred to as motor-with-toy models (MWT); and nine were those involving the movement of body parts, referred to as motor-without-toy models (MW/OT). Examples of motor-with-toy models were placing a small doll into a small tub or placing a small car on one's temple. Examples of motor-without-toy models were rubbing the top of one's head with one's hand or waving bye-bye with hand held upright. According to the visibility property, the 18 models were again divided into two

Table 1 Description of all the models presented to Min and their corresponding property.

Models used for Min	Object-manipulation	Visibility
Place spoon in cup and stir	Motor with toy	Visible
Touch Big Bird to ear	Motor with toy	Invisible
Wipe chin with washcloth	Motor with toy	Invisible
Stroke hair with brush	Motor with toy	Invisible
Put doll in tub and take out	Motor with toy	Visible
Open book and close again	Motor with toy	Visible
Touch car to temple	Motor with toy	Invisible
Bang hammer on table twice	Motor with toy	Visible
Place Mega blocks on top of each other	Motor with toy	Visible
Smile	Motor without toy	Invisible
Nod head	Motor without toy	Invisible
Wave bye-bye with hand held upright	Motor without toy	Visible
Clasp hands together intertwining fingers	Motor without toy	Visible
Touch top of one hand with other hand	Motor without toy	Visible
Lean head from side to side	Motor without toy	Invisible
Rub top of head with hand	Motor without toy	Invisible
Open and close hand	Motor without toy	Visible
Blink	Motor without toy	Invisible

Table 2 A description of all the models presented to Will, the six-year old, and their corresponding property.

Models used for Will	Object-manipulation	Visibility
Shuffle card deck	Motor with toy	Visible
Create paper fan	Motor with toy	Visible
Tie shoe lace	Motor with toy	Visible
Tie kerchief on top of head	Motor with toy	Invisible
Put ponytail holder in hair	Motor with toy	Invisible
One crochet point	Motor with toy	Visible
Braid doll's hair	Motor with toy	Visible
Put on tie	Motor with toy	Invisible
Put pencil behind ear	Motor with toy	Invisible
Make peace sign above head with hand	Motor without toy	Invisible
Touch fingers to each other consecutively	Motor without toy	Visible
Wink with both eyes, one at a time	Motor without toy	Invisible
Create "church & steeple" with hands	Motor without toy	Visible
Snap fingers	Motor without toy	Visible
Touch both shoulders with opposite hands	Motor without toy	Invisible
Clasp hands together over head	Motor without toy	Invisible
"Patty Kate" moves	Motor without toy	Visible
Walk two fingers over length of head	Motor without toy	Invisible

Table 3 Description of all the models presented to Winnie and their corresponding property.

Models used for Winnie	Object-manipulation	Visibility
Cup and spoon	Motor with toy	Visible
Touch Big Bird to ear	Motor with toy	Invisible
Wipe chin with washcloth	Motor with toy	Invisible
Stroke hair with brush	Motor with toy	Invisible
Push doll and tub together	Motor with toy	Visible
Open book and put upside down	Motor with toy	Visible
Touch car to temple	Motor with toy	Invisible
Push hammer across table	Motor with toy	Visible
Place Mega blocks on top of each other	Motor with toy	Visible
Smile	Motor without toy	Invisible
Nod head	Motor without toy	Invisible
Wave bye-bye with hand held upright	Motor without toy	Visible
Clasp hands together intertwining fingers	Motor without toy	Visible
Touch top of one hand with other hand	Motor without toy	Visible
Lean head from side to side	Motor without toy	Invisible
Rub top of head with hand	Motor without toy	Invisible
Open and close hand	Motor without toy	Visible
Blink	Motor without toy	Invisible

types: nine were those within the field of vision of the person producing them, referred to as visible models (VIS); and nine were those outside of the field of vision of the person producing them, referred to as invisible models (INV). Examples of visible models were placing a small doll into a small tub or waving bye-bye with hand held upright. Examples of invisible models were placing a small car on one's temple or rubbing the top of one's head with one's hand. Correspondingly, the children's responses to these various types of models were referred to as motor-with-toy responses, motor-without-toy responses, visible responses, and invisible responses.

Within each of the modeled response types and for each child individually, six models were assigned to be training models, which were associated with the delivery of a reinforcer (social event) during a reinforcement procedure to be described later, and three models were chosen to be probe models, not associated with reinforcement. This assignment was made according to the following rules: (a) the training and probe models remained as such throughout all phases of the experiment; (b) The actions and toys involved in the training and probe models were chosen to be similar in terms of difficulty level; (c) according to the object-manipulation property, the six motor-with-toy training models consisted of three that were visible, and three that were invisible, and the same was true for motor-without-toy training models; (d) the motor-with-toy probe models consisted of one invisible and two visible models, and the motor-without-toy probe models consisted of two invisible and one visible model; (e) according to the visibility property, the six visible training models consisted of three that were motor-with-toy, and three that were motor-without-toy, and the same was true for invisible models; and (f) also according to the visibility property, the visible probe models consisted of two motor-with-toy and one-motor-without toy models, and the invisible probe models consisted of one motor-with-toy and two motor-without-toy models. See Tables 1 through 3 for a list of all the modeled responses used, and which properties they possessed, for all three children.

The assignment of models to training or probe status for the two infants was counterbalanced across infants to control for difficulty level of all responses. In addition, the ordering of the training using each modeled response property in both Experiments 1 and 2 was counterbalanced across the two infants.

All models were presented according to a controlled randomization schedule: No probe models appeared in the first two or last two presentation positions; no two consecutive model presentation were probe models; and a maximum of two presentations of the same type of model occurred consecutively.

Data Analysis

Data were collected and reported for responses to models according to the modeled response property being used for training, as well as the responses to models according to the modeled response property not being used for training, during every session of both experiments 1 and 2. This was done to assess whether there was any systematic effect of the experimental conditions on both the responses to models grouped according to either modeled response property. All the graphs are comprised of a unshaded portion and a shaded portion. The unshaded portions of the graphs represent the effects of the experimental manipulations on matching of response types according to the modeled response property targeted for reinforcement. The shaded portions represent the monitoring of the effects of the experimental procedures on matching responses according to the modeled response property not targeted for reinforcement.

In addition to recording matches of modeled responses, non-matching behavior following all models was also recorded in order to assess whether the child produced any responses following each model, for example, whether the child manipulated the toys in any fashion following their presentation.

In the beginning of Experiment 1, both the infants engaged in uncooperative behavior that led to many sessions being canceled. In fact, Min was not brought into the laboratory for a two week period during the reinforcement condition of Experiment 1 because her behavior was too disruptive. And following this two week period, five consecutive session were conducted without any modeling. These sessions focused delivering reinforcement for entering the experimental room, sitting and looking at the experimenter. With Winnie, the initiation of Experiment 1 had to be postponed for three months because he was fussy and uncooperative in the experimental room. Uncooperative behavior was defined as kicking the table; standing up in the chair; turning away from the experimenter; and/or sliding down in the chair.

During the course of both experiments with the two infants, several sessions had to be terminated because the child was crying or upset. No session was ever terminated for Will, the six-year-old boy. The distribution of terminated sessions for Min and Winnie are represented in Tables 4 and 5. There was a higher percentage of terminated sessions during the modeling alone baseline condition, when the infants were first learning to sit quietly and look at the experimenter. No systematic differences were found between reinforcement and DRO sessions of any type; or between modeled response types.

Dependent Variables

The dependent variables measured here were matching of the models produced by the experimenter, represented in Tables 1 through 3. A match was a response that was identical to the modeled response, or that was a close approximation, the requirements for which were predetermined. For example, for the model that involved placing a three prong Mega Block on top of a four prong Mega Block in parallel fashion, the components required for an approximation were that the blocks be connected in parallel fashion and that the prongs of the bottom block be inserted into the holes of the top block by at least one centimeter. Some of the models such as the blink and the smile had no approximations (For more details about each model and the requirements for matches and approximations see Appendix A).

Interobserver Agreement

Two observers scored all the video taped sessions during both Experiments 1and 2 for all three children. Reliability measures were taken for matching responses throughout all the experimental sessions by using the point-by-point agreement method that consists of the following calculation: (number of agreements/ (agreements + disagreements)) x 100 (Kazdin, 1982). One of the observers was the experimenter, and the other was a person

Table 4 Percentage of sessions terminated during each experimental condition for Min, during both Experiments.

	Experiment 1				Experiment 2	
	MAB	Reinforcement	DRO-6	DRO-0	DRO-0	Reinforcement
MWT	14%	5%	0%	5%		
MW/OT	10%	3%	0%	9%		
INV					8%	3%
VIS					3%	6%

MAB = Modeling alone Baseline condition

DRO-6 = DRO 6 seconds
DRO-0 = DRO 0 seconds

MWT = Motor-with-toy responses
MW/OT = Motor-without-toy responses

VIS = Visible responses
INV = Invisible responses

RF = Reinforcement for matching

Table 5 Percentage of sessions terminated during each experimental condition for Winnie, during both Experiments.

	Experiment 1				Experiment 2	
	MAB	DRO-0	Reinforcement	DRO-0	DRO-0	Reinforcement
VIS	33%	18%	2%	6%		
INV	33%	5%	12%	0%		
MW/OT					0%	0%
MWT					0%	0%

MAB = Modeling alone Baseline condition

DRO-6 = DRO 6 seconds

DRO-0 = DRO 0 seconds

MWT = Motor-with-toy responses

MW/OT = Motor-without-toy responses

VIS = Visible responses

INV = Invisible responses

RF = Reinforcement for matching

who did not participate in the planning or conduction of the experimental procedures. This second observer has a B.S. in computer science and had taken psychology courses including one graduate course in learning. The range of values of interobserver agreement on matching responses for all three children across all experimental conditions was found to be as follows: For Min between 96% and 100%; for Will between 98% and 100%; and for Winnie between 95% and 100% (For more information see Table B1 in Appendix B).

Independent Variable

During all reinforcement procedures there was a presentation of social praise consisting of statements such as, "Good playing," "Good sitting," "Very good," and "Wonderful," for all the children. Puppets and edibles were presented to the infants; and tokens that could be exchanged for a variety of toys were presented to the six year old. These reinforcers were referred to as a social event and were presented contingently upon all matching of training models during the reinforcement procedures, and immediately after training models during the DRO procedures.

Procedural Reliability

Correct modeling and reinforcer delivery by the experimenter during all the experimental sessions was scored by the same two independent observers described above. Again the point-by-point agreement method (Kazdin, 1982) was calculated to obtain interobserver agreement on correct modeling and reinforcer delivery.

The reliability scores indicated that modeling by the experimenter occurred correctly throughout all the experimental conditions for all three children. This resulted because any incorrect modeling (incorrect action, or modeling while the child was looking away) was immediately terminated and followed by correct modeling after instructing the child to watch. Procedural reliability on correct modeling by the experimenter was found to be 100% during all experimental conditions for all three children (For more details see Tables B2 through B4 in Appendix B).

Procedural reliability on correct versus incorrect reinforcer delivery by the experimenter was also found to be 100% during all experimental conditions for all three children. Delivery of reinforcement was not correct, however, during every trial. Throughout all the experimental conditions, durng some trials reinforcement was delivered or omitted inappropriately. The range of values for correct reinforcer delivery, across experimental conditions, for the three children were found to be as follows: Between 95% and 100% for Min; between 96% and 100% for Will; and between 95% and 100% for Winnie (For more details see Tables B2 to B4 in Appendix B).

General Procedure

The parents brought the children to the Infant and Child Laboratory located at Queens College of the City University of New York. Upon arrival to the laboratory each day, the children remained in a reception area until they seemed comfortable in the laboratory environment (e.g. were fed, dry and alert). At this point, the infants were brought into the experimental room by the experimenter, and placed into a high chair. The six-year-old was escorted into the experimental room by the experimenter. The experimenter was seated in a chair across the table from the child.

Each child was presented with a series of trials. A trial consisted of the following: The experimenter said the child's name followed by "look at me." Once the child was making eye contact, the experimenter said "Watch what I do" and then modeled the motor response. No response was modeled unless the child was watching what the experimenter was doing. After modeling, the experimenter said to the child "Now you do that." In the case of models involving toy manipulation, the experimenter placed each toy in front of the child according to a pre-determined format (See Appendix A for more details). A six second period followed the modeling of each response at the completion of which a new trial was begun. Upon initiation of the response, many of the motor-with-toy responses involving two component toys were allotted additional time to be completed (See Appendix A for details).

If during the model presentation the child looked away, the experimenter said "look at me", and when the child was again looking at the experimenter, the model was repeated. Sometimes, with the infants, the looking behavior was reinforced prior to the repetition of the model. This was done to ensure that the child watched the entire model presentation. In addition, if the experimenter began to model a response incorrectly, this incorrect presentation was terminated as a "watch me again" instruction was followed by the correct modeling. This was to ensure that no changes in modeling of any responses occurred.

There were two types of trials, training and probe. Training trials were associated with reinforcement during the reinforcement conditions of both experiments 1 and 2, and with a DRO 0-second procedure during the DRO condition of experiments 1 and 2. Probe trials were never presented with reinforcement or a DRO 0-second procedure. Within the reinforcement conditions, during the training trials, if a matching response occurred or was initiated during the six seconds following the model, a social event was presented; and during the DRO 0-second conditions, the training consisted of a model followed by a social event provided no matching response occurred. If a matching response occurred, then the social event for that trial was canceled. If the matching response occurred simultaneously with the reinforcer delivery, the reinforcer delivery was terminated. Throughout all of the experimental conditions, the probe trials remained unchanged. They consisted of the model followed by a six second period, followed by the beginning of the next trial whether a matching response occurred or not. There were six training trials and three probe trials (a total of nine trials) in each modeled response type, all of which were presented once per session.

A session consisted of a presentation of all models from both modeled response types being measured, a total of 18 trials. The children were exposed to one or two sessions per day. Each session throughout both experiments 1, and 2 was independently recorded using a video-tape recorder to enable later scoring by two observers.

Throughout each experimental session in both experiments 1 and 2, a social event was presented contingent upon attending responses such as sitting up, eye contact, and cooperative play in an attempt to reinforce these responses. Each session lasted between

15 and 30 minutes.

Procedure

Experiment 1 consisted of the following experimental conditions, listed in the order in which they were presented (A description of each condition follows): a modeling alone baseline condition; a DRO 0-second procedure presented during all the training trials of both modeled response types (Will and Winnie only); a reinforcement procedure introduced in a sequential fashion across the two response types; a DRO 6-second procedure introduced for only one response type (Min only); and a DRO 0-second procedure implemented sequentially across the two response types.

Experiment 2 consisted of the following experimental conditions, described in the order in which they were presented: a DRO 0-second procedure presented during all the training trials of both response types; and a reinforcement procedure implemented sequentially for each of the two response types according to the second modeled response property. Before the initiation of Experiment 1, all three children were exposed to a no modeling pre-baseline condition.

No Modeling Pre-baseline. Before the baseline data were collected, the experimenter sat in the chair opposite the child and played with the child using age appropriate toys that were then used in the experimental sessions. This was done to assess whether any of the children had difficulty manipulating any of the toys to be used in the experimental sessions. If a difficulty was encountered, then the toy was replaced with a similar one the child could manipulate. In addition, if the child engaged in behavior that resembled the targeted model for that particular toy, then the action associated with that toy was changed to one in which that child did not engage.

During these pre-baseline sessions, the experimenter presented a social event contingent upon sitting behavior, eye contact, and cooperative play in an attempt to reinforce these responses.

Modeling Alone Baseline condition. During Experiment 1, a baseline measure of responses to models was obtained for all children to assess their operant level of matches of these models. Each child was exposed to complete sessions without contingent reinforcer delivery for matching of any models. Each trial consisted of a presentation of the model followed by the instruction "now you do that". The instruction was followed by a six second period at the end of which the next trial was begun.

DRO 0-second condition. During this procedure, the training models and the instruction "Now you do that" were immediately followed by a social event. The next trial began six seconds after the instruction. If a match began to occur while the model was being presented, or immediately after the model was presented, but before the social event could be, the social event for that trial was canceled. In addition, if the matching response occurred, or began to occur during the delivery of the social event, the delivery of the social event was terminated. This negative contingency was included to ensure that no adventitious reinforcement occurred for matching responses. The presentation of the probe trials during the DRO procedure remained the same as during the modeling alone baseline procedure.

The DRO procedure was implemented for several reasons. First of all, the purpose of the DRO procedure was to determine whether the reinforcement contingencies established during the reinforcement procedure were still operative. Second, to see whether the same response classes would be demonstrated under the change in contingency relations. And third, at the end of the DRO condition, matching of any models would no longer be reinforced, and thus, this condition would provide a baseline that would be easily discriminable from the subsequent reinforcement condition at the beginning of Experiment 2.

Reinforcement condition. The reinforcement procedure consisted of a presentation of the social event contingent upon matching of training models. During Experiment 1, the training models were targeted for reinforcement according to the first modeled response property (the object-manipulation property for Min and Will, and the visibility property for Winnie). During Experiment 2, the training models were targeted for reinforcement according to the second modeled response property (The visibility property for Min and Will and the object-manipulation property for Winnie). Each trial, during this condition, consisted of a presentation of the model followed by the instruction "now you do that". The instruction was followed by a six second period during which if the child produced a matching response, reinforcement in the form of a social event was immediately presented.

Experimental Design.

Each child was exposed to two experiments, each consisting of training with one property of the modeled responses. The conditions in Experiments 1 and 2 were presented according to a multiple-baseline-across-responses experimental design. This was to analyze the effects of reinforcement on training and probe models, and the formation of response classes during Experiments 1 and 2.

Throughout both Experiments 1 and 2, for all three children, the presentation of the probe trials remained unchanged. The different experimental conditions were applied to the training trials only.

Experiment 1 for Min, consisted of training with modeled responses according to the object-manipulation property (motor-with-toy and motor-without-toy). Min was exposed to the following experimental conditions (See Table 6). A modeling alone baseline condition, followed by a reinforcement condition introduced in a sequential fashion for matching of motor-with-toy and motor-without-toy training models. Reinforcement was introduced for matching of motor-with-toy training models while motor-without-toy training models continued to be presented as in the modeling alone baseline condition. When matching of the motor-with-toy training and probe models was occurring at 33% or above for at least 5 consecutive sessions, reinforcement was introduced for matching of motor-without-toy training models as well. This reinforcement condition was followed by a DRO 6-second condition introduced only during motor-with-toy training trials. This condition was terminated, and never introduced during motor-without-toy training trials because during this DRO 6-second procedure, Min became fussy, was crying and kept repeating the previously reinforced matching responses. In

Table 6 All experimental conditions presented to Min, during both Experiments.

Min	Experiment 1					Experiment 2		
MWT	MAB	RF	DRO-6	DRO-0	DRO-0	DRO-0	Monitoring only	
Sessions	1-6	7-37	38-43	44-62		53-62	63-100	
MW/OT	MAB	RF	RF	RF	DRO-0	DRO-0	Monitoring only	
Sessions	1-19	20-52				52-62	63-100	
INV	Monitoring only					DRO-0	RF	RF
Sessions	1-52					53-62	63-100	
VIS	Monitoring only					DRO-0	DRO-0	RF
Sessions	1-52					53-84		85-100

MAB = Modeling alone Baseline condition

DRO-6 = DRO 6 seconds

DRO-0 = DRO 0 seconds

MWT = Motor-with-toy responses

MW/OT = Motor-without-toy responses

VIS = Visible responses

INV = Invisible responses

RF = Reinforcement for matching

addition, the DRO 6-second procedure was not effective in decreasing matching responses.

For these reasons, the DRO 6-second procedure was changed to a DRO 0-second procedure, which has been shown to be effective in decreasing matching responses (Burgess, Burgess, & Esveldt, 1970). With the DRO 0-second procedure, reinforcement was presented immediately following the model, and prior to the child's having an opportunity to respond, therefore creating a discriminable difference between these trials and reinforcement trials independently of the child's responding.

This DRO 0-second condition was implemented in a sequential fashion during motor-with-toy and motor-without-toy training trials only. The portion of the DRO 0-second condition where all the training trials were presented with a DRO 0-second procedure, sessions 53 to 62, served as a baseline for Experiment 2.

Experiment 2 for Min consisted of training the same modeled responses now according the visibility property (invisible responses and visible responses). Following the low levels of all matching responses during the DRO 0-second condition (sessions 53 to 62), a reinforcement condition was implemented for matching of invisible training models, while the visible training models continued to be presented with a DRO 0-second procedure. When matching of invisible training and probe models was occurring at 50% or above for at least 5 consecutive sessions, reinforcement was introduced for matching of visible training models as well.

Experiment 1 for Will also consisted training according to the object-manipulation property (motor-with-toy and motor-without-toy). Will was presented with the following experimental conditions (see Table 7). The modeling alone baseline condition was introduced first, followed by a DRO 0-second condition. During this DRO 0-second condition, a DRO 0-second procedure was implemented during the motor-with-toy and motor-without toy training trials only.

Min was not exposed to a DRO condition following the modeling alone baseline condition because she was the first infant to participate and the decision to implement this condition was based upon her data. Following Min's participation, it was decided that to better compare the results of experiments 1 and 2, a DRO 0-second procedure should be presented prior to the reinforcement condition in Experiment 1, as was the case during Experiment 2.

Once a stable baseline measure of responding was obtained during both the modeling alone baseline condition and DRO condition, a reinforcement condition was presented. During this reinforcement condition, reinforcement was implemented in a sequential fashion for matching of motor-with-toy and motor-without-toy training models. Reinforcement was introduced for matching of motor-with-toy training models, while the motor-without-toy training trials continued to be presented with a DRO 0-second procedure When matching of motor-with-toy training and probe models was occurring at 50% or above for at least 5 consecutive sessions, reinforcement was introduced for matching of motor-without-toy training models as well. This reinforcement condition was followed by a DRO 0-second condition during which a DRO 0-second procedure was

Table 7. All experimental conditions presented to Will during both experiments.

Will	Experiment 1					Experiment 2		
MWT	MAB	DRO-0	RF	RF	DRO-0	DRO-0	Monitoring only	
Sessions	1-7	8-17	18-23	24-43	44-52	52-59	60-74	
MW/OT	MAB	DRO-0	DRO-0	RF	RF	DRO-0	Monitoring only	
Sessions	1-7	8-17	18-23	24-43	44-52	52-59	60-74	
INV	Monitoring only					DRO-0	RF	RF
Sessions	1-52					52-59	60-68	69-74
VIS	Monitoring only					DRO-0	DRO-0	RF
Sessions	1-52					52-59	60-68	69-74

MAB = Modeling alone Baseline condition

DRO-6 = DRO 6 seconds

DRO-0 = DRO 0 seconds

MWT = Motor-with-toy responses

MW/OT = Motor-without-toy responses

VIS = Visible responses

INV = Invisible responses

RF = Reinforcement for matching

implemented in a sequential fashion for motor-with-toy and motor-without-toy training trials. Once a decrease was obtained for matching of all models, Experiment 2 was begun. The section of the DRO 0-second condition when all training models were being presented with a DRO 0-second procedure, sessions 52 to 54, served as a baseline for Experiment 2.

Experiment 2 for Will consisted of training with the same modeled responses now according to the visibility property (invisible responses and visible responses). Following the very low percentage of matching of all invisible and visible models during the DRO 0-second procedure (sessions 51 to 54) which served as a baseline, a reinforcement condition was implemented in a sequential fashion for matching of invisible and visible training models. Reinforcement was presented for matching of invisible training models while the visible training trials continued to be presented with the DRO procedure. When matching of the invisible training models was occurring at 50% or above for at least 5 consecutive sessions, reinforcement was introduced for matching of visible training models.

Winnie was presented with a different ordering of the two modeled response properties correlated with reinforcement during both Experiment 1 and 2. Experiment 1 for Winnie consisted of training with modeled responses according to the visibility property (visible and invisible) of the modeled responses. Winnie was exposed to the following experimental conditions (See Table 8). A modeling alone baseline condition was followed by a DRO-0-second condition, presented during visible and invisible training trials only. Once a stable measure of responding was obtained during both the modeling alone baseline condition and the DRO condition, a reinforcement condition was introduced in which reinforcement was presented in a sequential fashion for matching of visible and invisible training models. Reinforcement was presented for matching of visible training models while the invisible training trials continued to be presented with the DRO procedure. When matching of the visible training and probe models was occurring at 50% or above for at least 5 consecutive sessions, reinforcement was introduced for matching of invisible training models as well. This reinforcement condition was followed by a DRO 0-second condition implemented in a sequential fashion during visible and invisible training trials only. The portion of the DRO 0-second condition when all the training trials were being presented with a DRO 0-second procedure, sessions 49 to 52, served as a baseline for Experiment 2.

Experiment 2 for Winnie consisted of training according the object-manipulation property (motor-without-toy and motor-with-toy responses). Following the low levels of all matching responses during the DRO 0-second condition (sessions 49 to 52) which served as a baseline, a reinforcement condition was implemented for in a sequential fashion for matching of motor-without-toy and motor-with-toy training models. Reinforcement was presented for matching of motor-without-toy training models while the motor-with-toy training trials continued to be presented with the DRO procedure. When matching of motor-without-toy training models was occurring at 50% or above for at least 5 consecutive sessions, reinforcement was introduced for matching of motor-with-toy training models as well.

Table 8. All experimental conditions presented to Winnie during both experiments.

Winnie	Experiment 1					Experiment 2		
VIS	MAB	DRO-0	RF	RF	DRO-0	DRO-0	Monitoring only	
Sessions	1-6	7-11	12-25	26-36	37-48	49-52	52-70	
INV	MAB	DRO-0	DRO-0	RF	RF	DRO-0	Monitoring only	
Sessions	1-6	7-11	12-25	26-36	37-48	49-52	52-70	
MW/OT	Monitoring only					DRO-0	RF	RF
Sessions	1-48					49-52	53-61	62-70
MWT	Monitoring only					DRO-0	DRO-0	RF
Sessions	1-48					49-52	53-61	62-70

MAB = Modeling alone Baseline condition

DRO-6 = DRO 6 seconds

DRO-0 = DRO 0 seconds

MWT = Motor-with-toy responses

MW/OT = Motor-without-toy responses

VIS = Visible responses

INV = Invisible responses

RF = Reinforcement for matching

Results and Discussion

During Experiment 1 for all three children, the sequential implementation of reinforcement for imitation of the training models of both response types according to one of the two modeled response properties produced a systematic increase in imitation of these training models. This finding indicates that imitation of the training models was under the stimulus control of modeled response property. In addition, a systematic increase in imitation of the probe models of each response type was obtained along with the training models of similar type, providing a demonstration of generalized imitation within each response type of the modeled response property targeted for reinforcement. This finding also indicates that there was a clear discrimination between the probe models of the two response types, indicating that two response classes were formed according to the modeled response property targeted for reinforcement.

The DRO procedure, implemented during the training trials only, resulted in a decrease in matching of the training models as well as in a corresponding decrease in matching of the probe models of similar type. This finding indicates that the response classes established for each of the two modeled response properties targeted for reinforcement, during the reinforcement condition were maintained during the DRO 0-second condition.

During Experiment 2, the second modeled response property of the same modeled responses was targeted for reinforcement. The sequential implementation of reinforcement for each of the two response types according to this second modeled response property resulted in a systematic increase in imitation of these training models. These results indicate that responding during Experiment 2 had come under the control of the new reinforcement contingencies established according to the second modeled response property without interference of prior training according to the first modeled response property.

In addition, as with Experiment 1, the systematic increase in imitation of the training models for each response type was accompanied by a systematic increase in imitation of the probe models of similar type, even though imitation of these probe models was never reinforced. This result indicates that generalized imitation occurred within each response type according to the second modeled response property targeted for reinforcement. Also, the discrimination demonstrated between the probe models of these two response types indicates the formation of two new response classes formed according to the second modeled response property targeted for reinforcement.

The results for each of the children will be presented separately.

The Results Obtained with Min

Figures 1 and 2 represent the results of Experiments 1 and 2, respectively, for the infant girl, Min. Experiment 1 concerns the effects of differential reinforcement on matching of models according the object-manipulation property, and Experiment 2 concerns the effects of differential reinforcement on matching of models according to the visibility property. Figure 1 represents the percentage of trials during which Min matched motor-with-toy models (top graph) and motor-without-toy models (bottom graph), across

Figure Caption

Figure 1 This figure represents Min's data for both motor-with-toy and motor-without-toy response types. The unshaded portion of the top graph represents the percentage of both motor-with-toy training and probe trials with a match throughout all experimental conditions of Experiment 1, training according to the object-manipulation property. The shaded portion of the top graph represents monitored matching of motor-with-toy training and probe models during Experiment 2, training according to the visibility property. The unshaded portion of the bottom graph represents the percentage of both motor-without-toy training and probe trials with a match throughout all experimental conditions of Experiment 1. The shaded portion of the bottom graph represents monitored matching of motor-without-toy training and probe models during Experiment 2.

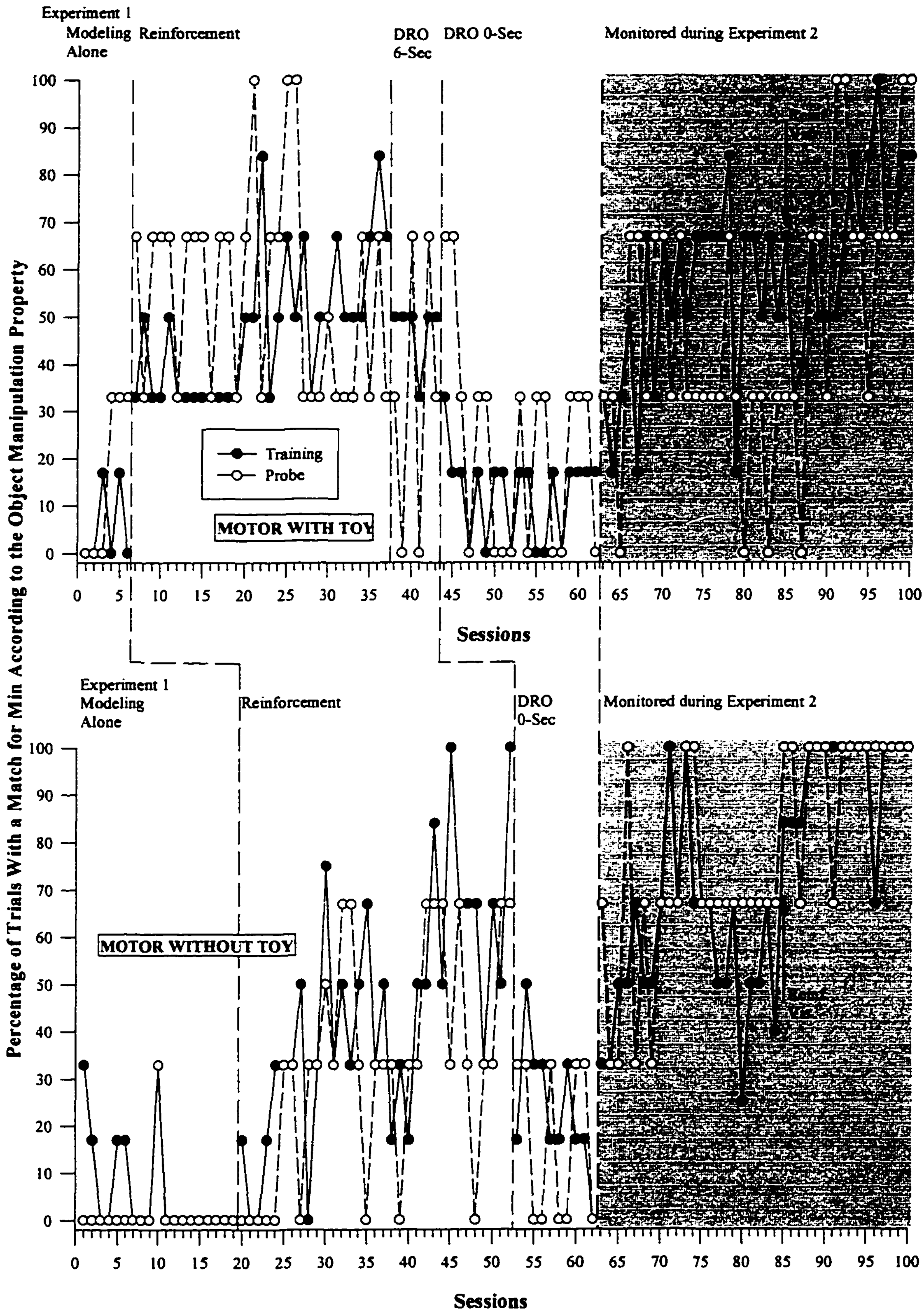
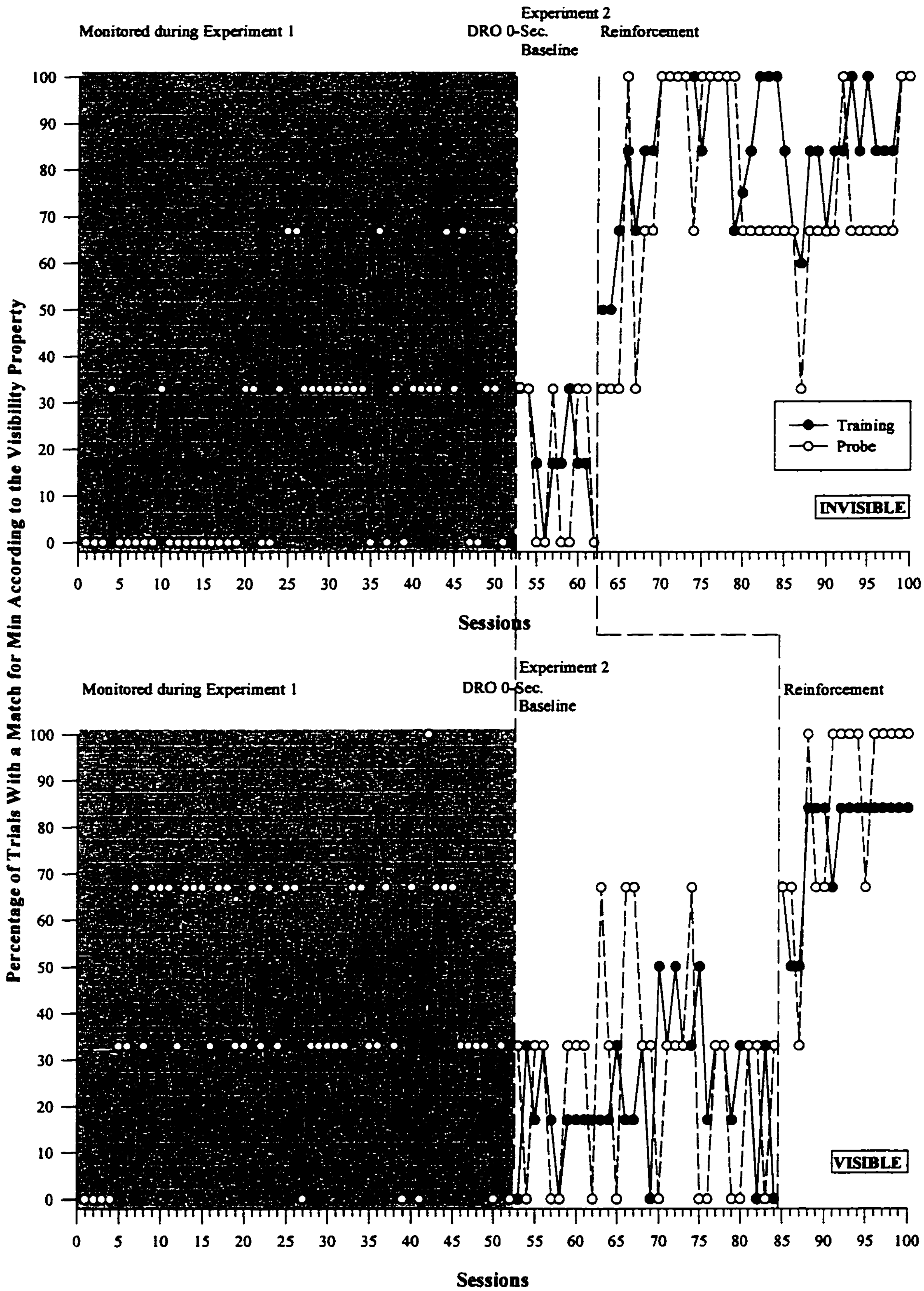

Experiment 1
Modeling Alone
Reinforcement
DRO 6-Sec
DRO 0-Sec
Monitored during Experiment 2
Training
Probe
MOTOR WITH TOY
Percentage of Trials With a Match for Min According to the Object Manipulation Property
Sessions
Experiment 1
Modeling Alone
Reinforcement
DRO 0-Sec
Monitored during Experiment 2
MOTOR WITHOUT TOY
Sessions

Figure Caption

Figure 2 This figure represents Min's data for invisible and visible response types. The unshaded portion of the top graph represents the percentage of both invisible training and probe trials with a match throughout Experiment 2, training according to the visibility property. The shaded portion of the top graph represents monitored matching of invisible training and probe models during Experiment 1, training according to the object-manipulation property. The shaded portion of the bottom graph represents the percentage of both visible training and probe trials with a match throughout Experiment 2. The shaded portion of the bottom graph represents monitored matching of visible training and probe models during Experiment 1.


Experiment 2
Monitored during Experiment 1
DRO 0-Sec. Baseline
Reinforcement
Percentage of Trials With a Match for Min According to the Visibility Property
Training
Probe
INVISIBLE
Sessions
Experiment 2
Monitored during Experiment 1
DRO 0-Sec. Baseline
Reinforcement
VISIBLE
Sessions

sessions. The filled circles represent training trials, and the unfilled circles represent probe trials.

After Experiment 1 was completed, we continued to monitor matching of modeled responses according to the object-manipulation property. Those data, monitored during Experiment 2, are represented in the shaded portions of Figure 1.

Figure 2 represents the percentage of trials during which Min matched invisible models (top graph) and visible models (bottom graph), across sessions. Again, the filled circles represent training trials and the unfilled circles represent probe trials. The shaded portion of Figure 2 represents the same data reported for Experiment 1. The difference is that this data represents the monitoring of matching of modeled responses according to the visibility property. To facilitate communication, the results in the shaded portions of all the figures for Min as well as the other two children will be described last.

Unshaded portion of Figures 1 and 2. With respect to Experiment 1 (Figure 1), the first experimental condition represented was the modeling alone baseline condition. During the modeling alone baseline condition, the percentage of training trials (filled circles) with a match was at low levels, between 0% and 33%, for both motor-with-toy and motor-without-toy (top and bottom graphs).

The data in the top graph of Figure 1 (filled circles) indicate that when reinforcement was introduced (at the dashed vertical line) for matching of motor-with-toy training models, the percentage of trials with a match increased above baseline levels to between 67% and 84%. From the bottom graph in Figure 1 (filled circles), it can be determined that there was no such increase in matching of motor-without-toy training models during the modeling alone baseline condition. When reinforcement was introduced for matching of motor-without-toy training models however, the percentage of motor-without-toy training trials with a match increased above baseline levels to 100%. The sequential implementation of reinforcement for imitation of training models for motor-with-toy and motor-without-toy response types produced a systematic increase in imitation of these response types, indicating that imitation of training models according to the object-manipulation property (motor-with-toy and motor-without-toy) was under the control of the reinforcement contingencies.

Concerning performance during the probe trials (unfilled circles), from the top graph in Figure 1, modeling alone baseline condition, it can be determined that the percentage of motor-with-toy probe trials (unfilled circles) with a match was at low levels, between 0% and 33%. From the bottom graph in Figure 1, it can be seen that the percentage of motor-without-toy probe trials (unfilled circles) with a match was also between 0% and 33%.

From the top graph of Figure 1, it can be seen that when reinforcement was introduced for matching of motor-with-toy training models (filled circles), matching of motor-with-toy probe models (unfilled circles), which was never reinforced, also increased over baseline levels to between 67% and 100% levels. From the bottom graph of Figure 1 it can be determined that responding during the motor-without-toy probe trials (unfilled circles) was not affected by the introduction of reinforcement for matching of motor-with-toy training models. Once reinforcement was introduced for matching of motor-without-toy training models, however, an increase in matching of motor-without-toy probe models was obtained. Matching of motor-without-toy probe models increased to a maximum value of 67%, even though matching of these models was never reinforced. The systematic increase in imitation of the probe models along with the training models indicates generalization from imitation training during training trials to imitation during nonreinforced probe trials. Thus, these results are a demonstration of generalized imitation within motor-with-toy and also within motor-without-toy responses.

In additicn, because there was a clear discrimination between motor-with-toy probe trials (top graph) and motor-without-toy probe trials (bottom graph), it was conclude that two response classes according to the object-manipulation property were formed: a motor-with-toy class of generalized imitation; and a motor-without-toy class of generalized imitation.

A DRO 6-second procedure was introduced after 37 sessions as a further test of the continued effectiveness of the reinforcers. With respect to the introduction of the DRO 6-second procedure during the motor-with-toy training trials, the data in the top graph of Figure 1 indicate that this procedure failed to produce a substantial decrease in the percentage of motor-with-toy training or motor-with-toy probe trials with a match. Furthermore, the infant became fussy, was crying and kept repeating the imitative responses that had been reinforced during the reinforcement condition. For these reasons, the DRO 6-second procedure was changed to a DRO 0-second procedure.

The filled circles in the top graph of Figure 1 indicate that with the introduction of the DRO 0-second procedure during motor-with-toy training trials, the percentage of motor-with-toy training trials with a match decreased to baseline levels, between 0% and 17%. The filled circles in the bottom graph of Figure 1 indicate that the DRO 0-second procedure implemented for motor-with-toy training models did not produce a similar decrease in the percentage of motor-without-toy training trials with a match, until it was implemented during motor-without-toy training trials as well. With the introduction of the DRO 0-second procedure, the percentage of motor-without-toy training trials with a match also decreased to baseline levels, between 0% and 33%. These results indicate that the systematic decrease in matching of motor-with-toy and motor-without-toy training models was the result of the change in the reinforcement contingencies. That is, the DRO 0-second procedure was effective in reducing matching during training trials.

Concerning performance during the probe trials, the unfilled circles in both graphs indicate that there was also a systematic decrease in the percentage of motor-with-toy and motor-without-toy probe trials with a match, to between 0% and 33%. This decrease was a result of the DRO 0-second procedure having been applied to the training trials alone.

The implementation of the DRO 0-second procedure during motor-with-toy training trials produced a decrease in imitation of motor-with-toy training and probe models. No such decrease was obtained for imitation of motor-without-toy probe models until the DRO 0-second procedure was introduced during motor-without-toy training trials, at which point matching of motor-without-toy probe trials also decreased. This indicates that the response classes established according to the object-manipulation property during the reinforcement condition were maintained during the DRO 0-second condition.

The results of Experiment 2 for Min are represented in Figure 2 starting with session 53. The top graph represents the percentage of matching during invisible training and probe trials, filled circles and unfilled circles, respectively, across sessions. The bottom graph represents the percentage of matching during visible training and probe trials, filled circles and unfilled circles, respectively, across sessions.

From session 53 to 62 all the training trials for both visible and invisible models were presented with a DRO 0-second procedure (top and bottom graphs). During the DRO 0-second procedure, the percentage of all training and probe trials with a match according to the visibility property was between 0% and 33%. Given that from session 53 to 62 matching of any models was no longer reinforced, and matching was at near zero levels, this period was easily discriminable from the subsequent reinforcement condition at the beginning of Experiment 2. Therefore this period served as a baseline for Experiment 2.

The data in the top graph of Figure 2 indicate that when reinforcement was introduced for matching of invisible training models (filled circles, at the dashed vertical line), the percentage of invisible training trials with a match increased to 100% within eight sessions. No such increase was obtained during the visible training trials (filled circles, bottom graph), which remained at low levels until reinforcement was introduced for matching of visible training models. With the introduction of reinforcement for matching of visible training models (bottom graph, at dashed vertical line), the percentage of visible training trials with a match increased to 84% within four sessions. This systematic increase in imitation of invisible training models and visible training models with the introduction of reinforcement for each indicates that responding during Experiment 2 had come under the control of the new reinforcement contingencies established according to the visibility property.

Concerning the probe data according to the visibility property, from the top graph of Figure 2, it can be seen that when reinforcement was introduced for matching of invisible training models, matching of invisible probe models (unfilled circles), never reinforced, also increased over baseline levels to 100%. From the bottom graph of Figure 2 it can be seen that no such increase was obtained during the visible probe trials (unfilled circles) until reinforcement was introduced for matching of visible training models. Once reinforcement was introduced for matching of visible training models, the percentage of visible probe trials with a match increased to 100%, even though matching of these models was never reinforced.

As with Experiment 1, the systematic increase in imitation of the probe models along with the training models indicates generalization from imitation training during training trials to imitation during nonreinforced probe trials. Thus, the results of Experiment 2 are a demonstration of generalized imitation within invisible and visible response types, obtained through training according to the visibility property of the modeled responses without interference of prior training according to the object-manipulation property of the same modeled responses.

In addition, as with Experiment 1, because there was a clear discrimination between invisible probe trials (top graph) and visible probe trials (bottom graph), one can conclude that two new response classes were formed: an invisible response class of generalized imitation; and a visible response class of generalized imitation. This formation of two new response classes was obtained according to the visibility property, without interference of prior training according to the object-manipulation property of the same modeled responses.

The Results Obtained with Will

The results of Experiments 1 and 2 for the six-year-old boy, Will, are similar to those just described for Min, and are represented in Figures 3 and 4. Experiment 1 concerns the effects of differential reinforcement on matching of models according to the object-manipulation property, and Experiment 2 concerns the effects of differential reinforcement on matching of models according to the visibility property. Figure 3 represents the percentage of trials during which Will matched motor-with-toy models (top graph) and motor-without-toy models (bottom graph), across sessions. The shaded portion of Figure 3, discussed later, represents a continued monitoring of matching of modeled responses according to the object-manipulation property during Experiment 2. Figure 4 represents the percentage of trials during which Will matched invisible models (top graph) and visible models (bottom graph), across sessions. The shaded

Figure Caption

Figure 3 This figure represents Will's data for both motor-with-toy and motor-without-toy modeled response types. The unshaded portion of the top graph represents the percentage of both motor-with-toy training and probe trials with a match throughout all experimental conditions of Experiment 1, training according to the object-manipulation property. The shaded portion of the top graph represents monitored matching of motor-with-toy training and probe models during Experiment 2, training according to the visibility property. The unshaded portion of the bottom graph represents the percentage of both motor-without-toy training and probe trials with a match throughout all experimental conditions during Experiment 1. The shaded portion of the bottom graph represents monitored matching of motor-without-toy training and probe models during Experiment 2.

Figure 3

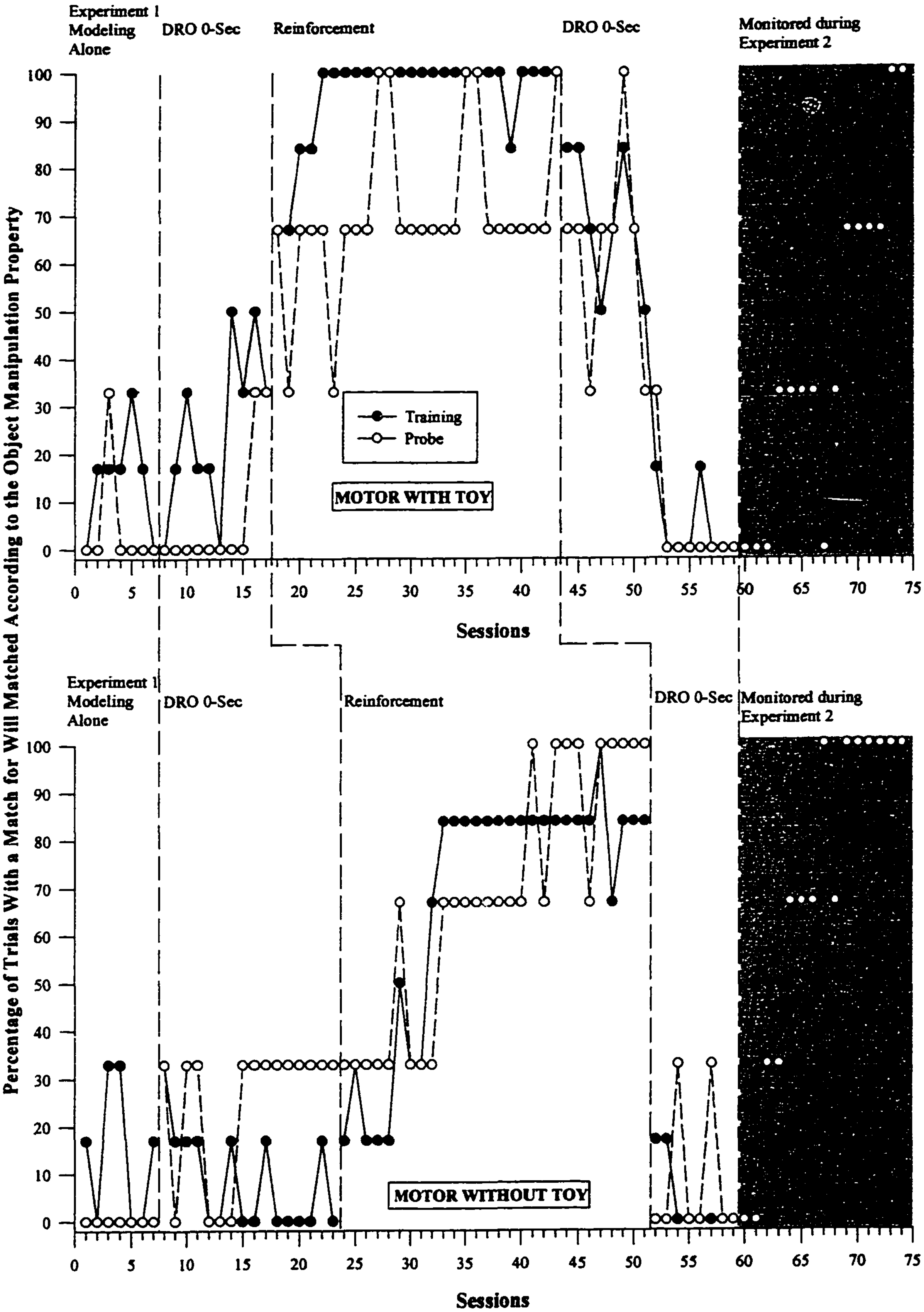
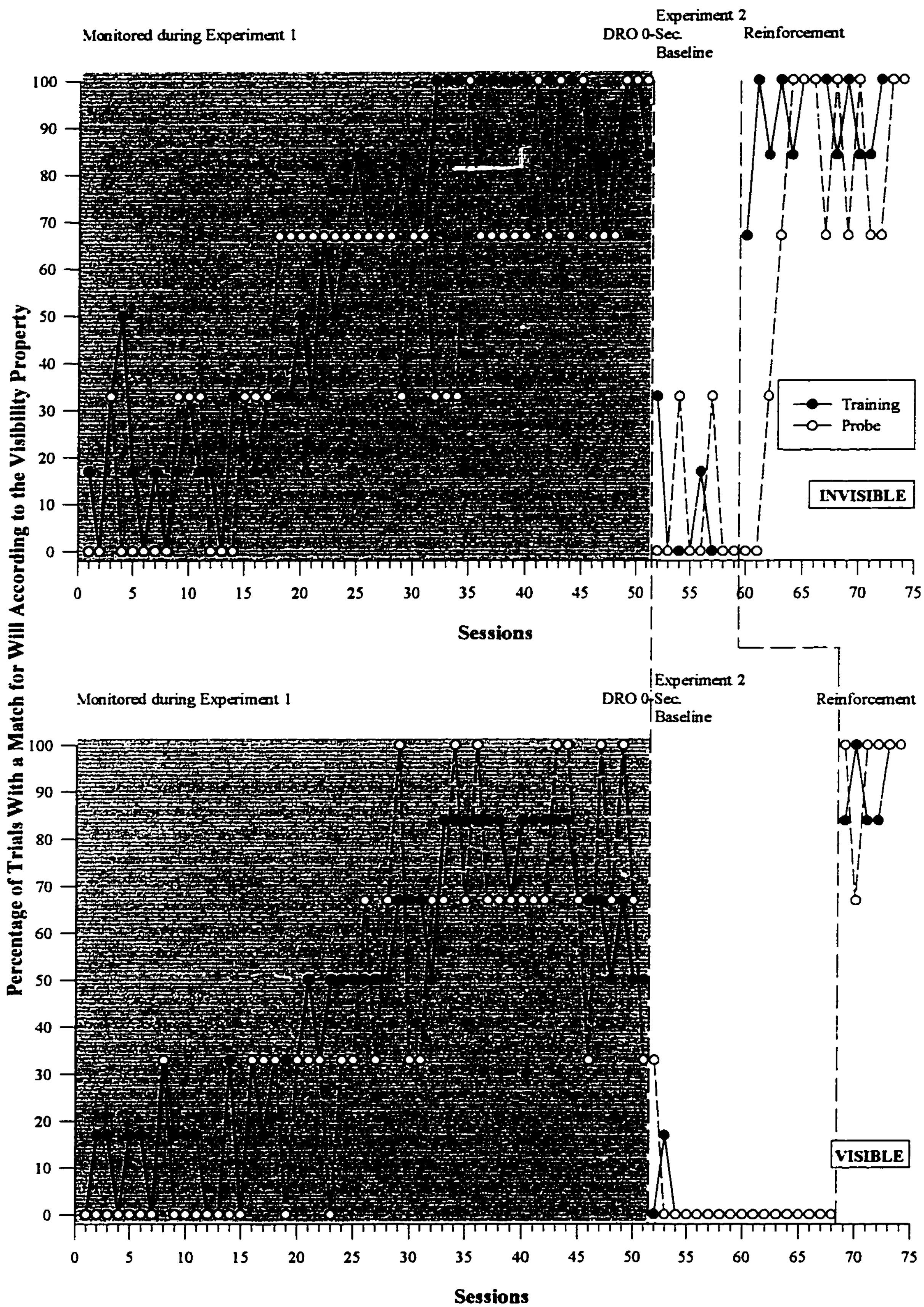

Experiment 1
Modeling Alone
DRO 0-Sec
Reinforcement
DRO 0-Sec
Monitored during Experiment 2
Percentage of Trials With a Match for Will Matched According to the Object Manipulation Property
Training
Probe
MOTOR WITH TOY
Sessions
Experiment 1
Modeling Alone
DRO 0-Sec
Reinforcement
DRO 0-Sec
Monitored during Experiment 2
MOTOR WITHOUT TOY
Sessions

Figure Caption

Figure 4 This figure represents Will's data for invisible and visible modeled response types. The unshaded portion of the top graph represents the percentage of both invisible training and probe trials with a match throughout Experiment 2, training according to the visibility property. The shaded portion of the top graph represents monitored matching of invisible training and probe models during Experiment 1, training according to the object-manipulation property. The unshaded portion of the bottom graph represents the percentage of both visible training and probe trials with a match throughout all experimental conditions of Experiment 2. The shaded portion of the bottom graph represents monitored matching of visible training and probe models during Experiment 1.

Figure 4


Monitored during Experiment 1
Experiment 2
DRO 0-Sec.
Baseline
Reinforcement
Training
Probe
INVISIBLE
Percentage of Trials With a Match for Will According to the Visibility Property
Sessions
Monitored during Experiment 1
Experiment 2
DRO 0-Sec.
Baseline
Reinforcement
VISIBLE
Sessions

portion of Figure 4, discussed later, represents the monitored matching of modeled responses according to the visibility property during Experiment 1.

Unshaded portion of Figures 3 and 4 With respect to Experiment 1 (Figure 3), it can be seen that during the modeling alone baseline condition, the percentage of motor-with-toy training trials (top graph) and motor-without-toy training trials (bottom graph), with a match was at approximately the same low levels, between 0% and 33%. In addition, during the modeling alone baseline procedure, the percentage of motor-with-toy probe trials (top graph) with a match was also at low levels, between 0% and 33%. The same was true for the motor-without-toy probe trials (bottom graph).

As was discussed above, the second condition presented to this child was the DRO 0-second condition. During this condition, the percentage of motor-with-toy training trials (top graph) with a match remained at baseline levels, between 0% and 33%, with the exception of two sessions during which matching went up to 50%. From the bottom graph of Figure 3, it can be seen that with the introduction of a DRO 0-second procedure during motor-without-toy training trials, the percentage of motor-without-toy training trials with a match also remained at baseline levels, between 0% and 33%.

The introduction of the DRO 0-second procedure during motor-with-toy and motor-without-toy training trials did not affect matching during either motor-with-toy or motor-without-toy probe trials which remained at low baseline levels.

The data in Figure 3 indicate that the sequential implementation of reinforcement for matching of motor-with-toy and motor-without-toy training models resulted in a systematic increase in imitation of these training models. This finding indicates that imitation of the training models was under the stimulus control of the object-manipulation property (motor-with-toy and motor-without-toy)of the modeled responses.

In addition, the data in Figure 3 indicate that the sequential implementation of reinforcement for matching of motor-with-toy and motor-without-toy training models produced a systematic increase in imitation of the probe models along with training models of similar type. This finding indicates generalization from imitation training during training trials to imitation during nonreinforced probe trials. Thus, these results provide a demonstration, with this child as well, of generalized imitation within motor-with-toy and motor-without-toy responses.

In addition, as with Min, because there was a clear discrimination between motor-with-toy probe trials, and motor-without-toy probe trials it was concluded that two response classes, were formed according to the object-manipulation property: a motor-with-toy class of generalized imitation; and a motor-without-toy class of generalized imitation.

As mentioned above, a DRO 0-second procedure was introduced after 43 sessions as a further test of the continued effectiveness of the reinforcers. The data in Figure 3 (top and bottom graph) indicate that the sequential implementation of a DRO 0-second procedure during the motor-with-toy and motor-without-toy training trials produced a systematic decrease in matching of motor-with-toy and motor-without-toy training models, indicating that the decrease in matching responses was the result of the change in the reinforcement contingencies. That is, the DRO 0-second procedure was effective in reducing matching during training trials. By the end of the DRO 0-second procedure, matching of all training models decreased to 0%

In addition, a systematic decrease was obtained in matching of motor-with-toy and motor-without-toy probe models along with the training models of similar type, indicating that the response classes formed during the reinforcement condition were maintained during the DRO condition. As was found with the training models, by the end of the DRO 0-second procedure, matching of all probe models decreased to 0%.

The results of Experiment 2, for Will, are represented in Figure 4. The top graph represents the percentage of matching during invisible training and probe trials, respectively, across sessions. The bottom graph represents the percentage of matching during visible training and probe trials, respectively, across sessions.

During sessions 52 through 59 all the invisible and visible training trials were presented with a DRO 0-second procedure (top and bottom graphs). During these DRO 0-second sessions, the percentage of all training and probe trials with a match was between 0% and 33% levels. Given that during sessions 52 to 59 matching of any models was no longer reinforced, and matching was at near zero levels, this period was easily discriminable from the subsequent reinforcement condition at the beginning of Experiment 2. Therefore this period served as a baseline for Experiment 2.

The data in Figure 3 indicate that the sequential implementation of reinforcement for matching of invisible and visible responses produced a systematic increase in imitation of invisible and visible training models. This finding indicates that imitation during Experiment 2 had come under the control of the new reinforcement contingencies established with the visibility property of the modeled responses.

In addition, the data in Figure 4 indicate that the sequential implementation of reinforcement for matching of invisible and visible training models produced a systematic increase in imitation of the probe models along with the training models of similar type. This finding indicates generalization from imitation training during training trials to imitation during nonreinforced probe trials. Thus, with this child as well, the results of Experiment 2 are a demonstration of generalized imitation within invisible and visible response types, obtained through training with the visibility property of the modeled responses.

In addition, as with Experiment 1, because there was a clear discrimination between invisible probe trials and visible probe trials, it was concluded that two new response classes were formed: an invisible response class of generalized imitation; and a visible response class of generalized imitation. This formation of two new response classes was obtained according to the visibility property, without interference of prior training with the object-manipulation property of the same modeled responses.

The Results Obtained with Winnie

The infant boy, Winnie, was exposed to training according to the visibility property first, and according to the object manipulation property second, as a partial control for order of training effects. Additionally, with each modeled response property, the order of treatment of each response type was reversed from that experienced by the first two children. Again, these changes effected a partial control for order of training effects. Figures 5 and 6 represent the results of experiments 1 and 2, respectively, for Winnie. Experiment 1 concerns the effects of differential reinforcement on matching of models according to the visibility property, and Experiment 2 concerns the effects of differential reinforcement on matching of models according to the object-manipulation property. Figure 5 represents the percentage of trials during which Winnie matched visible models (top graph) and invisible models (bottom graph), across sessions. After Experiment 1 was completed, we continued to monitor matches of models arranged according to the visibility property. Those data, monitored during Experiment 2, are represented in the shaded portion of Figure 5 and will be discussed later.

Figure 6 represents the percentage of trials during which Winnie matched motor-without-toy models (top graph) and motor-with-toy models (bottom graph) across sessions. The shaded portion of Figure 6, discussed later, represents the monitoring of responding during Experiment 1.

Unshaded portion of Figures 5 and 6. With respect to Experiment 1 (Figure 5), during the modeling-alone baseline condition, the percentage of visible training trials (top graph), and invisible training trials (bottom graph) with a match was at low levels, between 0% and 17%.

As with Will, following the modeling alone baseline condition, this child was exposed to a DRO 0-second procedure introduced during the visible and invisible training

Figure Caption

Figure 5 This figure represents Winnie's data for both visible and invisible response types. The unshaded portion of the top graph represents the percentage of both visible training and probe trials with a match throughout all experimental conditions of Experiment 1, training according to the visibility property. The shaded portion represents monitored matching of visible training and probe models during Experiment 2, training according to the object-manipulation property. The unshaded portion of the bottom graph represents the percentage of both invisible training and probe trials with a match throughout all experimental conditions of Experiment 1. The shaded portion represents monitored matching of invisible training and probe models during Experiment 2.

Figure 5

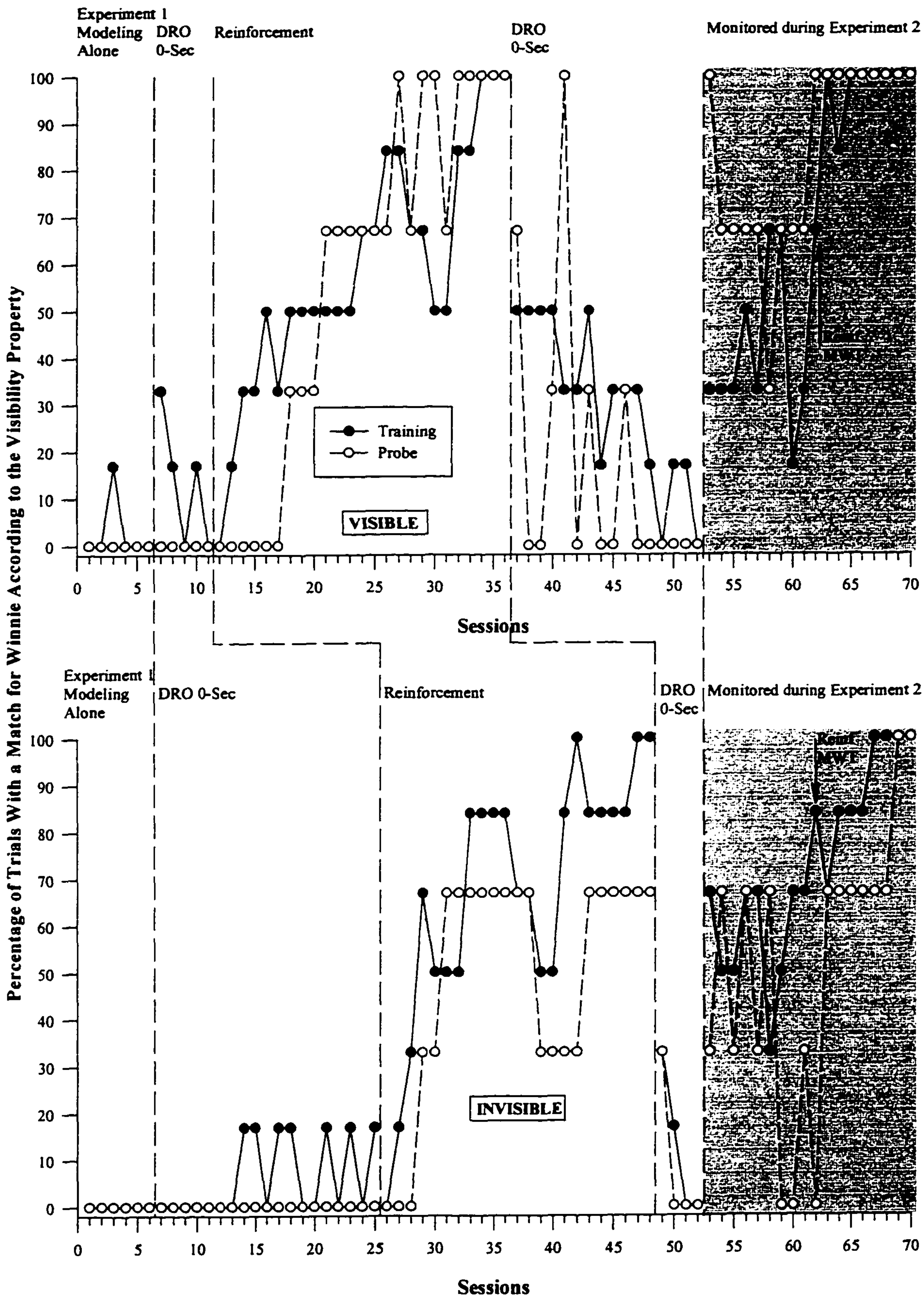
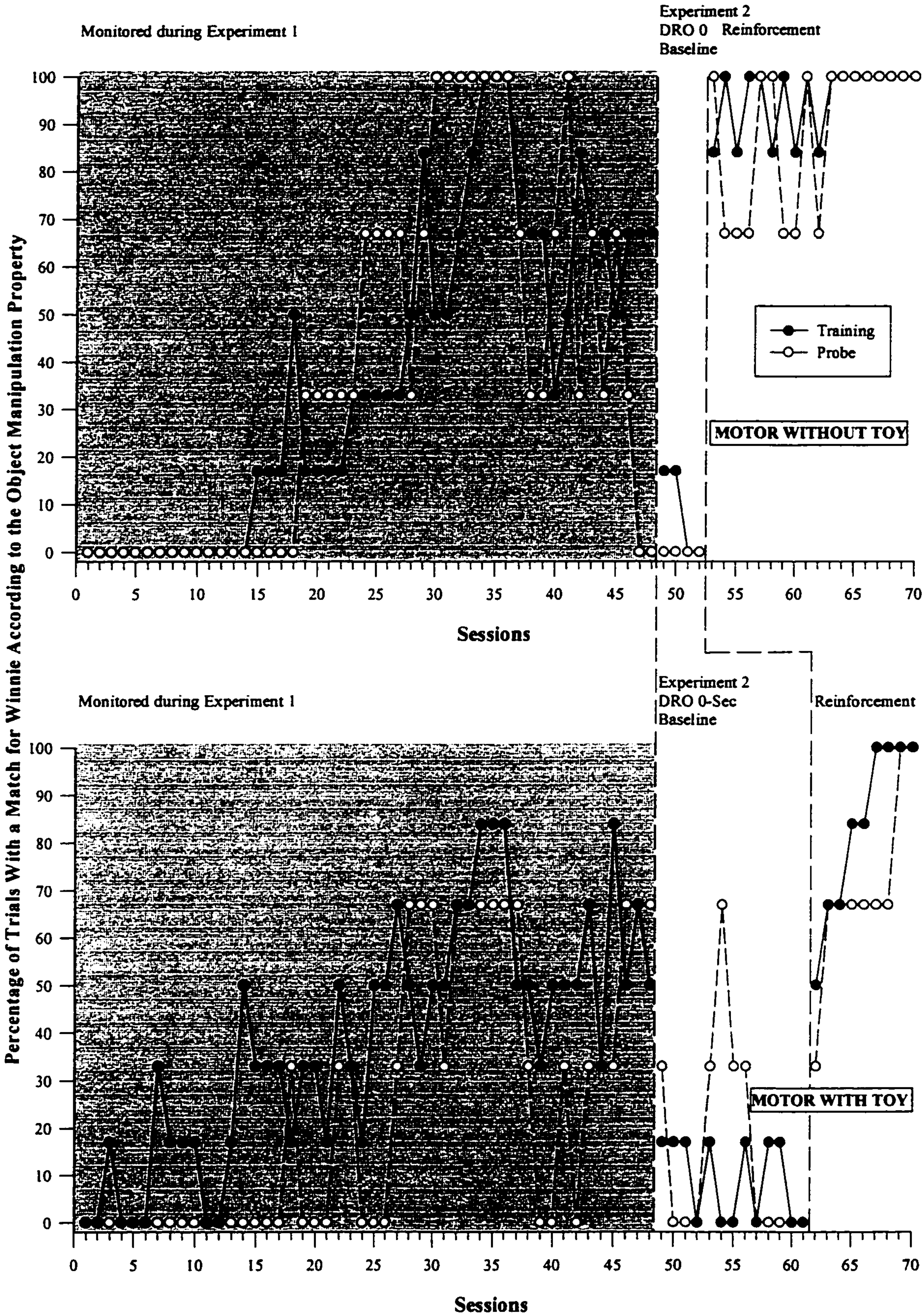

Experiment 1
Modeling Alone
DRO 0-Sec
Reinforcement
DRO 0-Sec
Monitored during Experiment 2
Percentage of Trials With a Match for Winnie According to the Visibility Property
Training
Probe
VISIBLE
Sessions
Experiment 1
Modeling Alone
DRO 0-Sec
Reinforcement
DRO 0-Sec
Monitored during Experiment 2
INVISIBLE
Sessions

Figure Caption

Figure 6 This figure represents Winnie's data for motor-without-toy and motor-with-toy response types. The unshaded portion of the top graph represents the percentage of both motor-without-toy training and probe trials with a match throughout Experiment 2, training according to the object-manipulation property. The shaded portion of the top graph represents monitored matching of motor-without-toy training and probe models during Experiment 1, training according to the visibility property. The unshaded portion of the bottom graph represents the percentage of both motor-with-toy training and probe trials with a match throughout Experiment 2. The shaded portion of the bottom graph represents monitored matching of motor-with-toy training and probe models during Experiment 1.



Monitored during Experiment 1
Experiment 2
DRO 0 Baseline
Reinforcement
Training
Probe
MOTOR WITHOUT TOY
Sessions
Percentage of Trials With a Match for Winnie According to the Object Manipulation Property
Monitored during Experiment 1
Experiment 2
DRO 0-Sec Baseline
Reinforcement
MOTOR WITH TOY
Sessions

trials only. The percentage of visible training and probe trials with a match as well as the percentage of invisible training and probe trials with a match remained at baseline levels throughout the DRO 0-second procedure.

The data in Figure 5 indicate that the sequential implementation of reinforcement for imitation of visible and invisible training models produced a systematic increase in imitation of these training models. These results indicate that imitation of training models according to the visibility property (visible and invisible) was under the control of the reinforcement contingencies. In addition, the data in Figure 5 indicate that a systematic increase in imitation of the probe models along with the training models was obtained even though imitation of the probe models was never reinforced. These results indicate generalization from imitation training during training trials to imitation during nonreinforced probe trials. Thus these results are a demonstration of generalized imitation within visible and invisible modeled response types.

Also, because there was a clear discrimination between visible probe trials (top graph) and invisible probe trials (bottom graph), it was concluded that two response classes were formed through training according to the visibility property: a visible response class of generalized imitation; and an invisible response class of generalized imitation.

Therefore, the results obtained with Winnie during Experiment 1 were similar to those obtained with Min and Will. Control by the reinforcement contingencies was obtained for matching of the training models; generalized imitation was obtained within each modeled response type; and response class formation was demonstrated for each modeled response type. These results were obtained with all three children regardless of which modeled response property was trained first.

As mentioned above, a DRO 0-second procedure was introduced after 35 sessions as a further test of the continued effectiveness of the reinforcers.

The data in Figure 5 indicate that the sequential implementation of the DRO 0-second procedure during visible and invisible training trials resulted in a systematic decrease in imitation of visible and invisible training models. This finding indicates that the decrease in imitation of the training models was the result of the change in the reinforcement contingencies. That is, the DRO 0-second procedure was effective in reducing matching during training trials for this third child as well.

The data in Figure 5 also indicate that a systematic decrease in matching of visible and invisible probe models, not presented with a DRO 0-second procedure, was obtained along with the training models of similar type. This finding indicates that the response classes established according to the visibility property during the reinforcement condition were maintained during the DRO 0-sec condition.

The results of Experiment 2 for Winnie are represented in Figure 6. The top graph represents the percentage of motor-without-toy training and probe trials with a match, across sessions. The bottom graph represents the percentage of motor-with-toy training and probe trials with a match, across sessions. Throughout sessions 48 to 51, all the training trials for both motor-without-toy and motor-with-toy models were presented with a DRO 0-second procedure (top and bottom graphs). During the DRO 0-second procedure, the percentage of all training and probe trials with a match was at 0% levels. Given that during sessions 48 to 51 matching of any models was no longer reinforced, and matching was at 0% levels, this period was easily discriminable from the subsequent reinforcement condition at the beginning of Experiment 2. Therefore this period served as a baseline for Experiment 2.

The data in Figure 6 indicate that the sequential implementation of reinforcement for matching of motor-without-toy and motor-with-toy training models resulted in a systematic increase in imitation of motor-without-toy and motor-with-toy training models. This finding indicates that responding during Experiment 2 had come under the control of the new reinforcement contingencies established according to the object-manipulation property, without interference of prior training with the visibility property of the same modeled responses.

In addition, the data in Figure 6 indicate that, as with Experiment 1, and as with Min and Will, the sequential implementation of reinforcement for matching of motor-without-toy and motor-with-toy training models produced a systematic increase in imitation of the probe models along with the training models of similar type although imitation of the probe models was never reinforced. This finding indicates generalization from imitation training during training trials to imitation during nonreinforced probe trials. Thus, these data, resulting from training with the object-manipulation property of the modeled responses, provide a second demonstration of generalized imitation, with Winnie, this time within motor-without-toy responses and within motor-with-toy responses.

Also, given the clear discrimination obtained between motor-without-toy probe trials and motor-with-toy probe trials, it was concluded that two new response classes were formed, this time according to the object-manipulation property: a motor-without-toy class of generalized imitation; and a motor-with-toy class of generalized imitation. This new response class formation, according to the object-manipulation property, was obtained without interference of prior training with the visibility property of the same modeled responses.

Therefore, at least with the visibility property and the object-manipulation property, response class formation occurred according to the modeled response property that was made relevant for reinforcement, without regard to which modeled response property was trained first.

The DRO 0-second procedure was instrumental in the analysis of the results of Experiment 2. Reinforcement was implemented sequentially for imitation of training models of each modeled response type according to the second modeled response property. Therefore, while the training models of one response type were presented with reinforcement, the training models of the other modeled response type continued to be presented with a DRO 0-second procedure. At this point in Experiment 2, the children experienced three different types of trials: Training trials of one response type presented with reinforcement; training trials of the second response type presented with a DRO procedure; and all the probe trials of both response types remaining unchanged from

Experiment 1, that is, presented without a reinforcement or DRO procedure. Table 9 represents a breakdown of the experimental trials to provide a detailed description of what the children experienced.

As can be see from Table 9, at the beginning of Experiment 2, the children experienced three different types of experimental trials (e.g. training trials, probe trials, and DRO trials). The training and probe trials of both the response types were similar, with the exception of a reinforcer delivery during the training trials with a match of the response type targeted for reinforcement. During the DRO trials however, the model was followed by the reinforcer delivery. Given pervious findings of generalized imitation, that have reported generalized imitation even with models of different types (Baer and Sherman, 1964; Baer, Peterson and Sherman, 1967) it was expected that matching of all the probe models, of both response types, would increase along with the training models targeted for reinforcement.

During these sessions at the beginning of Experiment 2, when reinforcement is introduced for matching of models of the first modeled response type according to the second modeled-response property, there was no reinforcement history for matching of the two modeled responses types according to this second modeled response property. There was however, a reinforcement history for matching of modeled response types according to the first modeled response property. Given that the six training models of this new modeled response type and all six probe models consisted of an equal distribution of the modeled response types according to the first modeled response property trained,

Table 9 A breakdown of the different trial types presented and the separate components of each.

Trial Steps	Training Trials	Probe Trials	DRO Trials
1	Present model	Present model	Present Model
2	Instruct child	Instruct child	Instruct child
3	Wait 6 seconds	Wait 6 seconds	Present RF
4	Present RF	Start new trial	Wait 6 seconds
5	Start new trial		Start new trial

RF = Reinforcement in the form of a social event.

an increase in matching of all the probe models along with an increase in matching of the new training models would not have been surprising. What was obtained however, was an increase only in matching of the probe models of the same response type as the training models targeted for reinforcement. Matching of the probe models of the second response type according to this second modeled response property increased only when reinforcement was introduced for matching of that particular response type. This provided a second demonstration of response-class formation according to the second modeled response property trained.

Shaded Portion of the Figures

The shaded portion of all the Figures for all three children indicate that training according to one of the two properties of the modeled responses did not systematically affect responding according to the other property of the same modeled responses that was not relevant for reinforcement.

The monitored data in the shaded portion of all the graphs indicate that following the introduction of reinforcement for matching of training models of a given response type according to the modeled response property targeted for reinforcement, produced an increase in the percentage of training trials with a match of both response types according to the modeled response property not targeted for reinforcement. This increase occurred of necessity with the increase in the percentage of training trials with a match of the response type presented with reinforcement, because these reinforced training trials were comprised of an equal number of both response types within the modeled response property not targeted for reinforcement. The same held true during the probe trials.

Discussion

The results of experiments 1 and 2 with all three children have provided clear demonstrations of generalized imitation within each of the modeled response types, and response-class formation according to both the object-manipulation property and the visibility property of the modeled responses. During the modeling alone baseline condition, with all three children, imitation of all models according to both modeled response properties was demonstrated to be at low levels. During the initial DRO 0-second condition, presented to Will and Winnie, imitation of all models remained unchanged from baseline levels. These results suggest that the DRO 0-second procedure did not have a suppression effect on matching behavior, as might be expected given the negative contingency for matching responses included in the DRO procedure.

In Experiment 1, for all three children, the introduction of reinforcement sequentially for imitation of the training models of both modeled response types resulted in a systematic increase in imitation above baseline and DRO levels. Matching of the probe models also increased systematically along with the training models of similar type, following the introduction of reinforcement for matching of the training models. These results provided a replication of the results obtained in previous generalized imitation research (Baer et al., 1964; Sherman, et al. 1977; Hursh & Sherman, 1973; Baer & Deguchi, 1985; Kymissis & Poulson, 1996; Poulson & Kymissis, 1988; Poulson, et al. 1991; Poulson, et al. 1993; Metz, 1965; Young et al. 1994; Lovaas, et al. 1966; Baer, et al., 1967; & Garcia, et al. 1971) which have shown that a reinforcement procedure implemented for matching of training models, resulted in an increase in matching of these training models as well as in an increase in matching of probe models of a similar type, but which were never correlated with reinforcement. This has been described as generalization from imitation training during training trials to imitation during nonreinforced probe trials.

In addition, the Poulson et al. (1993) and the Garcia, et al. (1971) studies have demonstrated response-class formation with models of different modeled response types, but they did not look at imitation according to the visibility property. In the present study, two separate instances of response-class formation were demonstrated with each of the three children. In Experiment 1, response-class formation was demonstrated according to the first response property trained. These response classes, first demonstrated during the reinforcement condition, were maintained during the DRO condition that followed. In Experiment 2 response-class formation was demonstrated according to the second modeled response property trained.

During Experiment 2, with Min and Will, and Experiment 1 for Winnie, generalized imitation was demonstrated with visible and invisible modeled response types. In addition, a discrimination was demonstrated between these two modeled response types. These results extend the findings of Poulson et al. (1993), and Garcia et al. (1971) to visible and invisible modeled response types.

In addition, the results of the present study indicate that response topography was not important in obtaining generalized imitation or response-class formation, because even with a change in the modeled response property made relevant for reinforcement, generalized imitation and response-class formation were obtained. These results clearly indicate that it was the reinforcement procedure that was responsible for producing behavior change, regardless of response topography. It has previously been surmised that response topography alone might define the boundaries of generalized imitation (Poulson et al., 1993; & Young et al., 1995). The present study makes it clear that response topography can define the boundaries of generalized imitation only to the extent that it is discriminative for reinforcement.

The present study showed that response class membership can be manipulated even within the same set of responses by varying the property of the responses that is made relevant for reinforcement, and without interference of prior training with another property of those same responses. Imitation during Experiment 1 came under the stimulus control of model type correlated with reinforcement.

During Experiment 2, with the same 18 models, the reinforcement contingencies were changed so that reinforcement was introduced sequentially for each of the two modeled response types according to the second property of the same modeled responses. For Min and Will these were invisible and visible modeled responses, and for Winnie these were motor-with-toy and motor-without-toy models. The shift to the second modeled response property made relevant for reinforcement in Experiment 2, produced a corresponding change in the children's responding; they no longer responded according to the modeled response property established as a discriminative for reinforcement during

Experiment 1 . A new discrimination was demonstrated during Experiment 2 between the two modeled response types according to the second modeled response property, consistent with the new reinforcement contingencies. Therefore the stimulus control established during Experiment 1 according to the first modeled response property was shifted, during Experiment 2, to the second modeled response property of the same modeled responses, without any interference of prior training.

In addition, with the introduction of reinforcement for each response type during Experiment 2, matching of the training and probe models of each response type increased much more rapidly than during Experiment 1. This result was found with all three children. One explanation might be that the DRO 0-second procedure was producing a suppression effect on responding which was lifted with its termination, causing a rapid increase in matching behavior. A more plausible explanation might be however, that the difference in rate of increase in matching behavior between experiments 1 and 2 reflects the prior acquisition of the matching responses during Experiment 1. Acquisition of the matching responses was not necessary during Experiment 2, given that the children were already producing the matching responses prior to the initiation of Experiment 2. This finding was not very surprising given the many sessions of exposure to the models and with high percentages of matching of most of the models prior to Experiment 2. What was unexpected was that generalized imitation and response-class formation also occurred more rapidly during Experiment 2. That is, the children's responding seemed to come under the stimulus control of the two new modeled response types according to the second modeled response property much more rapidly during Experiment 2.

The clear discrimination obtained between the two modeled response types in both Experiments 1 and 2 indicates that the children were learning to respond differentially to the two modeled response types, according to the contingencies of reinforcement programmed for each. So that even when these contingencies were shifted to a new property of the same modeled responses, imitation followed accordingly. This might be similar to the results obtained in studies investigating concept formation. For example, a procedure designed by Lea (1984), to test for concept formation involved training pigeons to discriminate between two different sets of slides, each consisting of pictures of objects placed in the same category by humans (i.e. trees vs. chairs). Responding in the presence of set 1 was reinforced and responding in the presence of set 2 was not. Following the successful training of this discrimination, responding in the presence of some slides from set 1 was no longer reinforced, and responding in the presence of some slides from set 2 was reinforced. The purpose of this procedure was to see whether exposure to the reversed contingencies for some of the slides would affect responding in the presence of all the slides.

A study conducted by Vaughan (1988), using a procedure similar to the one just described, found that the change in the reinforcement contingencies resulted in a corresponding change in responding to all the slides (Lea, 1984; and Vaughan, 1988). In addition, Vaughan (1988) found that with repeated exposure to contingency reversals for some of the slides, acquisition of new discriminations occurs more rapidly.

In the present study, the rapid formation of new imitative classes in Experiment 2, that corresponded to the new modeled response property made relevant for reinforcement, indicates that an increasing number of exposures to this type of shift in contingency, would be correlated with an increasingly more rapid formation of new imitative classes. It would not have been practical to test out this prediction with the infants and young child in the present experiment. Nevertheless, with older children who might be available to participate in many more experimental sessions, it would be an interesting question to pursue.

The results of both experiments 1 and 2 with Winnie demonstrate that it was not necessary to train the object-manipulation property first to obtain results similar to those of Min and Will. Winnie produced similar results with exposure to the visibility property of the modeled responses first. In addition, the results obtained with Winnie indicate that it was not necessary to train motor-with-toy responses first according to the object-manipulation property, or invisible responses first according to the visibility property to obtain reinforcer control, generalized imitation and response class formation. Winnie's performance was similar to Min and Will's even with a different ordering of modeled response types. During Experiment 1, Winnie was exposed to reinforcement first, for imitation of visible models, and then for imitation of invisible models, the opposite order of Min and Will's training. Also, during Experiment 2, he was exposed to reinforcement for matching of motor-without-toy training models first, followed by reinforcement for matching of motor-with-toy training models. Neither of these changes in order of treatment produced a change in the functional relations observed.

One limitation of the present study is that we did not counterbalance all possible orders of treatment. This may be a consideration for future research.

The results of the present study indicate that there was no systematic difference in the number of trials required to produce generalized imitation with invisible and visible models. This is inconsistent with what Piaget might have predicted, especially with the infants.

Invisible responses were investigated by Piaget (1962). He observed that even infants as young as 12 months could reproduce models that involved responses outside of the field of vision of the person producing them (i.e. smiling, blinking). Piaget wrote that the infant might have been learning how it felt to produce the modeled response. He called this a "tactilo-kinesthetic" impression. The child learns how it must feel to do as the model does and then tries to recreate this feeling. When the modeled response is already in the child's repertoire (e.g. blinking) then the child tries to recreate the feeling of blinking after observing the model blink. If the response in not already in the child's repertoire, then the feeling of engaging in that response is learned through a series of approximations consisting of responses the child already produces and that progressively resemble the modeled response. Piaget believed that these responses would be more difficult to imitate than those the child could see him or herself produce because of all the extra steps involved in their reproduction. A similar, but briefer, description of imitation of invisible models by children was given by Baer and Deguchi (1985), although they did not predict whether imitation of invisible models would require more trials to mastery than visible models. In any case, in the present set of experiments, there were no differences in number of trials required to show generalized imitation of visible and invisible models.

It is recommended that, given the length of the present study, future research be conducted with children from ages 6 and up. The six-year-old boy, Will proved to be a much more cooperative participant. In addition, it took much longer to complete the study with each of the two infants, especially Winnie, than it did with Will. It took four months to complete the study with Will, whereas it took five months to complete the study with Min, and 10 months to complete the study with Winnie. With the infants, many sessions were used to reinforce sitting and looking behavior. It is important for the child to remain seated and look at the experimenter while the response is being modeled. This can be very difficult with one-year-old infants who are not under tight instructional control.

An important problem in obtaining instructional control over child behavior during experimental sessions was the apparent variability of the strength of different reinforcers used. The infants required frequent change in the stimuli used as reinforcers, whereas the six-year-old boy was given tokens that were exchanged for backup reinforcers at the completion of each session. This token system was effective because if the child satiated on some of the backup reinforcers others could be substituted. It was also possible to ask the older child what objects he would like to exchange his tokens for prior to the experimental session, therefore giving the experimenter an opportunity to provide these preferred objects.

An additional consideration for future research might be to exposed different populations, such as older children with developmental disabilities, to similar experimental procedures as those described above, which might prove to be successful in assessing cognitive functioning in populations with developmental disabilities.

Appendix A

The following is a list of definitions for each modeled response for all three children. These definitions provide a basis for determining whether a particular response would be considered a match or an approximation to the model. In addition, the following descriptions include the requirements for proper modeling and stimulus presentation to the children.

A printout of all the response definitions to follow, for all three children, was made assessable to both observers during the scoring of all sessions.

Definitions of Models presented to Min

Cup and Spoon

Model. Hold the cup with one hand, place the spoon in the cup and stir at least once.

Present to infant by placing the cup and spoon in front of the infant with the spoon next to the cup, and perpendicular to the table. The spoon should be placed on the side corresponding to the infant's handedness (if known).

Approximation. Considered an approximation if the cup is held with one hand and the spoon placed in the cup even if the objects are dropped at any point during the action. the action must be completed within 6 seconds of its initiation.

Big Bird

Model. Pick up Big Bird from the table and raise to ear level, touch Big Bird to ear.

Present to the infant by placing Big Bird in front of the infant perpendicular to the table edge.

Approximation. Considered an approximation as long as Big Bird is placed in contact with any part of the ear or the neck below ear level, outside of the field of vision of the infant.

Washcloth

Model. Pick up the washcloth from the table and touch to chin. Then bring the washcloth down the neck to the collar bone in a wiping motion.

Present to infant by placing the washcloth on the table, in front of the infant.

Approximation. Considered an approximation as long as the washcloth is placed anywhere from the edge of the chin downward to the collarbone. The wiping motion is not necessary, but if it does occur, it must consist of a wiping motion in the area below chin level in order to remain outside of the field of vision of the infant.

Touch brush to hair

Model. Pick up the brush from the table and bring to the top of the head, beyond the forehead. Stroke the hair on top of the head with the brush once going from front to back in one movement.

Present the brush to the infant by placing it on the table, in front of the infant, perpendicular to the table edge.

Approximation. Considered an approximation if the infant stokes hair on any part of the head above ear level, going forward or backward but not ending below hairline around face.

Doll and Tub

Model. Pick up the doll which is on the table and place in the tub which is positioned parallel to the doll and perpendicular to the table edge. Place the doll in the tub in parallel fashion so that the doll fits into inner part of tub. Let go of the doll, then immediately pick doll up again and remove from tub. The action should be completed within 6 seconds of its initiation.

Present to the infant by placing the doll and the tub in front of the infant parallel to each other and perpendicular to the table edge.

Approximation. Considered an approximation if the doll is picked up, placed on top of the tub and removed again. Not necessary to place the doll in the tub, nor is it necessary to let go of the doll when placed in the tub.

Book

Model. Open book cover all the way, so that both covers are touching the table and then close again.

Present to infant by placing the book in front of the infant perpendicular to the table edge.

Approximation. Considered an approximation if the book is opened all the way so that both covers are touching the table, and the book is closed again within 12 seconds. It can be opened at any page. In addition, the other pages can be turned in the meantime.

Car

Model. Pick up the car from the table and raise to the side of the face touching it to the temple.

Present the car to the infant by placing in front of the infant on the table.

Approximation. Considered an approximation as long as the car is placed in contact with any part of the head beyond the hairline and between the ear and the top of the head.

Hammer

Model. Pick up the hammer from table and bang the hammerhead on the table twice in succession within 2 seconds.

Present the hammer to the infant by placing it in front of the infant parallel to the table edge.

Approximation. Considered an approximation if the hammerhead or the side of the hammer is banged two or more times within two seconds.

Mega Blocks

Models. Pick up the 3 prong block from the table and place on top of the 4 prong block in parallel fashion, interlocking the two blocks.

Present to the infant by placing both blocks next to each other, both perpendicular to the table edge.

Approximation. Considered an approximation as long as the 3 prong block is placed on the 4 prong block in parallel fashion. Interlocking the two blocks all the way is not necessary.

Smile

Model. Full smile with mouth open and hold for 1 second, and close mouth again.

Approximation. Considered an approximation if there is a smile consisting of open mouth with or without sound, lasting at least 1 second.

Nod Head

Model. Nod head forward and then swing head back to upright position again.

Approximation. Considered an approximation if there is a clear nod of the head in forward movement which does not involve the movement of the torso as a whole.

Wave bye-bye

Model. Place forearm in upright position and move the hand to the left and then to the right.

Approximation. Considered an approximation if there is any movement of the hand from one side to the other, or up and down, with arm held upright.

Clasp Hands Together

Model. Extend forearms in front of torso, clasp hands together, palm to palm, and intertwine fingers.

Approximation. Considered an approximation if there is any action involving the placing together of the hands with the fingers on top of each other or intertwined. The hands must be in front of the torso.

Touch top of Hand

Model. Place one hand flat on table with palm facing downward. Touch the top of that hand with the palm of the other.

Approximation. Considered an approximation if there is any action involving the touching of the top of one hand with the palm or fingers of the other, even if the first hand is not on the table.

Lean Head

Model. Moving just the head, lean the head to the left, towards the shoulder and then to the right, again towards the shoulder.

Approximation. Considered an approximation if there is any movement of the head from side to side even if it involved the whole torso.

Rub Top of Head

Model. Lift head to the top of the head from the side, position hand on top of the head and rub from left to right once.

Approximation. Considered an approximation if the hand touches the top of the head, any point above the ears, and the hand moves in a rubbing fashion, in any direction.

Open and Close Hand

Model. Extend forearm out in front of the torso to a position which is perpendicular to the torso and lay flat on table. With palm facing upward, close fist and then open again.

Approximation. Considered an approximation if the arm is in front of the torso and the hand closes and opens. Arm does not have to be on the table.

Blink

Model. Close both eyes tightly, simultaneously, hold for 1 second and then open again.

Definitions of Models Presented to Winnie

Cup and Spoon

Model. Hold the cup with one hand and turn upside down. Place the spoon on top of the cup base. This action should be completed within 6 seconds of its initiation.

Present to the infant by placing the cup and spoon in front of the infant with the spoon next to the cup and perpendicular to the table. The spoon should be placed on the side corresponding to the infant's handedness (if known).

Approximation. Considered an approximation if the cup and spoon are held instead of placed on the table, as long as the cup is turned upside down and the spoon is positioned on top of the cup base.

Big Bird

Model. Pick Big Bird up from the table and raise to ear level, touch Big Bird to ear.

Present to the infant by placing Big Bird in front of the infant perpendicular to the table edge.

Approximation. Considered an approximation as long as Big Bird is placed in contact with any part of the ear or the neck below ear level, outside of the field of vision of the infant. Washcloth

Model. Pick up the washcloth from the table and touch to chin. Then bring the washcloth down the neck to the collar bone in a wiping motion.

Present to the infant by placing the washcloth on the table, in front of the infant.

Approximation. Considered an approximation as long as the washcloth is placed anywhere from the edge of the chin downward to the collarbone. Wiping motion is not necessary, but if it does occur, it must consist of a wiping motion in the area below the chin level in order to remain outside of the field of vision of the infant.

Touch brush to hair

Model. Pick up the brush from the table and bring to the top of the head, beyond the forehead. Stroke the hair on top of the head with the brush once going from front to back in one movement.

Present to the infant by placing it in front of the infant perpendicular to the table edge.

Approximation. Considered an approximation if the infant stokes hair on any part of the head above ear level, going forward or backward but not ending below the hairline around face.

Doll and Tub

Model. Pick up the doll in one hand and the tub in the other. Then place both hands on opposite sides of the table, each holding one component of the toy, then move both hands to the center of the center of the table along the edge simultaneously until both toy components come into contact.

Present to the infant by placing the doll and tub in front of the infant in parallel to each other and perpendicular to the table edge.

Approximation Considered an approximation if the toy components are picked up one in each hand, hands are moved apart from each other and brought back together again. The movement does not have to be the entire length of the table edge.

Book

Model. Open the book and turn upside down and place upside down on the table.

Present to the infant by placing the book in front of the infant perpendicular to the table edge.

Approximation. Considered an approximation if the book is opened and turned upside down on the table even if some pages are turned in between. This action has to be completed within 12 seconds of its initiation.

Car

Model. Pick up the car from the table and raise to the side of the face touching it to the temple.

Present to the infant by placing the car in front of the infant on the table.

Approximation. Considered an approximation as long as the car is placed in contact with any part of the head beyond the hairline and between the ear and the top of the head.

Hammer

Model. Pick up the hammer from table and push across the table with the hammer head facing down on the table, touching the table.

Present the hammer to the infant by placing it in front of the infant parallel to the table edge.

Approximation. Considered an approximation if the hammerhead, or the side of the hammer is touching the table while the hammer is being pushed. Does not have to be pushed across the entire length of the table, an area of at least four inches is sufficient.

Mega Blocks

Models. Pick up the 3 prong block from the table and place on top of the 4 prong block in parallel fashion, interlocking the two blocks.

Present to infant by placing both blocks next to each other, both perpendicular to the table edge.

Approximation. Considered an approximation as long as either block is placed on the second block in parallel fashion. Interlocking the two blocks all the way is not necessary.

Smile

Model. Full smile with mouth open and hold for 1 second, and close mouth again.

Approximation. Considered an approximation if there is a smile consisting of open mouth with or without sound, lasting at least 1 second.

Nod Head

Model. Nod head forward and then swing head back to upright position again, repeat.

Approximation. Considered an approximation if there is a clear nod of the head in forward movement even if the movement involves the whole torso.

Wave bye-bye

Model. Place forearm in upright position and move hand to the left and then to the right.

Approximation. Considered an approximation if there is any movement of the hand from one side to the other, or up and down, with the arm held upright.

Clasp Hands Together

Model. Extend forearms in front of torso, clasp hands together, palm to palm, and intertwine fingers.

Approximation. Considered an approximation if there is any action involving the placing together of the hands with the fingers on top of each other or intertwined. The hands must be in front of the torso.

Touch top of Hand

Model. Place one hand flat on table with palm facing downward. Touch the top of that hand with the palm of the other.

Approximation. Considered an approximation if there is any action involving the touching of the top of one hand with the palm or fingers of the other, even if the first hand is not on the table.

Lean Head

Model. Moving just the head, lean head to the left, towards the shoulder and then to the right, again towards the shoulder.

Approximation. Considered an approximation if there is any movement of the head from side to side, even if the movement involves the whole torso.

Rub Top of Head

Model. Lift head to the top of the head from the side, position hand on top of the head and rub from left to right once.

Approximation. Considered an approximation if the hand touches the top of the head, any point above the ears, and the hand moves in a rubbing fashion, in any direction.

Open and Close Hand

Model. Extend forearm out in front of torso to a position which is perpendicular to the torso and lay flat on table. With palm facing upward, close fist and then open again.

Approximation. Considered an approximation if the arm is extended in front of the torso and the hand closes and opens. Arm does not have to be on table.

Blink

Model. Close both eyes tightly, simultaneously, hold for 1 second and then open again.

Definitions for Models Presented to Will

Shuffle card deck

Model. Pick up the two stacks of cards, one in each hand, then put the two stacks of cards next to each other and shuffle into each other.

Present to child by placing the two stacks of cards in front of child in two stacks perpendicular to table edge.

Approximation. Considered an approximation if shuffling motion is made with both stacks of cards simultaneously, and both stacks of cards are within three inches of each other. The stacks do not have to be touching.

Create paper fan

Model. Pick up a piece of paper from table and fold into fan by flipping back and forth, perpendicular to table edge. The paper must be folded at least six times.

Present a new piece of paper to child by placing it on the table perpendicular to the table edge.

Approximation. The piece of paper does not have to be folded evenly, but it must be folded at least six times.

Tie shoe lace

Model. Take each lace of the shoe in each hand, put one lace over the other forming an "X" and let go with right hand. Reach through loop created under "X" with right hand and pull right lace through, forming a knot.

Present to child by placing the shoe (with untied shoe laces) in front of child on table.

Approximation. Any response that includes crossing the laces to form an "X" (even if done more than once), and pulling either of the laces through the loop with right hand. Making the knot is not required.

Tie kerchief on top of head

Model. Place the kerchief around head from back to front, ending up on forehead. Tie a knot on forehead with two ends of the kerchief by putting one hand between the forehead and the kerchief, and pulling the appropriate end through, while holding the kerchief tightly with the other hand.

Untie the knot and present the kerchief to the child by placing it on the table in front of the child.

Approximation. Considered an approximation if the kerchief is placed around head with the ends of the kerchief on the forehead, and the ends are twisted around each other. Making a knot is not required.

Put Ponytail Holder in Hair

Model. Take a chunk of hair from the top of the head (any side) in left hand. Place the ponytail holder on the chunk of hair and hold down with left hand. Wrap the ponytail holder around the chunk of hair once with right hand.

Remove the ponytail holder from hair and present it to the child by placing it on the table in front of the child.

Approximation. Either hand can be used to accomplish each action. Considered an approximation if the chunk of hair is taken in hand and the ponytail holder is wrapped around the chunk of hair once.

One Crochet Point

Model. Pick up the yarn with both hands and make two loops around index finger of left hand. Pick up the crochet needle with right hand, push the needle through the first loop (between yarn and finger), hook the second loop and pull through the first loop.

Present to the child by untying the yarn and placing the yarn and the needle on the table in front of the child.

Braid Doll's Hair

Model. Place the doll flat on the table with hair out flat away from the doll's head. Divide hair into three chunks. Take both side chunks and cross each individually over the middle chunk, forming and "X".

Present to the child by placing the doll flat on table with hair stretched out.

Approximation. Considered an approximation if hair is divided into three chunks, and two crossing motions are made with any of the hair chunks.

Put Tie on Around Neck

Model. Put the tie around neck, hold each end with one hand and cross one end over the other. Then pull the other end over the horizontal end from the top.

Present the tie to the child by placing it on the table in front of the child.

Approximation. Considered an approximation of the tie is place around neck, the two ends are crossed over each other, and a motion it made to pull the back end over the front end.

Place Pencil Behind Ear

Model. Pick up the pencil and slide behind ear from front to back.

Present the pencil to the child by placing it on the table in front of the child in parallel fashion to the table edge.

Approximation. Any motion that involves picking up the pencil and placing it near the ear in a front-to-back movement.

Make Peace Sign with Hand Above Head

Model. Place hand above head front back of head and make a "V" with index and middle finger.

Approximation. Considered an approximation if hand is placed on head from back of head or sides of head, and a "V" is made with index and middle finger.

Touch Fingers of Both Hands Consecutively

Model. Touch the finger tips of both hands together by starting and ending with the thumb touching the pinkie.

Wink

Model. Wink both eyes, one at a time.

Approximation. Winking twice, even with the same eye.

Create "church and steeple" with hands

Model. Intertwine all fingers of both hands together, except for the index fingers and thumbs. Push the palms of both hands together and form triangles with the index fingers and thumbs.

Approximation. Considered an approximation if at least two sets of fingers are intertwined and the palms of both hands are brought together. The formation of the triangles with the index fingers and thumbs is not required.

Snap Fingers

Model. Touch middle finger and thumb of either hand together and snap, making cracking sound.

Approximation. Considered an approximation if the thumb is touched to the middle or index finger and snapped. Cracking sound is not required.

Touch Both Shoulders

Model. Touch the left shoulder with the right hand by crossing the right arm over behind the head. And then touch the right shoulder with the left arm by crossing the left arm over behind the head.

Approximation. Considered an approximation as long as the left arm is crossed over behind the head to the vicinity of the left shoulder (touching not required) and the right arm is crossed over behind the head to the vicinity of the left should (touching not required). The order of left versus right shoulder first can vary.

Clasp Hands Together Over Head

Model. Position both hands above the head from the sides of the head, and clasp hands together intertwining the fingers of both hands.

Approximation. Considered an approximation if hands, positioned above the head from the sides of head and are clasped together. Intertwining of the fingers is not required.

"Patty Kate" Moves

Model. Cross both arms in front of chest making an "X", the touching shoulders with opposite hands, clap hands together in front of chest, extend right hand, clap hands together again, and then extend left hand.

Approximation. Considered and approximation if arms are crossed in front of chest creating an "X", then hands are clapped together and each hand is extended and retrieved in succession.

Walk Two Fingers Over Length of Head

Model. Position hand behind head and move up to the top of the head. Walk the index and middle fingers (with other fingers tucked in) over the length of the head from back to front until the hairline.

Approximation. Considered an approximation if the hand is place above the head from the back, and then the index and middle fingers are walked over the top of the head from back to front, even if the other fingers are not tucked in.

Appendix B

Interobserver Agreement and Procedural Reliability Tables

Table B1

Interobserver Agreement data on Matching Responses for Min

	Baseline	Training	DRO 0-sec	Training
Training P1	100%	98%	99%	97%
Probe P1	100%	97%	98%	98%
Training P2	100%	98%	99%	97%
Probe P2	100%	97%	98%	98%

Interobserver Agreement data on Matching Responses for Will

	Baseline	DRO 0-sec	Training	DRO 0-sec	Training
Training P1	100%	99%	98%	99%	98%
Probe P1	100%	100%	97%	98%	98%
Training P2	100%	99%	98%	99%	98%
Probe P2	100%	100%	97%	98%	98%

Interobserver Agreement data on Matching Responses for Winnie

	Baseline	DRO 0-sec	Training	DRO 0-sec	Training
Training P1	100%	98%	97%	98%	99%
Probe P1	100%	100%	95%	96%	98%
Training P2	100%	98%	97%	98%	99%
Probe P2	100%	100%	95%	96%	99%

Table B2

Correct Experimenter Modeling for Min

	Baseline	Training	DRO 0-sec	Training
Training P1	100%	100%	100%	100%
Probe P1	100%	100%	100%	100%
Training P2	100%	100%	100%	100%
Probe P2	100%	100%	100%	100%

Correct Reinforcer Delivery by Experimenter for Min

	Baseline	Training	DRO 0-sec	Training
Training P1	100%	100%	95%	100%
Probe P1	100%	98%	100%	100%
Training P2	100%	100%	95%	100%
Probe P2	100%	98%	100%	100%

Note: P1 and P2 refer to the two response properties according to which training took place.

Table B3

Correct Experimenter Modeling For Will

	Baseline	DRO 0-sec	Training	DRO 0-sec	Training
Training P1	100%	100%	100%	100%	100%
Probe P1	100%	100%	100%	100%	100%
Training P2	100%	100%	100%	100%	100%
Probe P2	100%	100%	100%	100%	100%

Correct Reinforcer Delivery by Experimenter for Will

	Baseline	DRO 0-sec	Training	DRO 0-sec	Training
Training P1	100%	98%	97%	99%	100%
Probe P1	100%	100%	99%	100%	100%
Training P2	100%	98%	97%	99%	100%
Probe P2	100%	100%	99%	100%	100%

Note: P1 and P2 refer to the two dimensions along which training took place.

Table B4

Correct Experimenter Modeling for Winnie

	Baseline	DRO 0-sec	Training	DRO 0-sec	Training
Training P1	100%	100%	100%	100%	100%
Probe P1	100%	100%	100%	100%	100%
Training P2	100%	100%	100%	100%	100%
Probe P2	100%	100%	100%	100%	100%

Correct Reinforcer Delivery by Experimenter for Winnie

	Baseline	DRO 0-sec	Training	DRO 0-sec	Training
Training P1	100%	100%	99%	98%	100%
Probe P1	100%	100%	96%	100%	98%
Training P2	100%	100%	99%	98%	100%
Probe P2	100%	100%	96%	100%	98%

Note: P1 and P2 refer to the two response properties according to which training took place.

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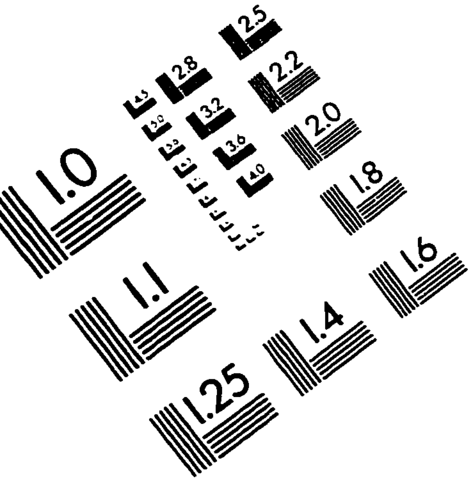
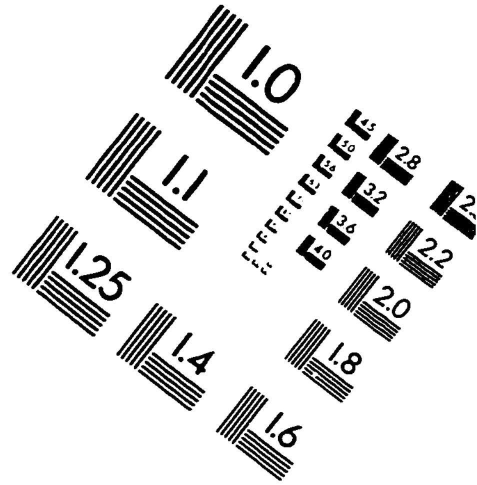
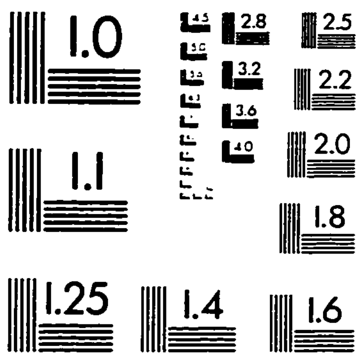
IMAGE EVALUATION TEST TARGET (QA-3)







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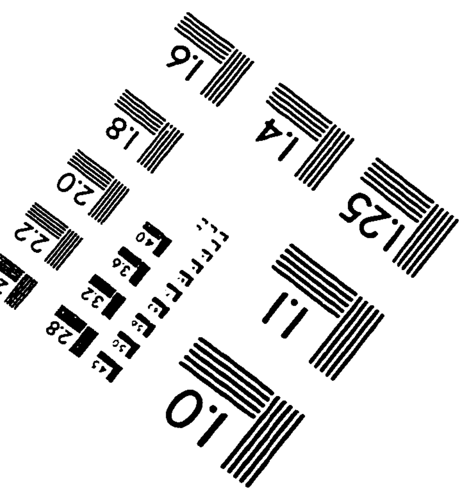

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