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RESPONSE-CLASS FORMATION ACROSS FRENCH, GREEK, AND TURKISH WORDS IN GENERALIZED VOCAL IMITATION BY PRESCHOOL CHILDREN

by

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

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Abstract

RESPONSE-CLASS FORMATION ACROSS FRENCH, GREEK, AND TURKISH WORDS IN GENERALIZED VOCAL IMITATION BY PRESCHOOL CHILDREN

by

Nursel Kahya

Adviser: Professor Claire L. Poulson

Generalized imitation of words within French, Greek, and Turkish languages was investigated in three normally developing preschool children. During 20-minute experimental sessions vocal responses were modeled for the child by an adult. Models consisted of French, Greek, and Turkish words containing phonemes that do not exist in English. Six phonemes were selected to serve as discriminative stimuli to be modeled: two each from French, Greek, and Turkish languages. Then, for each of these phonemes, six two-syllable and six three-syllable words containing the phonemes in the initial position were identified. The dependent measures were the percentages of the targeted phonemes and the percentages of whole words per session that were matched by the child within three seconds of the model. Whole words were modeled, but reinforcement was contingent upon the child matching the targeted phonemes only. During each session 72 words were modeled. Of these, there were 54

words during training trials for which correct articulation of the phonemes was reinforced. There were 18 words during probe trials for which matching of the phonemes was not reinforced. Generalized imitation training was introduced in a multiple-baseline experimental design across the pairs of French, Greek, and Turkish phonemes. There were two experimental conditions: model-alone and model-and-reinforcement. During the model-alone condition the experimenter modeled the words with no differential consequences for matching the phonemes. During the model-and-reinforcement condition, matching of the phonemes produced reinforcement, and non-matching produced a correction procedure.

After the experimental question was answered, an extra training procedure was implemented for those phonemes for which the children had not been entirely successful. These extra training sessions occurred immediately prior to their regular experimental sessions, which remained unchanged. During the extra training procedure only the targeted phonemes were modeled and reinforcement was contingent upon correct phoneme productions.

There were three primary findings. First, reinforcement of phoneme matching produced primary generalization of the targeted phonemes from the trained word context to the non-trained word context. Second, reinforcement of phoneme matching produced generalized imitation of words during training trials. Third, reinforcement of phoneme matching during training trials produced generalized imitation of words during probe trials. Implications concerning

primary generalization and the formation of response classes within the class of vocal generalized imitation are discussed.

I dedicate this experience and this work to my mother, Müşerref Balkaç with love and appreciation for her enthusiastic support. Even though she was miles away, she was always there for me.

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Table of Contents

List of Tables

List of Figures

If one assumes that children learn most of their communicative responding through contingent reinforcement, it would require a tremendous amount of time for parents and teachers to shape the full range of social and linguistic behavior that children display. Fortunately, modeled behavior may evoke increasingly mature child social and linguistic behavior for parents and teachers to reinforce, so that very lengthy and sophisticated shaping procedures alone may not be required. Thus, much imitative responding may be reinforced. Furthermore, unreinforced imitative responses frequently are emitted when they occur in the context of reinforced imitative responses. This phenomenon is called generalized imitation.

Generalized imitation is defined as the occurrence of novel, nonreinforced modeled responses that are emitted when other modeled responses are associated with reinforcement (Baer & Deguchi, 1985). Generalized imitation has been widely studied. It has been demonstrated to occur in typically developing infants (Gena, Poulson, Kymissis, Andreatos & Kyparissos, 1997; Poulson & Kymissis, 1988; Poulson, Kymissis, Reeve, Andreatos & Reeve, 1991; Poulson, Andreatos, Kyparissos, Kymissis & Parnes, 1993), in infants with developmental disabilities (Poulson, Andreatos, Parnes & Kymissis, 1997), in infants with Down Syndrome (Poulson, Parnes, Andreatos & Kymissis, 1997), in typically developing children (Baer & Sherman, 1964; Brigham & Sherman, 1968; Steinman, 1970a, 1970b), in children with autism (Young, Krantz, McClannahan & Poulson, 1994), in retarded children (Baer, Peterson & Sherman, 1967; Furnell & Thomas, 1976; Garcia, Baer & Firestone, 1971;

Schroeder & Baer, 1972), and in schizophrenic children (Lovaas, Berberich, Perloff & Schaeffer, 1966).

One of the characteristics of generalized imitation is that the probability of unreinforced matching behavior increases or decreases systematically when reinforcement is introduced or withheld contingent on other matching behavior (Baer & Deguchi, 1985). It is this characteristic that leads one to conclude that generalized imitation meets the definition of a functional response class as defined by Skinner (1938). Functional response classes are not defined by common physical properties of stimuli or responses, but by common behavioral functions. The defining property of a functional response class is determined by the conditions of reinforcement. That is, when some members of a class of responses are associated with reinforcement, other members function as though they, too, had been associated with reinforcement. This characteristic of a functional response class is observed in the studies of generalized imitation. For example, in the earliest published study of generalized imitation (Baer & Sherman, 1964), it was demonstrated that four different responses formed one generalized imitative response class. In that study, a puppet was used to model head nodding, mouthing, and strange vocalizations for imitation by the preschool children. A fourth modeled response, bar-pressing, was interspersed among the other three modeled responses. Although bar-pressing was never reinforced, matching of bar-pressing increased when reinforcement followed the other three imitative responses.

The extent to which physical or topographical properties of modeled responses or matching responses may participate in the development of generalized imitation is not clear. Nevertheless, there is some evidence that response topography could play a role in the development of generalized imitation. Garcia, Baer & Firestone (1971) investigated generalized imitation within preselected topographical response boundaries. Four 8- to 14-year old severely retarded children were taught small-motor, large-motor, and short-vocal responses sequentially by modeling. A systematic increase in matching was observed during training trials when the responses were followed by social reinforcement. During probe trials matching also systematically increased even though it was never associated with reinforcement. Generalized imitation occurred within the topographical response boundaries, but imitation did not generalize across response types. A fourth response type, long-vocal, was not included in the training procedure, but was included in testing for generalization. Matching short-vocal responses did not generalize to long-vocal responses.

Poulson et al. (1993) demonstrated generalized imitation in 12- to 14-month old normally developing infants in which the topography of responses set the boundaries of response classes. Three types of responses, motor-with-toy, motor-without-toy, and vocal were modeled. Responses were modeled by the infant's mother. During training trials infant matching produced contingent social praise by the mother. Infant matching during probe trials, which were interspersed among training trials, was never reinforced. The results of this study show that, contingent upon reinforcement, infant matching increased

during the training trials of motor-with-toy. A systematic increase in matching was observed during probe trials of motor-with-toy when matching during training trials of the same type of responses continued to be reinforced. Infant matching during training and probe trials of two other types of responses remained at baseline levels. Introducing the treatment procedure to motor-without-toy and vocal responses resulted in a similar finding. In other words, generalized imitation was observed within response classes, not across response classes.

In a replication of Poulson et al. (1993), Young et al. (1994) obtained similar results with four autistic children. The three response topographies were vocal, pantomime and toy-play; edibles and contingent verbal praise were used as reinforcers. The procedure and the general findings were the same as in the Poulson et al. study.

The results of these three studies (i.e., Garcia et al., 1971; Poulson et al., 1993; and Young et al., 1994) have shown that there are boundaries in the formation of generalized imitative response classes. That is, reinforcing one set of imitative responses does not necessarily result in the imitation of all models, regardless of the type of response modeled. In these studies imitative vocal responding was found to form a separate response class from other non-vocal imitative responses. The Garcia et al. (1971) study may appear to be an exception, because short-vocal and long-vocal responses did not co-vary following the introduction of treatment for short-vocal responses. Nevertheless, it appears that long-vocal responses, which consisted of whole words, might have been well outside the repertoires of these severely retarded subjects to begin

with. They were selected as participants in the study precisely because they were non-imitative, and because they emitted no words. There is no evidence that any of them ever emitted a consonant sound, and the short-vocal training and probe models consisted entirely of vowel sounds. The data for all four subjects show that throughout the study no subject ever matched when a vowel-consonant word was modeled. Therefore, word matching might not have been free to vary with the introduction of reinforcement for vowel matching. Thus, with the possible exception of that study, vocal imitative responses appeared to form a single response class. The extent to which phonemes become members of syllable or word classes through a treatment procedure is an empirical question.

One cannot make the assumption that primary generalization from training individual phonemes will occur in new and different contexts (e.g. word, syllable, etc.) in the absence of further training in those contexts. Researchers and clinicians in articulation therapy have been interested in identifying factors that facilitate generalization of target phoneme from training context to untrained contexts (Bennett, 1974; Elbert & McReynolds, 1978; McLean, 1970; McReynolds & Elbert, 1981; Powell & McReynolds, 1969; Weaver-Spurlock & Brasseur, 1988). When teaching phoneme articulation, generalization was demonstrated: (a) from trained blends to untrained blends in children with articulation problems (McReynolds & Elbert, 1981); (b) from trained nonsense syllables to untrained nonsense syllables in children of typical development (Elbert & McReynolds, 1978; Waever-Spurlock & Brasseur, 1988); and (c) from trained words to untrained words in children of typical development (Powell &

McReynolds, 1969), and in males with developmental disabilities (McLean, 1970). The training procedure used in all these studies involved shifting control of the correct responses from matching modeled responses to labeling pictures. The main focus of those studies was to identify procedures that increase the frequency of correct sound production from trained exemplars to untrained exemplars.

The purpose of this investigation was as follows: (a) to show primary generalization of the targeted phonemes (non-English) from one word context to a different word context by using an imitation training procedure; (b) to show generalized imitation of words during training trials when the targeted phoneme imitation is associated with reinforcement; (c) to show generalized imitation of words during probe trials when the targeted phoneme imitation during training trials is associated with reinforcement; and (d) to analyze whether the targeted phonemes within language types will define the boundaries of vocal response classes in generalized imitation.

Method

Participants

The participants were three normally developing preschool children, one girl and two boys. The children were recruited through posters distributed on and near the Queens College campus, and by word of mouth. The children were from middle class families living in Queens. The mothers of all three children were college students.

During the initial visit the mothers confirmed that their children had no visual or hearing deficits. Furthermore, to determine whether a child had in his/her repertoire the targeted phonemes used in this experiment, the following screening procedure was implemented prior to formal pretesting and collection of baseline data: (a) the mothers were asked what language(s) they spoke at home, (b) the targeted phonemes were modeled for the mothers, who were asked whether their children had these phonemes in their repertoires, (c) the experimenter consulted professors in the Linguistics Department of Lehman College and the Graduate School of the City University of New York to determine the targeted phonemes' existence in languages that the participants were exposed to, and (d) during the initial visits, the experimenter observed the children to see whether they emitted any of the targeted phonemes used in the present experiment. It was determined that none of the targeted phonemes were in the repertoires of children who participated in this experiment.

Following are brief descriptions of the three participants:

Lori was three years and eight months old at the beginning of the experiment, and four years and two months old at the end. Her mother was Polish and her father was Pakistani. Lori was exposed at home to three languages, Polish, Urdu, and English.

Oscar was four years and eight months old at the beginning of the experiment, and five years and two months old at the end. He spoke Mandarin and English. At the beginning of the experiment Oscar's receptive language was

better than his expressive language. Nevertheless, his expressive language improved as the experiment progressed.

Ari was six years old at the beginning of the experiment, and six years and two months old at the end. He spoke English only.

Setting and Apparatus

The experiment was conducted in an experimental room at the Infant and Child Laboratory of the Department of Psychology at Queens College/CUNY. The room contained a table, measuring 44.5cm by 75.5 cm, an adult-size chair, and a high-chair. The experimenter and the child sat across the table facing each other. The table top was divided in two to mark the experimenter's and the child's sides of the table. A list of stimuli was placed in a copy-holder on the experimenter's side of the table in view of the experimenter. Two cups, one containing checkers and the other dried beans, were also placed on the experimenter's side of the table where they were visible to the child. A cardboard strip, measuring 7 cm by 27.5 cm, divided into 10 sections, was placed on the same side of the table as that on which the experimenter placed the beans earned by the child. The child was not permitted to touch any of these items. Earned checkers were handed to the child to fill the premarked spaces on a different cardboard strip. This strip measured 10.5 cm by 23.9 cm, divided into 10 sections, and was placed in front of the child. When a cardboard strip was filled with checkers it was moved to a chair next to the table visible to the child, but out of his/her reach. The stickers, candy basket, juice, and extra cardboard strips for the checkers were placed on a booster chair to the experimenter's right

and within her reach. Two video recording cameras, Panasonic model WV-3260/8AF, mounted on tripods, were used. One of these was used to record a frontal view of the participant. The other one was used to record a frontal view of the experimenter. A Panasonic WJ-3500 special-effects generator system switcher created a vertically split image allowing the experimenter and the child to appear simultaneously on a 20-inch color TV monitor. The Panasonic CTL-2062R TV monitor was placed behind the child's seat in view of the experimenter. This arrangement permitted recording of the child's and the experimenter's behavior from the video tapes. This also enabled the observers to make judgments on whether the presentations of modeled words were the same for training and probe trials during the model-alone and the model-and-reinforcement experimental conditions and the extra training procedure. A Marantz PDM 221 tape recorder was also used to record the responses, because it allowed slowing and speeding of the play back.

Stimuli

Pretest-1. To determine the extent to which the child accurately imitated any spoken words, the experimenter modeled 72 English stimulus words for the child to imitate. These words were the English counterparts of the French, Greek, and Turkish words that were to be modeled during the experiment. The purpose of this test was to determine whether the child (a) looked at the experimenter while remaining in his/her seat during modeling and responding, (b) followed the experimenter's instructions, and (c) already matched the modeled words without reinforcement.

Pretest-2. To determine the extent to which the child already imitated the French, Greek, and Turkish phonemes used in this experiment, 54 nonsense words and 18 stimulus words were modeled for the child to imitate. Each nonsense word contained one of the targeted phonemes. The 18 stimulus words were chosen from the words to be used during training trials of French, Greek, and Turkish languages and were interspersed among the 54 nonsense words.

Stimulus sets. Six phonemes not found in English were selected to serve as discriminative stimuli to be modeled: two each from French, Greek, and Turkish languages (see Table 1). Then, for each of these targeted phonemes, six two-syllable and six three-syllable words containing the targeted phonemes in the initial position were identified. This resulted in 24 words each in French, Greek, and Turkish, for a total of 72 words. Some words would be used during training trials. That is, the imitation of the targeted phoneme in a modeled word would produce reinforcement. Other words would be used during probe trials. That is, the imitation of the targeted phoneme in a modeled word would not produce reinforcement (see Table 2). The resulting models, 72 per session, included 54 training-trial words and 18 probe-trial words. A controlled randomization pattern was used in constructing 18 stimulus sets such that each targeted phoneme and each word of each language would have an equal probability of being modeled across sessions. The stimulus sets were constructed according to the following rules: (a) Every word appeared in each

Table 1

The phonetic symbol and a description of the phonemes from each language targeted in the present experiment

Languages	Phonetic Symbols	Descriptions
French	[ö]	front mid rounded vowel
French	[ɑ̃]	nasalized low back unrounded vowel
Greek	[ɣ]	voiced velar fricative
Greek	[p^{ϡ}]	voiceless bilabial aftricate
Turkish	[ü]	front high rounded vowel
Turkish	[ŕ]	alveolar trill

Table 2

The words modeled for the child to imitate

	Training Trial Two-Syllable Words	Probe Trial Two-Syllable Words	Training Trial Three-Syllable Words	Probe Trial Three-Syllable Words
French [ö]	semoule bedaine jeter tenable	celer belette	menacer besogner demimot petitesse venimeux	demiclef
French [ɶ̃]	enclos enter endive endos enfler	envie	encager encoller endiguer endemie	entamer enfilade
Greek [pˢ]	psallo psemma psilos psomas	psino psomi	psalithi pselisma psihoula psilono psonistis	psathoto
Greek [ɣ]	gala gati gamos goma gofos	gonos	gavatha galanos gonato gonicos	ganoma gouninos
Turkish [ŭ]	ŭçgen ülke ûstad ütme ŭye	ŭnlem	ŭflemek ŭmitsiz ûstyapı ûveyik	ünsiyet üzengi
Turkish [ř]	rakam rakı renkli rhtım	reçel rica	rahatlık randıman rivayet resimli rutubet	refakat

stimulus set only once, but never in the same position across sets, (b) the order of interspersing probe-trial words among training-trial words was different for each set, (c) no probe-trial word appeared in the first two or last two positions of a stimulus set, (d) two probe-trial words never appeared consecutively within a stimulus set, (e) a maximum of two occurrences of the same phoneme appeared consecutively in a set, and (f) the number of syllables in a word were counterbalanced within each stimulus set such that the same number of two- and three-syllable words occurred in each language.

Response Definition

To be scored, a child's response had to occur within three seconds of the offset of the modeled response. Each child's response was scored as one of the following: (a) matching the phoneme, (b) matching the whole word, (c) approximating the whole word, (d) emitting no vocalization, and (e) emitting an "other vocalization." The child's response was scored as matching the phoneme if the child matched only the targeted phoneme in the modeled word. The child's response was scored as matching the whole word if the child matched both the targeted phoneme and the word context in the modeled word. The child's response was scored as approximating the whole word, rather than matching phoneme or whole word, if the child correctly matched the word context but the targeted phoneme in a modeled word. If the child was silent during three seconds following the model, his/her response was scored as "no vocalization." When the child vocalized anything other than the targeted phoneme or the word context, his/her response was scored as an "other vocalization."

Dependent Measures

The dependent measures were the percentages of phonemes (targeted) and the percentages of whole words (the targeted phoneme and the word context) per session that the child matched within three seconds of the modeling of the word.

Procedures

General procedure. The child came to the laboratory accompanied by his/her mother, and sometimes as well by the father or the siblings. The primary experimenter then accompanied the child from the reception room to the experimental room, which was described above. Once inside the room the experimenter showed the child two types of token that could be exchanged for two types of back-up reinforcer. The first type of token, checkers, was for the child's matching responses. The experimenter showed the child the back-up reinforcers for tokens to be earned. These back-up reinforcers were the trinkets and books that the child could take home or the toys that he/she could play with for one to three minutes in the room. The second type of token, beans, was for the child's attending. Back-up reinforcers for the beans were variety of stickers, candies, or juice boxes. Each day the back-up reinforcers were rotated and at least two new items were added to the display. After choosing the back-up reinforcers, the child and the experimenter sat by the table facing each other. A trial started with the experimenter modeling a word. At the onset of each trial, the experimenter modeled a word by saying, "Say [word]" and waited for three seconds for the child to respond. The trial ended when the experimenter

delivered the consequence for the child's response. A session consisted of 72 trials and lasted approximately 20 minutes. Sessions were conducted three to six days a week, depending upon the availability of each family to participate. At the end of each session the child exchanged the earned checkers for back-up reinforcers. Bonuses were given for earning 20 or more checkers. Bonuses consisted of more back-up reinforcers. Number of required checkers to be earned for the bonuses gradually changed from 20 to 50.

Attending. To maintain the strength of the modeled response as a discriminative stimulus, a second type of token, dried beans, was presented contingently upon the child keeping his/her head up and looking at the experimenter while his/her hands remained under the table and his/her feet rested on the step of the high-chair. The beans were delivered at the end of a trial along with descriptive praise such as, "Very good, you looked at me. You get a bean." The child exchanged the beans for the back-up reinforcers every time he/she earned three beans. The child sometimes exchanged the beans for the back-up reinforcers later during the session if he/she verbally requested to do so. At the beginning of the experiment the beans were delivered on a CRF (continuous reinforcement) schedule. As soon as possible the schedule of bean delivery was faded to an intermittent schedule to reduce the session length.

Types of Trials

There were two types of trials: training trials and probe trials.

Training trials. The experimenter modeled the word and waited for three seconds for the child's response and provided reinforcement or a correction

procedure. A matching response, whether it was a phoneme or a whole word produced a token and an experimenter praise statement, "[the word], you said it correctly, very good!" If the child's response was a word approximation, no vocalization, or an "other vocalization," a correction procedure was used. In the correction procedure, the experimenter said "let's try it again" and modeled the word one more time. If the child emitted a matching response (either the targeted phoneme or both the targeted phoneme and the word context) after the correction procedure, the experimenter would tell the child that his/her response was correct (e.g. "very good, you said it correctly!"). Nevertheless, corrected responses did not earn a token. During the correction procedure, if the child did not emit a matching response within three seconds of the model, the experimenter told the child to "try again the next time" the word was modeled during the next session.

Probe trials. The experimenter modeled the word and waited for three seconds for the child's response, but provided no reinforcement or correction procedure. At the end of each probe trial the experimenter told the child the meaning of the word after repeating the word, e.g. "PSE'-LI-SMA is to whisper." This procedure was used to ensure that during training and probe trials the child was not exposed to the phonemes with differential frequency. Exposure to the phonemes with differential frequency could have occurred without this procedure, because during training trials the experimenter repeated the word at the end of each trial within the context of reinforcement and correction procedures.

Experimental Conditions

The two types of experimental conditions used were model-alone and model-and-reinforcement. Following the model-and-reinforcement condition an extra training procedure was implemented to facilitate mastery of the production of some of the phonemes.

Model-alone condition. During training and probe trials, the experimenter modeled the word and waited for three seconds for the child's response, but she provided no reinforcement or correction procedure. To ensure the child's exposure to the phonemes with the same frequency as in the model-and-reinforcement condition, during the model-alone condition at the end of each trial the experimenter told the child the meaning of the word after repeating the word.

Model-and-reinforcement condition. During training trials, the experimenter modeled the word and waited for three seconds for the child's response. Then the experimenter provided reinforcement or a correction procedure dependent upon the child's matching or non-matching response. During probe trials, the experimenter modeled the word and waited for three seconds for the child's response, but she provided no reinforcement or correction procedure.

Extra training procedure

After the experimental question was answered, an extra training procedure was implemented to facilitate mastery of the production of all of the phonemes. If the child had only infrequently emitted one of the two phonemes in

a given phoneme pair, additional training, specifically designed for that phoneme, was implemented before the regular sessions. During this additional training the experimenter modeled the phoneme while exaggerating tongue positions and lip movements. She modeled the targeted phoneme 30 to 50 times per extra training session. This allowed the child to see how the phoneme was produced and gave the child many opportunities to utter the targeted phoneme and to receive reinforcement for correct phoneme production. Each additional training session lasted approximately for 10 minutes. The procedure used during the regular sessions following the extra training procedure was identical to the procedure used during the model-and-reinforcement condition.

Experimental Design

Generalized-imitation training was introduced in a multiple-baseline experimental design across pairs of French, Greek, and Turkish phonemes. For each child the introduction of the model-and-reinforcement condition for the three languages was in a different order.

Generalization to a Second Experimenter

Generalization across experimenters was assessed by having a second experimenter conduct some of the sessions. Unlike the primary experimenter, who spoke English with a Turkish accent, the second experimenter did not have a foreign accent. To compare data obtained during sessions conducted by the primary and the secondary experimenters, the secondary experimenter's data were obtained from one session and the primary experimenter's data were obtained from three sessions immediately preceding the session conducted by

the second experimenter. For Ari, the second experimenter conducted one session for each language prior to the introduction of the model-and-reinforcement condition and another at the end of the experiment. Thus, there were three sessions during the model-alone condition and one session following the extra training procedure for Ari. Lori and Oscar had already begun participating in the experiment when the idea of obtaining such generalization data arose, so it was too late to obtain generalization data from them. Thus, for Lori and Oscar only post-treatment measures were obtained by the second experimenter following the extra training procedure.

Data Collection and Interobserver Agreement

All data were obtained from video and audio tapes. Should an observer have difficulty scoring a particular child response, he/she used the audio tape. Those trials, during which agreement fell below 80% were rescored up to three times independently, whether from the video tapes or the audio tapes.

Two independent observers scored every session. One person with a Ph.D. in Psychology, three doctoral students, one master level student, and two undergraduate students served as observers. Because the person with the Ph.D. degree had conducted a similar study, she required no training on data collection. All other observers required training to collect data prior to serving as an observer in this experiment. A point-by-point method was used to calculate interobserver agreement (Kazdin, 1982). Interobserver agreement was calculated by dividing the number of agreements by the number of agreements and disagreements and multiplying the quotient by 100.

Data Analysis

The raw data were converted to percentages of training and probe trials for each session. Mean percentages of training and probe trials during the model-alone, the model-and-reinforcement conditions and the extra training procedure were obtained for the following responses: phoneme matching and word matching. Data were analyzed across three languages for each child.

Procedural Reliability Measures

Procedural reliability measures were obtained on (a) correct modeling, (b) correct token delivery for phoneme matching, and (c) correct token delivery for word matching.

Correct modeling. Correct modeling concerns the extent to which the experimenter correctly modeled the word for the child to imitate. Occasionally, the experimenter omitted a word from the stimulus set or modeled the wrong word. During model-alone training trials the experimenter modeled the word correctly during 99-100% of 3541 trials. During model-and-reinforcement training trials the experimenter modeled the word correctly during 99-100% of 4986 trials. During the extra training procedure for training trials the experimenter modeled the word correctly during 100% of 1728 trials. During model-alone probe trials the experimenter modeled the word correctly during 97-100% of 1181 trials. During model-and-reinforcement probe trials the experimenter modeled the word correctly during 99-100% of 1661 trials. During the extra training procedure for probe trials the experimenter modeled the word correctly during 100% of 576 trials. For all three children the interobserver

agreement was 100% across languages during training and probe trials of the model-alone, the model-and-reinforcement conditions, and the extra training procedure.

Correct token delivery for phoneme matching. Token delivery for phoneme matching concerns the extent to which child matching of the phoneme produced a scheduled reinforcer. Table 3 and Table 4 show percentages of phoneme matching responses that produced reinforcement during training (Table 3) and probe trials (Table 4) of the model-alone, the model-and-reinforcement conditions, and the extra training procedure. The total number of phoneme matching responses per experimental condition and the extra training procedure is also shown in Table 3 and Table 4. During the model-alone condition for training trials and all three conditions for probe trials the experimenter never gave a reinforcer to any of the children after matching the phoneme. For all three children the percentage of correct token delivery during training trials was within the range of 86% to 97% during the model-and-reinforcement condition and 87% to 100% during the extra training procedure.

The interobserver agreement data on correct token delivery for phoneme matching was 100% across languages and experimental conditions and extra training procedure for all three children (not shown in any table).

Correct token delivery for word matching. Token delivery for word matching concerns the extent to which child matching of the modeled word produced a scheduled reinforcer. Table 5 and Table 6 show percentages of word matching that produced reinforcement during training (Table 5) and probe

Table 3

Percentages and numbers of phoneme matching responses that produced reinforcement during training trials

Child's name	Language	Model-Alone		Model-and- Reinforcement		Extra Training	
		%	# of responses	%	# of responses	%	# of responses
LORI	French	0	9	97	636	100	237
	Greek	0	51	93	286	99	177
	Turkish	0	47	95	78	96	168
OSCAR	French	0	54	94	457	98	83
	Greek	0	7	92	66	100	66
	Turkish	0	13	96	633	99	92
ARI	French	0	44	91	104	95	174
	Greek	0	13	96	431	98	186
	Turkish	0	10	86	222	87	102
TOTAL		0	248	94	2913	97	1285

Table 4

Percentages and numbers of phoneme matching responses that produced reinforcement during probe trials

Child's name	Language	Model-Alone		Model-and- Reinforcement		Extra Training	
		%	# of responses	%	# of responses	%	# of responses
LORI	French	0	3	0	210	0	80
	Greek	0	22	0	95	0	55
	Turkish	0	6	0	29	0	55
OSCAR	French	0	21	0	139	0	26
	Greek	0	1	0	23	0	22
	Turkish	0	1	0	234	0	35
ARI	French	0	21	0	37	0	57
	Greek	0	3	0	142	0	59
	Turkish	0	4	0	79	0	34
TOTAL		0	82	0	988	0	423

Table 5

Percentages and numbers of word matching responses that produced reinforcement during training trials

Child's name	Language	Model-Alone		Model-and- Reinforcement		Extra Training	
		%	# of responses	%	# of responses	%	# of responses
LORI	French	0	9	97	589	100	233
	Greek	0	35	93	255	99	157
	Turkish	0	37	97	61	96	149
OSCAR	French	0	27	94	368	97	70
	Greek	0	7	93	46	100	53
	Turkish	0	10	97	436	99	81
ARI	French	0	40	92	99	95	164
	Greek	0	2	98	352	98	165
	Turkish	0	10	87	196	86	91
TOTAL		0	177	95	2402	97	1163

Table 6

Percentages and numbers of word matching responses that produced reinforcement during probe trials

Child's name	Language	Model-Alone		Model-and- Reinforcement		Extra Training	
		%	# of responses	%	# of responses	%	# of responses
LORI	French	0	3	0	203	0	80
	Greek	0	10	0	68	0	40
	Turkish	0	3	0	26	0	43
OSCAR	French	0	19	0	139	0	26
	Greek	0	0	0	23	0	19
	Turkish	0	1	0	174	0	34
ARI	French	0	19	0	37	0	57
	Greek	0	0	0	124	0	56
	Turkish	0	4	0	78	0	34
TOTAL		0	59	0	872	0	389

trials (Table 6) of the model-alone, the model-and-reinforcement conditions, and the extra training procedure. The total number of word matching responses per experimental condition and extra training procedure is also shown in Table 5 and Table 6. During the model-alone condition for training trials and two experimental conditions and extra training procedure for probe trials the experimenter never gave a reinforcer to any of the children after matching the whole word. For all three children the percentage of correct token delivery during training trials was within the range of 87% to 98% during the model-and-reinforcement condition and 86% to 100% during the extra training procedure.

The interobserver agreement data on correct token delivery for word matching was 100% across languages and experimental conditions and extra training procedure for all three children (not shown in any table).

Results

The results of this experiment are described in four sections: (a) phoneme matching, (b) word matching during training trials, (c) word matching during probe trials, and (d) the summary of findings on word matching. Phoneme matching concerns the children's correct utterances of the targeted phonemes trained in one word context and assessed in a different word context. Word matching during training trials concerns the extent to which children's matching consisted of matching both the targeted phoneme and the word context, rather than the targeted phoneme alone. Word matching during probe trials concerns the extent to which imitation training on one set of words produced matching of

another set of words in which the phonemes were never associated with reinforcement. The summary of findings on word matching concerns the extent to which imitation training on the targeted phoneme in modeled words during training trials produced matching of the words during probe trials.

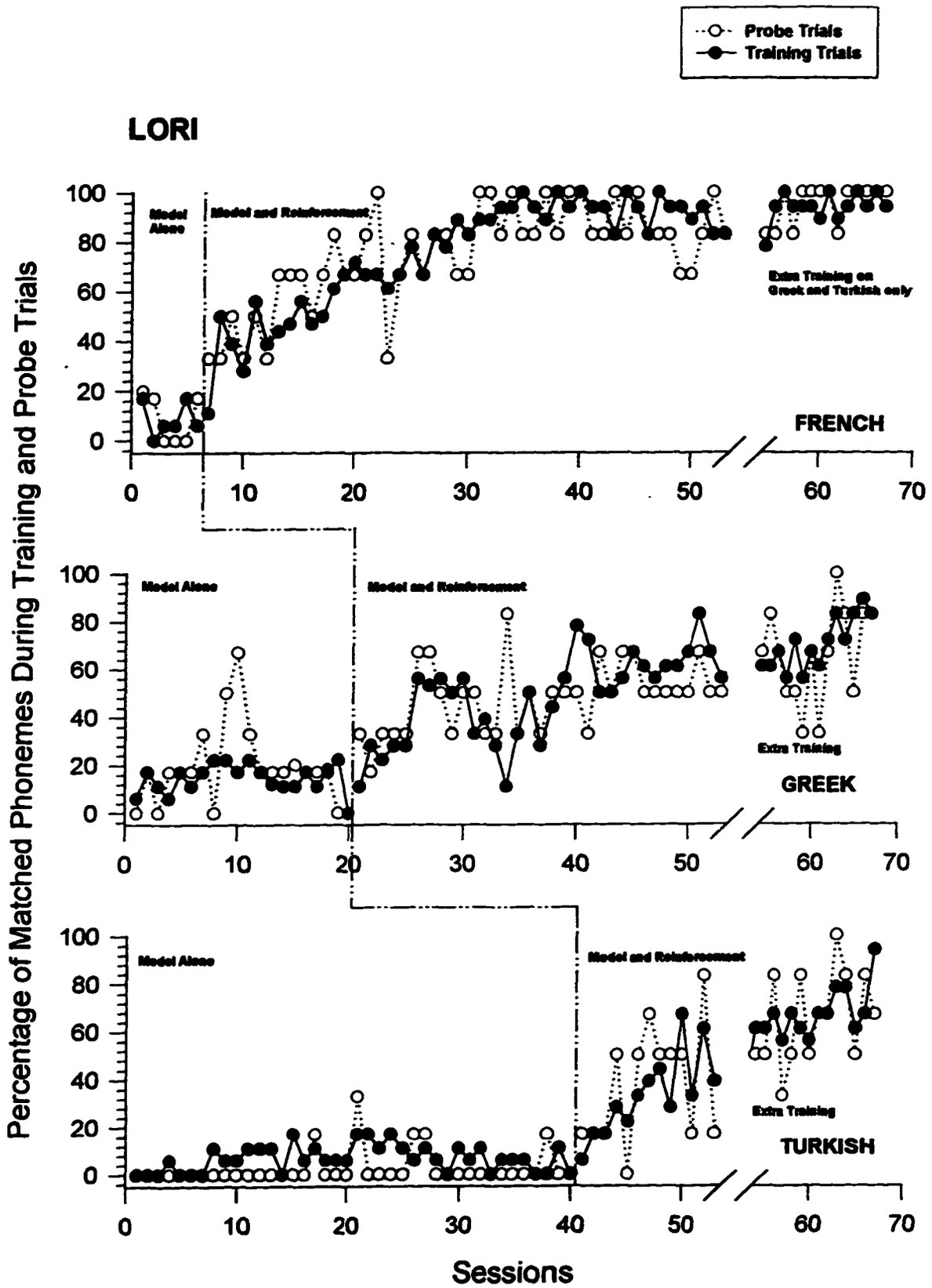
Phoneme Matching

Figures 1 through 3 show the percentages of phonemes (targeted) in the modeled words that were matched by the three children. Keep in mind that whole words were modeled, but that reinforcement was contingent upon the matching of one of the pairs of phonemes in each language. Figures 1 through 3 show the percentages of training (closed circles) trials and probe (open circles) trials during which the children matched the phonemes during model-alone, model-and-reinforcement experimental conditions, and the extra training procedure over consecutive sessions. First, the results for the training trials will be described. This will be followed by the results for the probe trials and the extra training trials.

Results for Lori

Training trials. As shown in Figure 1, during training trials of the model-alone condition, Lori's matching of French phonemes (first graph) was within the range of 0-17%. With the introduction of the model-and-reinforcement condition, French phoneme matching increased from 11% to 100% within 29 sessions. During modeling and reinforcement of French phonemes Lori's matching of Greek and Turkish phonemes (second and third graphs) during the model-alone

Figure 1. Percentage of matched targeted phonemes produced by Lori during training trials (closed circles) and probe trials (open circles) during the model-alone and the model-and-reinforcement experimental conditions and the extra training procedure across French, Greek, and Turkish languages. The point at which the model-and-reinforcement experimental condition was introduced is indicated by a vertical broken line.



condition remained stable during the training trials. Greek phoneme matching during model-alone training trials was within the range of 0-22%. During model-and-reinforcement training trials Greek phoneme matching increased from 11% to a high of 83% over 31 sessions. There was a gradual increase in matching phonemes with the exception of only one data point of 11% on the 34th session. During modeling and reinforcement of Greek phonemes, Lori's matching of Turkish phonemes during the model-alone condition remained stable. Turkish phoneme matching during model-alone training trials was within the range of 0-17%. During model-and-reinforcement training trials, Turkish phoneme matching increased from 6% to a high of 67% within the first 10 sessions. As described in the procedure section the interobserver agreement data were obtained for every session. The interobserver agreement was 100% across languages for phoneme matching during model-alone and model-and-reinforcement training trials. In summary, Lori's phoneme matching systematically increased with the introduction of the model-and-reinforcement condition during training trials of French, Greek, and Turkish.

Probe trials. Keep in mind that when the same phonemes were introduced in a different word context during probe trials, they were never associated with reinforcement. During probe trials of the model-alone condition, Lori's matching of French phonemes was within the range of 0-20%. During model-and-reinforcement probe trials, French phoneme matching increased from 33% to 100% over 16 sessions. From the 24th to the 53rd session French phoneme matching was usually between 83 and 100%. During modeling and

reinforcement of French phonemes, Lori's matching of Greek and Turkish phonemes during the model-alone condition remained stable during the probe trials. Greek phoneme matching during model-alone probe trials was within the range of 0-20%, with the exception of four unusually high data points of 33%, 50%, 67%, and 33% during sessions 7, 9, 10, and 11, respectively. Nevertheless, these data points returned to baseline levels before the introduction of modeling and reinforcement of Greek phonemes. During model-and-reinforcement probe trials, Greek phoneme matching increased from 33% to a high of 83% over the first 14 sessions of the model-and-reinforcement condition and then it stabilized between 33% and 67%. During modeling and reinforcement of Greek phonemes, Lori's matching of Turkish phonemes during the model-alone condition remained stable during the probe trials. Turkish phoneme matching during model-alone probe trials was within the range of 0-17%, with the exception of one high data point of 33% during session 21. During model-and-reinforcement probe trials Turkish phoneme matching increased from 17% to a high of 83% within the first 12 sessions. The interobserver agreement was 100% across languages for phoneme matching during model-alone and model-and-reinforcement probe trials except modeling and reinforcement of Greek which was 99%.

Extra training trials. As described in the procedure section, despite modeling and reinforcement, some children had difficulty in acquiring some of the phonemes. To facilitate the acquisition of these phonemes the extra training procedure was implemented after the experimental question had been

answered. All extra training sessions took place prior to the experimental sessions. Only data obtained during experimental sessions are shown in figures. For Lori, extra training was implemented for only one Greek and one Turkish phoneme. The Greek phoneme was [ɣ] and the Turkish phoneme was [r̆]. During extra training on Greek and Turkish phonemes, Greek phoneme matching during training trials increased from 61% to a high of 89% over 13 sessions. During extra training probe trials, Greek phoneme matching increased from the low of 33% to 100% over 10 sessions. During extra training on Greek and Turkish phonemes, Turkish phoneme matching during training trials increased from 61% to a high of 94% over 14 sessions. During extra training probe trials, Turkish phoneme matching increased from the low of 33% to 100% over 10 sessions. There was no extra training on French phonemes for Lori. Lori's French phoneme matching during training and probe trials remained unchanged during extra training on Greek and Turkish phonemes. The interobserver agreement was 100% across languages for phoneme matching during training and probe trials of the extra training procedure.

Results for Oscar and Ari

Results similar to Lori's were obtained with the other two children, Oscar and Ari, although they received treatment on phoneme production in the three languages in a different order from the first child. Figures 2 and 3 show the percentages of phonemes that were matched during training and probe trials by Oscar and Ari, respectively. Whenever the model-and-reinforcement condition was introduced, the percentages of matching phonemes increased

Figure 2. Percentage of matched targeted phonemes produced by Oscar during training trials (closed circles) and probe trials (open circles) during the model-alone and the model-and-reinforcement experimental conditions and the extra training procedure across French, Greek, and Turkish languages. The point at which the model-and-reinforcement experimental condition was introduced is indicated by a vertical broken line.

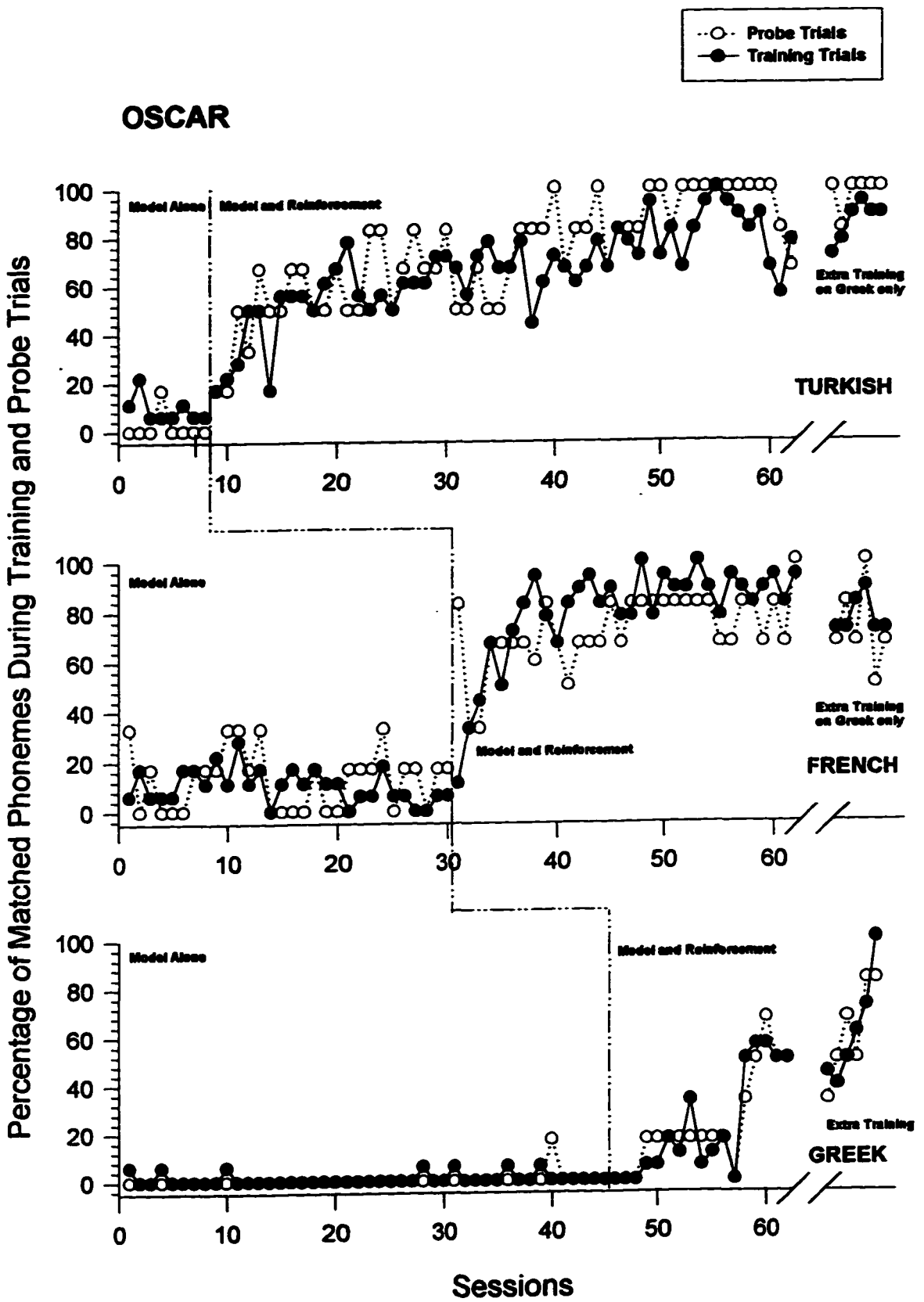
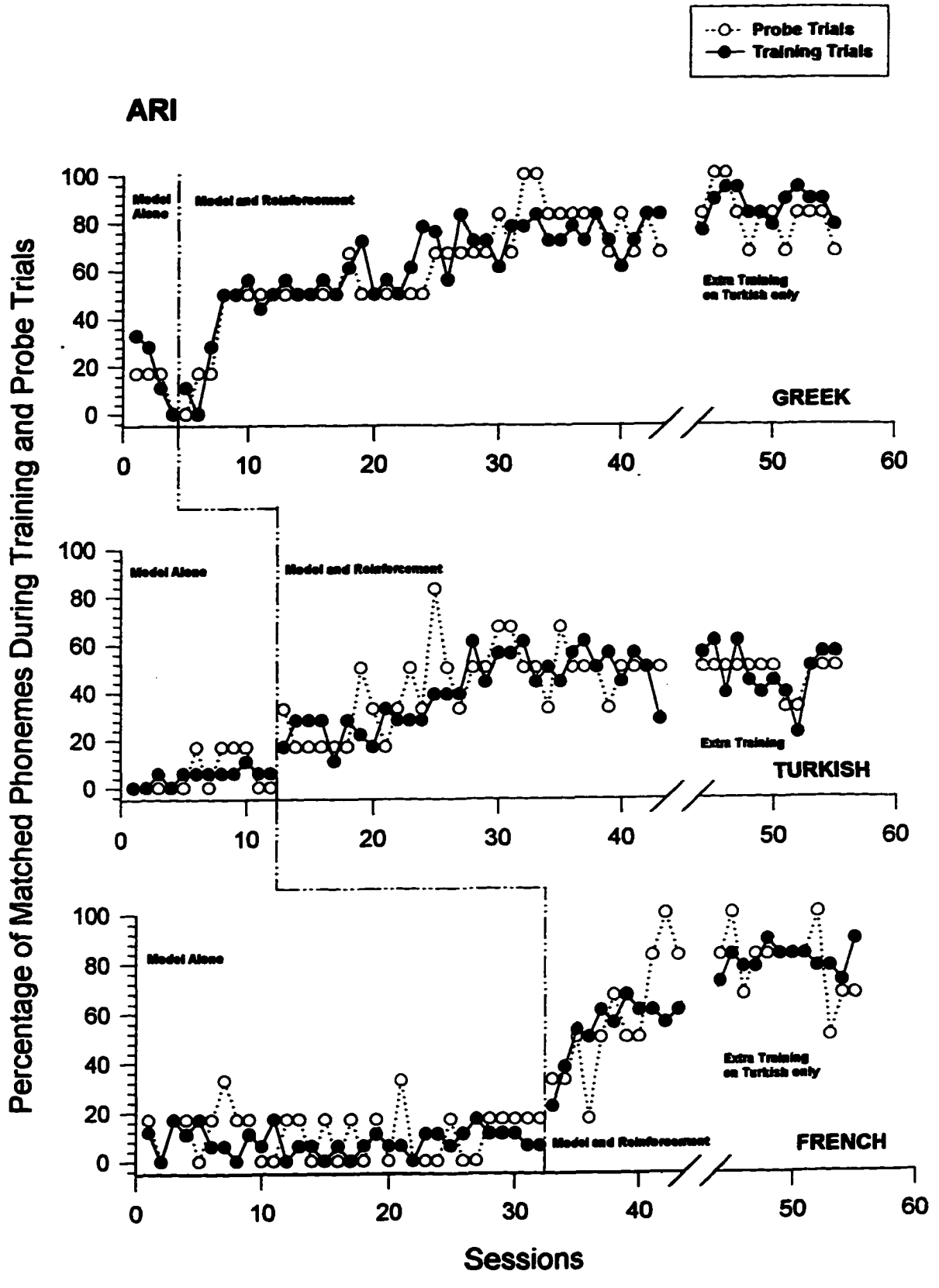


Figure 3. Percentage of matched targeted phonemes produced by Ari during training trials (closed circles) and probe trials (open circles) during the model-alone and the model-and-reinforcement experimental conditions and the extra training procedure across French, Greek, and Turkish languages. The point at which the model-and-reinforcement experimental condition was introduced is indicated by a vertical broken line.



systematically not only during training, but also during probe trials. There were some ways in which Oscar and Ari's data were different from Lori's. During the model-and-reinforcement training trials for French phonemes Oscar showed a more rapid acquisition than Lori. Whereas Lori's matching during training trials reached 100% within 29 sessions (Figure 1, Graph 1), Oscar's matching reached 100% within 18 sessions (Figure 2, Graph 2). For the French phonemes Ari's acquisition rate was also higher than Lori's. Ari's matching of French phonemes reached a high of 67% within 7 sessions during training trial (Figure 3, Graph 3). During the model-alone condition for the training and probe trials of Greek, Oscar's phoneme matching was usually 0% (Figure 2, Graph 3), whereas Lori's matching was usually within the range of 0-22% (Figure 1, Graph 2). Ari's matching of Greek phonemes during the same condition showed a declining trend from 33% to 0% during training trials and from 17% to 0% during probe trials (Figure 3, Graph 1). Extra training procedure was implemented for only one of the phonemes for Oscar and Ari. The phonemes that received extra training were [ɣ] in Greek for Oscar and [r̆] in Turkish for Ari. During extra training trials Oscar and Ari's data were similar to Lori's. During the extra training procedure all three children reached their highest percentages of matching phonemes. The interobserver agreement was 100% for Oscar and Ari for phoneme matching across languages and two experimental conditions and extra training procedure during training and probe trials.

Summary

With the introduction of the model-and-reinforcement condition, phoneme matching increased systematically during training trials across all three languages for Lori. Furthermore, with the introduction of the model-and-reinforcement condition during training trials, phoneme matching during nonreinforced probe trials also increased systematically across all three languages for Lori. The same functional relations on phoneme matching between training and probe trials were obtained with Oscar and Ari. That is, with the introduction of the model-and-reinforcement condition, phoneme matching increased systematically during training trials across all three languages for Oscar and Ari. Furthermore, with the introduction of the model-and-reinforcement condition during training trials, phoneme matching during nonreinforced probe trials also increased systematically across all three languages for Oscar and Ari.

Word Matching During Training Trials

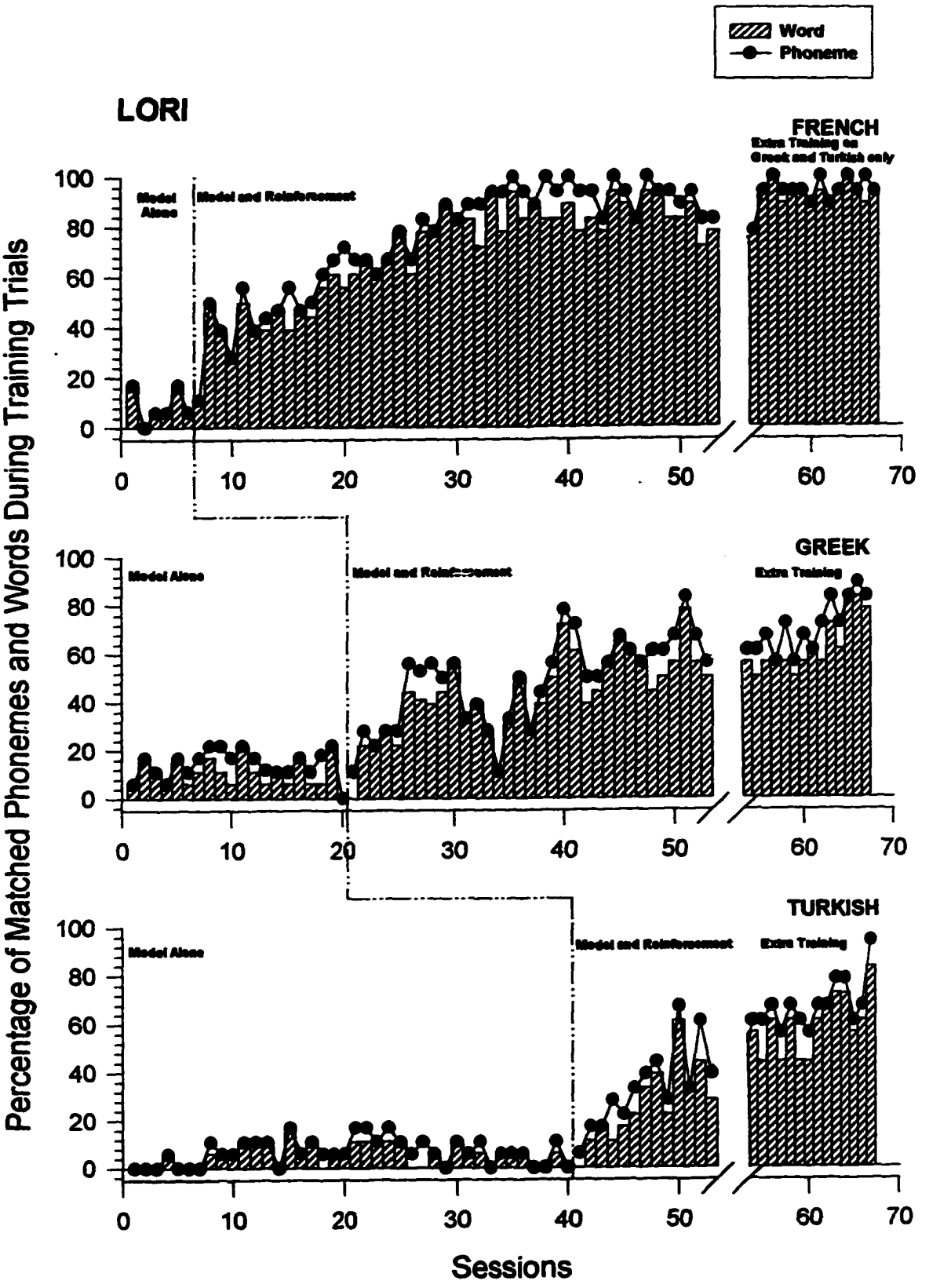
Figures 4 through 6 show the percentages of phoneme and whole word that were matched by the three children during training trials. Once again, bear in mind that whole words were modeled, but that reinforcement was contingent upon phoneme matching only. Figures 4 through 6 show the percentage of training trials during which the children matched phonemes (line graph) and whole words (bar graph) during the model-alone and the model-and-reinforcement experimental conditions and the extra training procedure over consecutive sessions.

Results for Lori

Phoneme. As shown in Figure 4, with the introduction of the model-and-reinforcement condition, Lori's phoneme matching increased systematically for French, Greek, and Turkish languages. As described under phoneme matching section, during modeling and reinforcement of French, Lori's phoneme matching increased from a high of 17% to 100 while her Greek and Turkish phoneme matching during the model-alone condition remained stable. Lori's phoneme matching during modeling and reinforcement of Greek increased from a high of 22% to a high of 83% while her Turkish phoneme matching during the model-alone condition remained stable. Finally, Lori's Turkish phoneme matching increased from a high of 17% to a high of 67%.

Word. With the introduction of the model-and-reinforcement condition, Lori's word matching during training trials increased systematically for French, Greek, and Turkish languages (Figure 4). During the model-and-reinforcement condition, Lori's French word matching increased from a high of 17% to a high of 94% while her Greek and Turkish word matching during the model-alone condition remained stable. During the model-and-reinforcement condition, Lori's Greek word matching increased from a high of 22% to a high of 78% while her Turkish word matching during the model-alone condition remained stable. Finally, Lori's Turkish word matching increased from a high of 17% to a high of 61%. The interobserver agreement was 100% for word matching during training trials across languages and the model-alone and model-and-reinforcement conditions for Lori.

Figure 4. Percentage of training trials during which Lori matched the targeted phonemes (line graph) and whole words (bar graph) during the model-alone and the model-and-reinforcement experimental conditions and the extra training procedure across French, Greek, and Turkish languages. The point at which the model-and-reinforcement experimental condition was introduced is indicated by a vertical broken line.



Correspondence in level. As shown in Figure 4, the levels of phoneme matching and word matching during training trials for Lori during any given session were very similar. For example, the percentages of French phonemes and French words matched by Lori (first graph) during the model-alone condition were identical during each of the six model-alone sessions. During modeling and reinforcement of French there were sessions during which both scores, matched phonemes and matched words during training trials, were not identical, as shown by the white space between the line graph and the bar graph. The white space may be quantified as a difference score. That is, when one subtracts the percentage of matched words from the percentage of matched phonemes, one produces a difference score. The mean difference score during modeling and reinforcement of French for Lori was only 6 percentage points. Lori's mean difference scores during the model-alone and model-and-reinforcement experimental conditions for Greek and Turkish (second and third graphs) were very similar. During the model-alone condition the mean difference scores for Lori were 4 percentage points for Greek and 1 percentage point for Turkish. During the model-and-reinforcement condition, Lori's mean difference scores were 5 percentage points for Greek and 7 percentage points for Turkish.

Extra training. During extra training on Greek and Turkish, Lori's mean difference scores for Greek and Turkish were the same, 8 percentage points. There was no extra training on French for Lori. During extra training on Greek and Turkish, Lori's mean difference score for French was smaller than for Greek

and Turkish. Lori's mean difference score during extra training on Greek and Turkish was only 2 percentage points for French. The interobserver agreement was 100% across languages for word matching during training trials of the extra training procedure.

Results for Oscar and Ari

Figures 5 and 6 show results for Oscar and Ari, respectively, which are similar to Lori's on word matching and phoneme matching during training trials. With the introduction of the model-and-reinforcement condition, phoneme matching increased systematically for all three languages. With the introduction of the model-and-reinforcement condition, word matching during training trials also increased systematically for each language. The levels of phoneme matching and word matching during training trials were similar during any given session. There were some ways in which Oscar and Ari's data were different from Lori's. During model-alone training trials of French, Oscar's mean difference score was higher than Lori's. Oscar's mean difference score was 5 percentage points, whereas Lori's was 0 percentage point. During modeling and reinforcement training trials, Oscar's mean difference scores were slightly higher than Lori's for all three languages. Lori's mean difference scores were 6, 5, and 7 percentage points, whereas Oscar's mean difference scores were 15, 7, and 20 percentage points for French, Greek, and Turkish, respectively. Furthermore, there was a difference in pattern between Oscar and Lori's mean difference scores. Lori's mean difference score remained fairly consistent from the beginning to the end of the model-and-reinforcement condition for all three

Figure 5. Percentage of training trials during which Oscar matched the targeted phonemes (line graph) and whole words (bar graph) during the model-alone and the model-and-reinforcement experimental conditions and the extra training procedure across French, Greek, and Turkish languages. The point at which the model-and-reinforcement experimental condition was introduced is indicated by a vertical broken line.

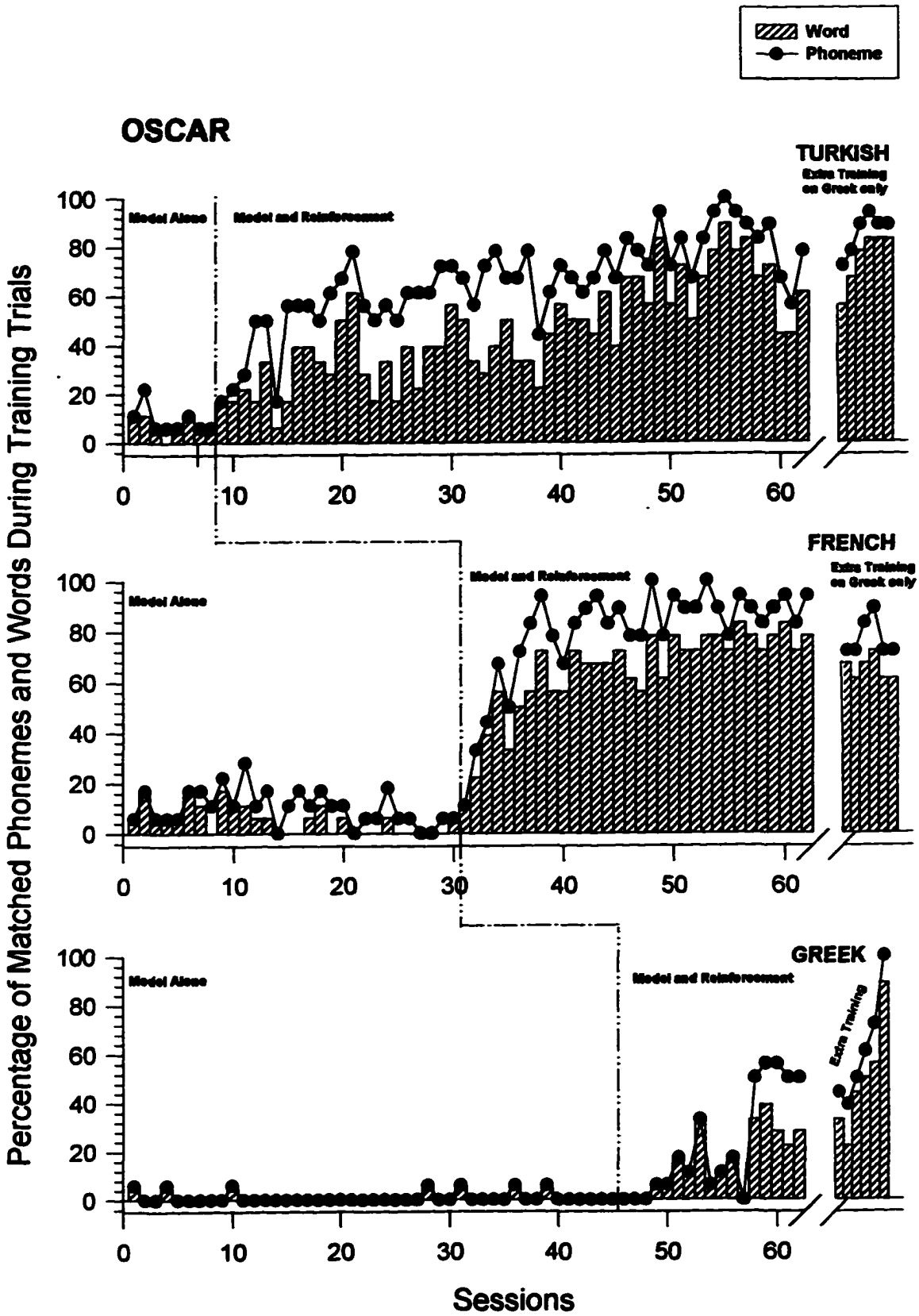
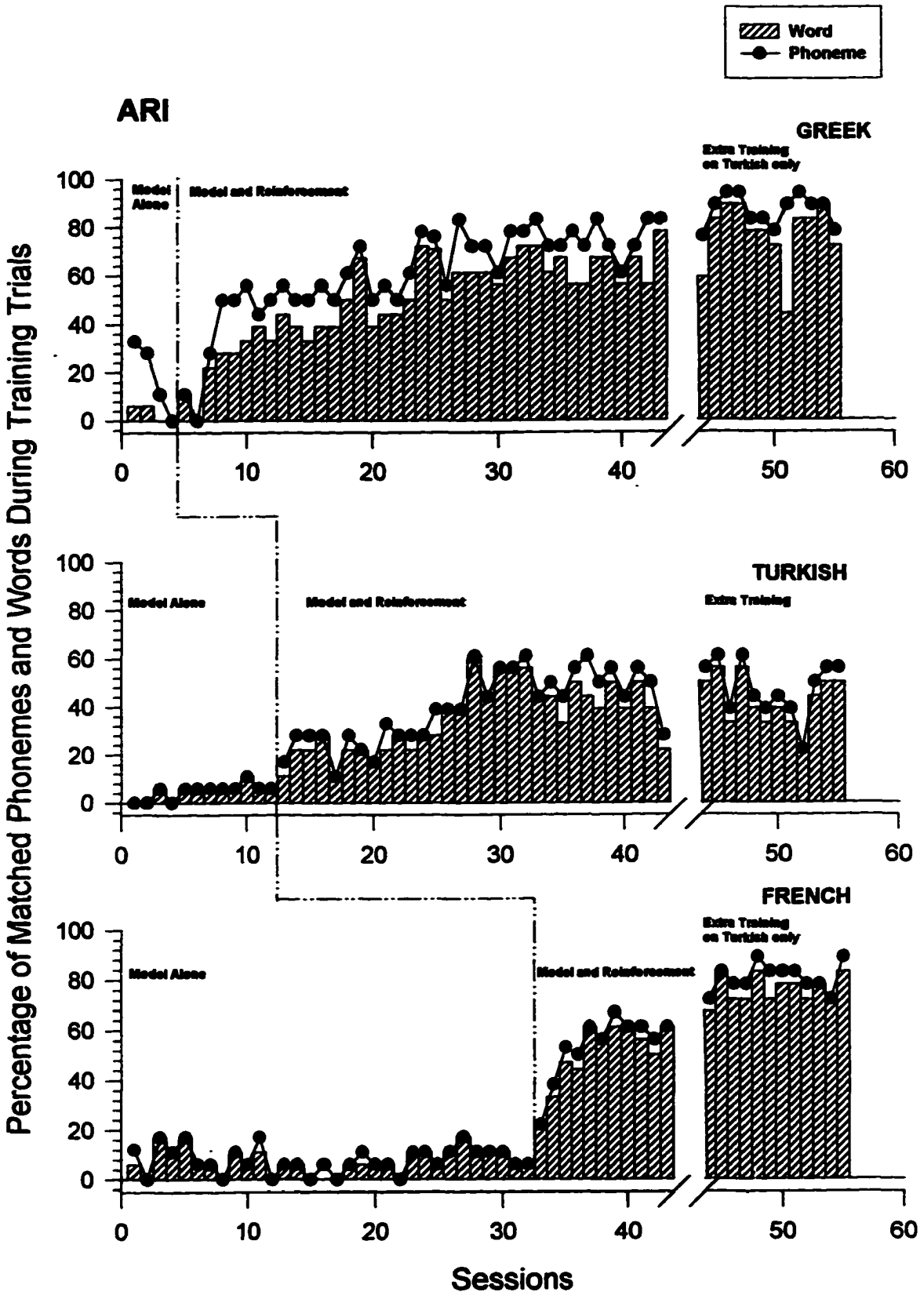


Figure 6. Percentage of training trials during which Ari matched the targeted phonemes (line graph) and whole words (bar graph) during the model-alone and the model-and-reinforcement experimental conditions and the extra training procedure across French, Greek, and Turkish languages. The point at which the model-and-reinforcement experimental condition was introduced is indicated by a vertical broken line.



languages. By contrast, Oscar's mean difference scores showed a gradual decrease over the same condition for Turkish and French languages. During modeling and reinforcement of Turkish (first graph of Figure 5), the mean difference score for Oscar was 23 percentage points between sessions 9 and 45. These differences decreased to 15 percentage points between sessions 46 and 62. During modeling and reinforcement of French (second graph of Figure 5) the mean difference score for Oscar was 17 percentage points between sessions 31 and 54. These differences decreased to 11 percentage points during the sessions 55 and 62. Oscar's mean difference score pattern during modeling and reinforcement of Greek was different than his pattern for Turkish and French. Oscar's mean difference scores showed a gradual decrease during modeling and reinforcement of Turkish and French. By contrast, during the same condition for Greek, Oscar's phoneme matching and word matching during training trials were identical at the beginning of the condition, but they differed from one another toward the end of the condition. During modeling and reinforcement of Greek (third graph of Figure 5) the levels of phoneme matching and word matching during training trials were identical between sessions 46 and 57. The mean difference score during sessions 47 and 62 was 22 percentage points.

As shown in Figure 6, Ari's mean difference scores during the model-alone and model-and-reinforcement experimental conditions for Greek (first graph) were higher than for Turkish and French (second and third graphs). Ari's levels of phoneme matching and word matching during training trials were very

similar for Turkish and French during the model-alone and model-and-reinforcement experimental conditions (0-5 percentage points). Ari's mean difference score during the model-alone condition for Greek was 15 percentage points. Ari's mean difference score during modeling and reinforcement of Greek was 12 percentage points between sessions 5 and 18. These differences decreased to 10 percentage points between sessions 19 and 43.

During extra training on Greek, Oscar's mean difference scores were 10, 12, and 12 percentage points for Turkish, French, and Greek, respectively. Ari's mean difference scores during extra training on Turkish were 10, 5, and 5 percentage points for Greek, Turkish, and French, respectively.

The interobserver agreements were 100% on word matching during training trials for Oscar and Ari across languages and the two experimental conditions and extra training procedure.

Summary

As noted in the previous section on phoneme matching, phoneme matching had increased systematically during training trials across all three languages for Lori. With the introduction of the model-and-reinforcement condition, word matching also increased systematically during training trials across all three languages for Lori. Furthermore, the levels of phoneme matching and word matching during any given session were identical or very similar during training trials for Lori. The same functional relations between phoneme matching and word matching were obtained with Oscar and Ari. As

noted in the previous section on phoneme matching, phoneme matching had increased systematically during training trials across all three languages for Oscar and Ari. With the introduction of the model-and-reinforcement condition, word matching also increased systematically during training trials across all three languages for Oscar and Ari. Furthermore, the levels of phoneme matching and word matching during any given session were identical or very similar during training trials for Oscar and Ari.

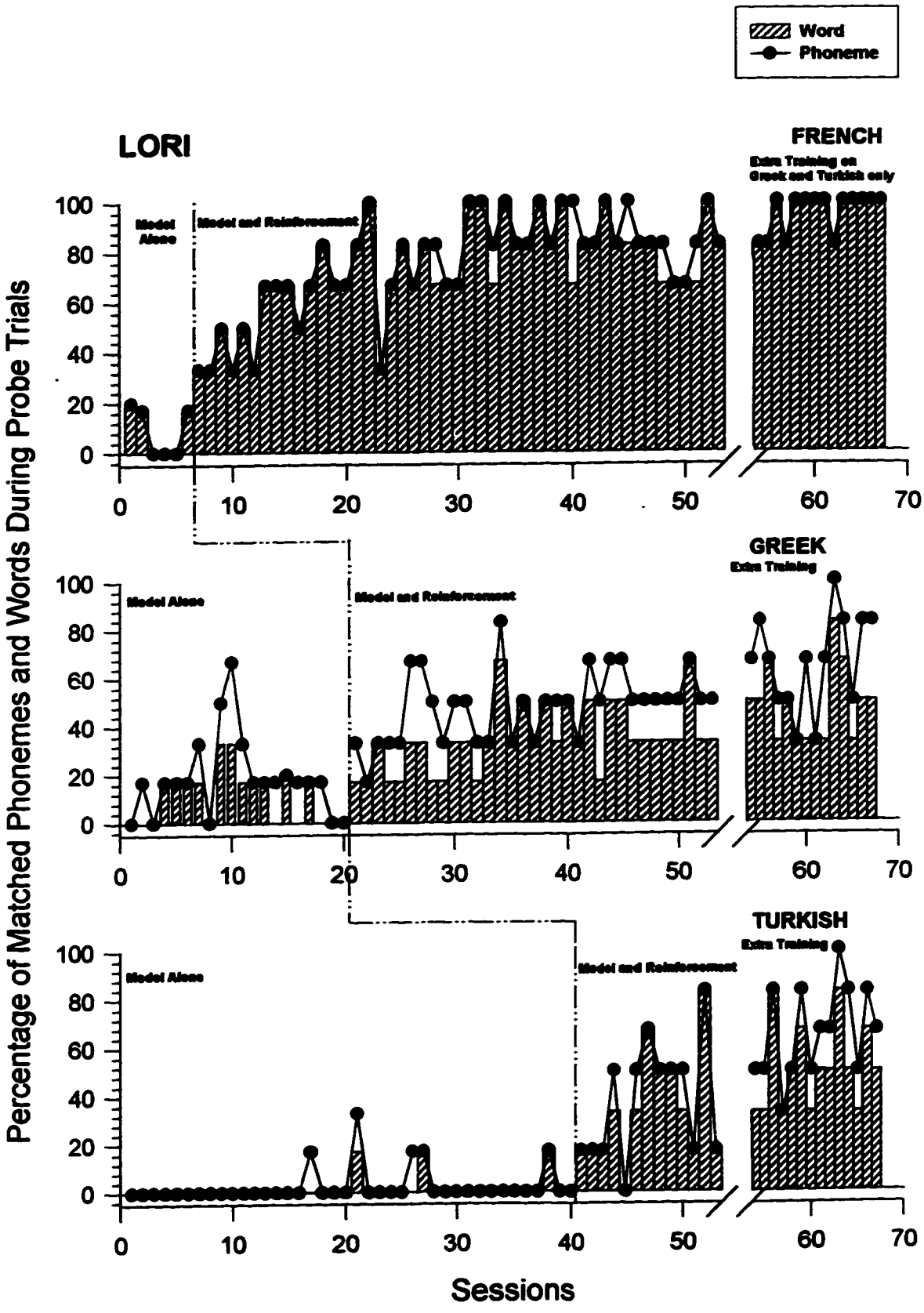
Word Matching During Probe Trials

Figures 7 through 9 show the percentages of phoneme and whole word that were matched by the three children during probe trials. Keep in mind that probe trials were interspersed among training trials and phoneme matching was never associated with reinforcement. Figures 7 through 9 show the percentage of probe trials during which the children matched phonemes (line graph) and words (bar graph) during the model-alone and the model-and-reinforcement experimental conditions and the extra training procedure over consecutive sessions.

Results for Lori

Phoneme. As shown in Figure 7, with the introduction of the model-and-reinforcement condition during training trials, Lori's phoneme matching during nonreinforced probe trials increased systematically for French, Greek, and Turkish languages. As described under the phoneme matching section, during the model-and-reinforcement condition Lori's French phoneme matching increased from a high of 20% to 100% while her Greek and Turkish phoneme

Figure 7. **Percentage of probe trials during which Lori matched the targeted phonemes (line graph) and whole words (bar graph) during the model-alone and the model-and-reinforcement experimental conditions and the extra training procedure across French, Greek, and Turkish languages. The point at which the model-and-reinforcement experimental condition was introduced is indicated by a vertical broken line.**



matching during the model-alone condition remained stable. During modeling and reinforcement of Greek Lori's phoneme matching increased from a high of 67% to a high of 83% while her Turkish phoneme matching during the model-alone condition remained stable. Finally, Lori's Turkish phoneme matching increased from a high of 33% to a high of 83%.

Word. With the introduction of the model-and-reinforcement condition during training trials, Lori's word matching during nonreinforced probe trials increased systematically for French, Greek, and Turkish languages (Figure 7). During the model-and-reinforcement condition Lori's French word matching increased from a high of 20% to 100% while her Greek and Turkish word matching during the model-alone condition remained stable. Lori's Greek word matching during the model-and-reinforcement condition increased from a high of 33% to a high of 67% while her Turkish word matching during the model-alone condition remained stable. Finally, Lori's Turkish word matching increased from a high of 17% to a high of 83%. The interobserver agreement was 100% for word matching during probe trials across languages and the model-alone and the model-and-reinforcement experimental conditions except for model-and-reinforcement probe trials of Greek. For modeling and reinforcement of Greek the interobserver agreement was 99% for nonreinforced probe trials.

Correspondence in level. The levels of phoneme matching and word matching during nonreinforced probe trials of any given session were very similar (Figure 7). For example, the percentages of French phonemes and French words matched by Lori (first graph) during model-alone probe trials were identical

during each of the six model-alone sessions. During modeling and reinforcement of French there were sessions during which both scores, matched phonemes and matched words during probe trials, were not identical. The mean difference score during modeling and reinforcement of French was only 2 percentage points. Lori's mean difference scores for Greek were higher than her mean difference scores for French during the model-alone and the model-and-reinforcement experimental conditions. For Greek, Lori's mean difference scores were 8 and 14 during the model-alone and the model-and-reinforcement conditions, respectively. The levels of Lori's phoneme matching and word matching during probe trials were similar during the model-alone and model-and-reinforcement conditions for Turkish. Lori's mean difference scores were 1 and 4 percentage points during the model-alone and model-and-reinforcement conditions for Turkish, respectively.

Extra training. During extra training on Greek and Turkish, Lori's mean difference scores were 18 percentage points for Greek and 14 percentage points for Turkish. There was no extra training on French for Lori. During extra training on Greek and Turkish, the percentages of French phonemes and French words matched by Lori during probe trials were identical for each of the 14 extra training sessions. The interobserver agreement was 100% across languages for word matching during nonreinforced probe trials of the extra training procedure.

Results for Oscar and Ari

Results similar to Lori's were obtained with the other two children. Figures 8 and 9 show the percentage of phonemes and words that were matched during

probe trials by Oscar and Ari, respectively. With the introduction of the model-and-reinforcement condition during training trials, phoneme matching during nonreinforced probe trials increased systematically for all three languages. With the introduction of the model-and-reinforcement condition during training trials, word matching during probe trials also increased systematically for all three languages. Moreover, the levels of phoneme matching and word matching during probe trials of any given session were identical or very similar. As shown in Figure 8, during probe trials the percentages of phonemes and words matched by Oscar during the model-alone condition for Turkish were identical (first graph). These scores were almost identical, .37 and 1 percentage points, for French and Greek, respectively (second and third graphs). During modeling and reinforcement probe trials of French and Greek , the percentages of phonemes and words matched by Oscar were identical. There was a difference in pattern between Oscar's and Lori's mean difference scores during the model-and-reinforcement of Turkish. Lori's mean difference score remained unchanged from the beginning to the end of the model-and-reinforcement condition for Turkish. By contrast, Oscar's mean difference score showed a gradual decrease over the same condition for Turkish. The mean difference score during the model-and-reinforcement condition for Turkish was 24 percentage points between sessions 9 and 48. This mean difference score was decreased to 4 percentage points between sessions 49 and 62.

As shown in Figure 9, Ari's matched phonemes and matched words during probe trials were identical during the model-alone condition for

Figure 8. Percentage of probe trials during which Oscar matched the targeted phonemes (line graph) and whole words (bar graph) during the model-alone and the model-and-reinforcement experimental conditions and the extra training procedure across French, Greek, and Turkish languages. The point at which the model-and-reinforcement experimental condition was introduced is indicated by a vertical broken line.

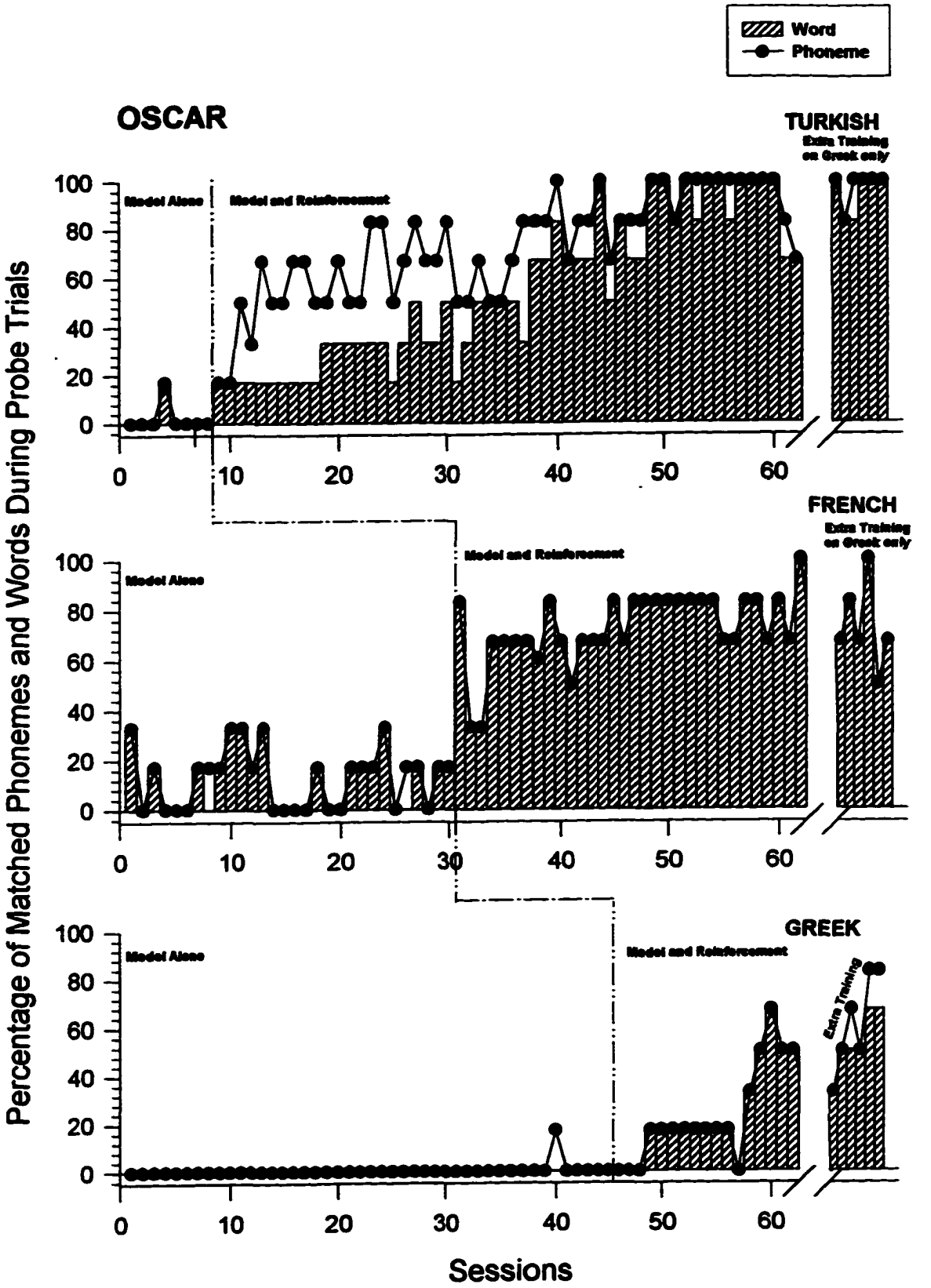
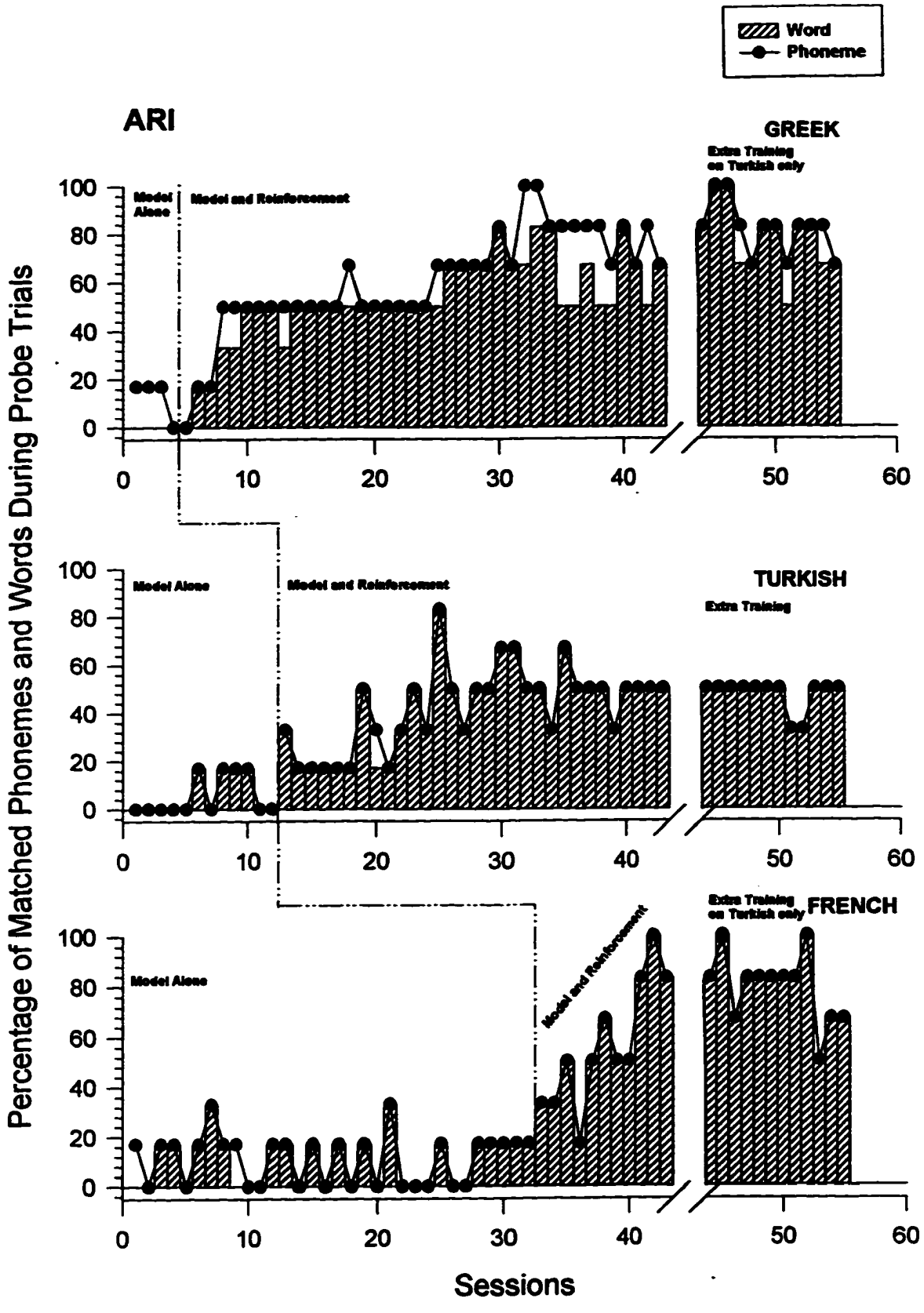


Figure 9. Percentage of probe trials during which Ari matched the targeted phonemes (line graph) and whole words (bar graph) during the model-alone and the model-and-reinforcement experimental conditions and the extra training procedure across French, Greek, and Turkish languages. The point at which the model-and-reinforcement experimental condition was introduced is indicated by a vertical broken line.



Turkish (second graph). Ari's mean difference score during the same condition for French was only 1 percentage point (third graph). During the model-alone condition for Greek (first graph), Ari's mean difference score was 13 percentage points. Ari's mean difference score pattern during the model-and-reinforcement condition for Greek was different than Lori's. Lori's mean difference score remained unchanged from the beginning to the end of the model-and-reinforcement condition for Greek. By contrast, Ari's mean difference score increased toward the end of the same condition for Greek. During modeling and reinforcement for Greek, Ari's mean difference score was only 3 percentage points between sessions 5 and 31. This mean difference score increased to 18 percentage points between sessions 32 and 43.

During the extra training procedures, the mean difference scores were very similar for Oscar and Ari during the nonreinforced probe trials for all three languages, but were slightly different than Lori's. Lori's mean difference scores during extra training on Greek and Turkish were 18 and 14 percentage points for Greek and Turkish, respectively. Whereas, the mean difference score during extra training on Greek for Oscar was 8 percentage points and during extra training on Turkish for Ari was 0 percentage point. For the languages in which no extra training were administered, the percentages of phoneme matching and word matching during probe trials were almost identical for Oscar and Ari. The interobserver agreements during probe trials were 100% on word matching for

Oscar and Ari across languages and the two experimental conditions and the extra training procedure.

Summary

As noted in the section on phoneme matching, phoneme matching had increased systematically during nonreinforced probe trials across all three languages for Lori. With the introduction of the model-and-reinforcement condition during training trials, word matching also increased systematically during probe trials across all three languages for Lori. Furthermore, levels of phoneme matching and word matching during any given session were identical or very similar during nonreinforced probe trials for Lori. The same functional relations between phoneme matching and word matching were obtained with Oscar and Ari. As noted in the section on phoneme matching, phoneme matching had increased systematically during nonreinforced probe trials across all three languages for Oscar and Ari. With the introduction of the model-and-reinforcement condition during training trials, word matching also increased systematically during probe trials across all three languages for Oscar and Ari. Furthermore, levels of phoneme matching and word matching during any given session were identical or very similar during nonreinforced probe trials for Oscar and Ari.

Summary of Findings on Word Matching

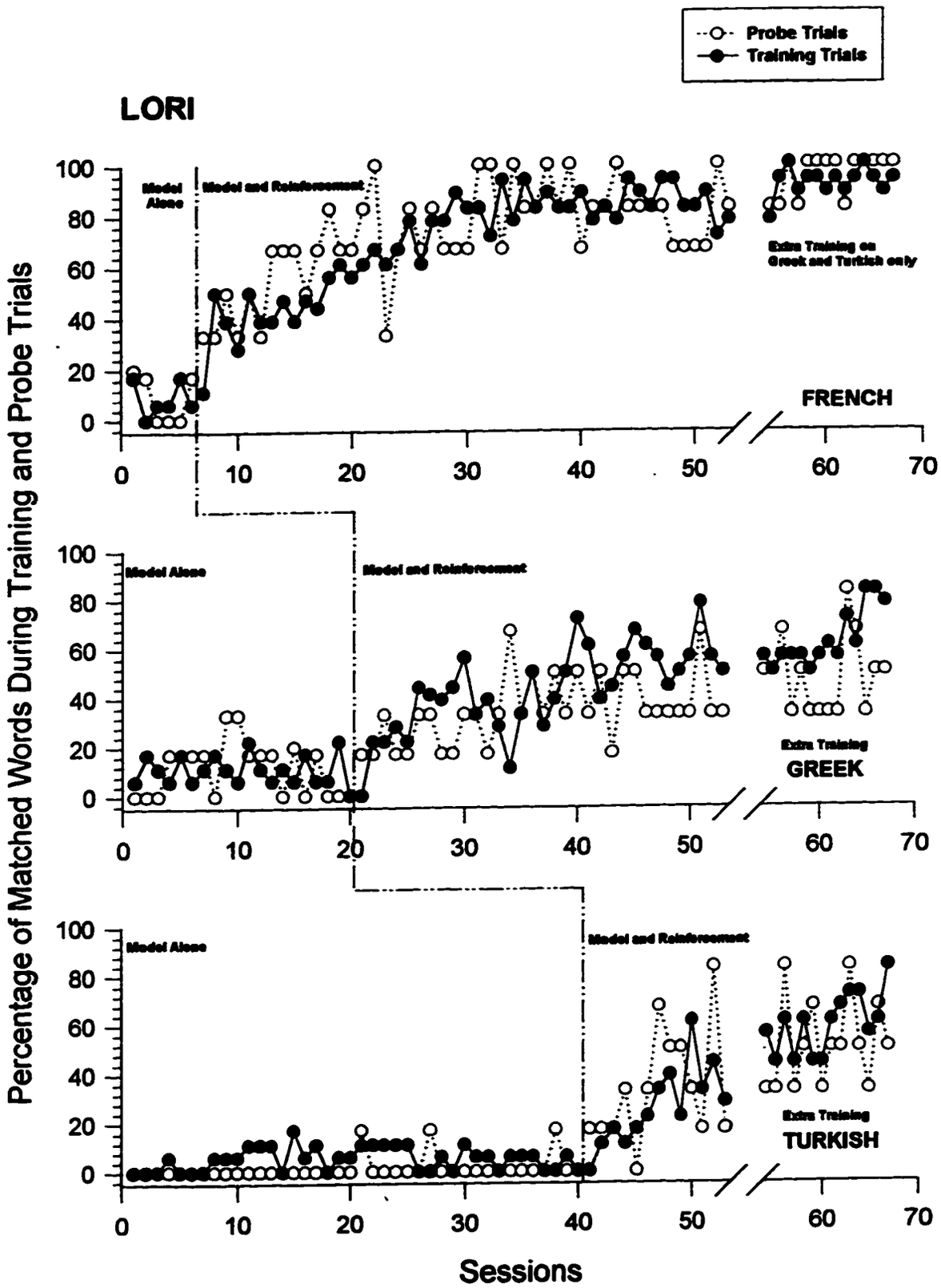
Figures 10 through 12 show the percentages of modeled words that were matched by the three children. As described in the procedure section, whole words were modeled, but reinforcement was contingent upon the matching of

one of the pairs of phonemes in each language. Figures 10 through 12 show the percentages of training (closed circles) trials and probe (open circles) trials during which the children matched the whole words during the model-alone, the model-and-reinforcement experimental conditions, and the extra training procedure over consecutive sessions. The description of the results for the training trials will be followed by the description of the results for the probe trials and the extra training trials.

Results for Lori

Training trials. As shown in Figure 10, during training trials of the model-alone condition, Lori's French word matching (first graph) was within the range of 0-17%. With the introduction of the model-and-reinforcement condition, French word matching increased from 11% to a high of 94% within 27 sessions. During modeling and reinforcement of French, Lori's Greek and Turkish word matching (second and third graphs) during the model-alone condition remained stable during the training trials. Lori's Greek word matching during model-alone training trials was within the range of 0-22%. During model-and-reinforcement training trials, Lori's Greek word matching increased from 0% to a high of 78% over 31 sessions. During modeling and reinforcement of Greek, Lori's Turkish word matching during the model-alone condition remained stable during the training trials. Lori's Turkish word matching during model-alone training trials was within the range of 0-17%. During model-and-reinforcement training trials Lori's Turkish word matching increased from 0% to a high of 61% within the first 10 sessions. In summary, Lori's word matching systematically increased with the

Figure 10. Percentage of matched whole words produced by Lori during training trials (closed circles) and probe trials (open circles) during the model-alone and the model-and-reinforcement experimental conditions and the extra training procedure across French, Greek, and Turkish languages. The point at which the model-and-reinforcement experimental condition was introduced is indicated by a vertical broken line.



introduction of the model-and-reinforcement condition during training trials of French, Greek, and Turkish.

Probe trials. Keep in mind that during probe trials neither phoneme matching nor word matching was ever associated with reinforcement. During nonreinforced probe trials of the model-alone condition, Lori's French word matching was within the range of 0-20%. During model-and-reinforcement probe trials, Lori's French word matching increased from 33% to 100% over 16 sessions. From the 24th to the 53rd session, Lori's French word matching was between 67 and 100%. During modeling and reinforcement of French, Lori's Greek and Turkish word matching during the model-alone condition remained stable during nonreinforced probe trials. Greek word matching during model-alone probe trials was within the range of 0-20%, with the exception of two high data points of 33% during sessions 9 and 10. During model-and-reinforcement probe trials, Lori's Greek word matching increased from 17% to a high of 67% over the first 14 sessions. During modeling and reinforcement of Greek, Lori's Turkish word matching during the model-alone condition remained stable during nonreinforced probe trials. Turkish word matching during model-alone probe trials was within the range of 0-17%, with the modal score at 0%. During model-and-reinforcement probe trials, Lori's Turkish word matching increased from 17% to a high of 83% within the first 12 sessions.

Extra training trials. As mentioned before, after the experimental question was answered, to facilitate the acquisition of the phonemes with which the children had difficulty, extra training was implemented for those phonemes

immediately prior to each experimental session. During extra training on Greek and Turkish, Lori's Greek word matching increased from 56% to a high of 83% over 12 sessions during training trials. During probe trials, Lori's Greek word matching increased from 50% to a high of 83% within the first 10 sessions. During extra training on Greek and Turkish, Lori's Turkish word matching increased from 56% to a high of 83% over 14 sessions during training trials. During probe trials, Lori's Turkish word matching increased from the low of 33% to a high of 83% within the first three sessions. There was no extra training on French for Lori. Lori's French word matching during training and probe trials remained unchanged during the extra training procedure on Greek and Turkish.

Results for Oscar and Ari

Results similar to Lori's were obtained with the other two children, Oscar and Ari, although they received treatment on phoneme production in the three languages in a different order from the first child. Figures 11 and 12 show the percentages of words that were matched during training and probe trials by Oscar and Ari, respectively. With the introduction of the model-and-reinforcement condition during training trials, the percentages of word matching increased systematically for French, Greek, and Turkish. With the introduction of the model-and-reinforcement condition during training trials, the percentages of word matching also increased systematically during nonreinforced probe trials for French, Greek, and Turkish.

Figure 11. Percentage of matched whole words produced by Oscar during training trials (closed circles) and probe trials (open circles) during the model-alone and the model-and-reinforcement experimental conditions and the extra training procedure across French, Greek, and Turkish languages. The point at which the model-and-reinforcement experimental condition was introduced is indicated by a vertical broken line.

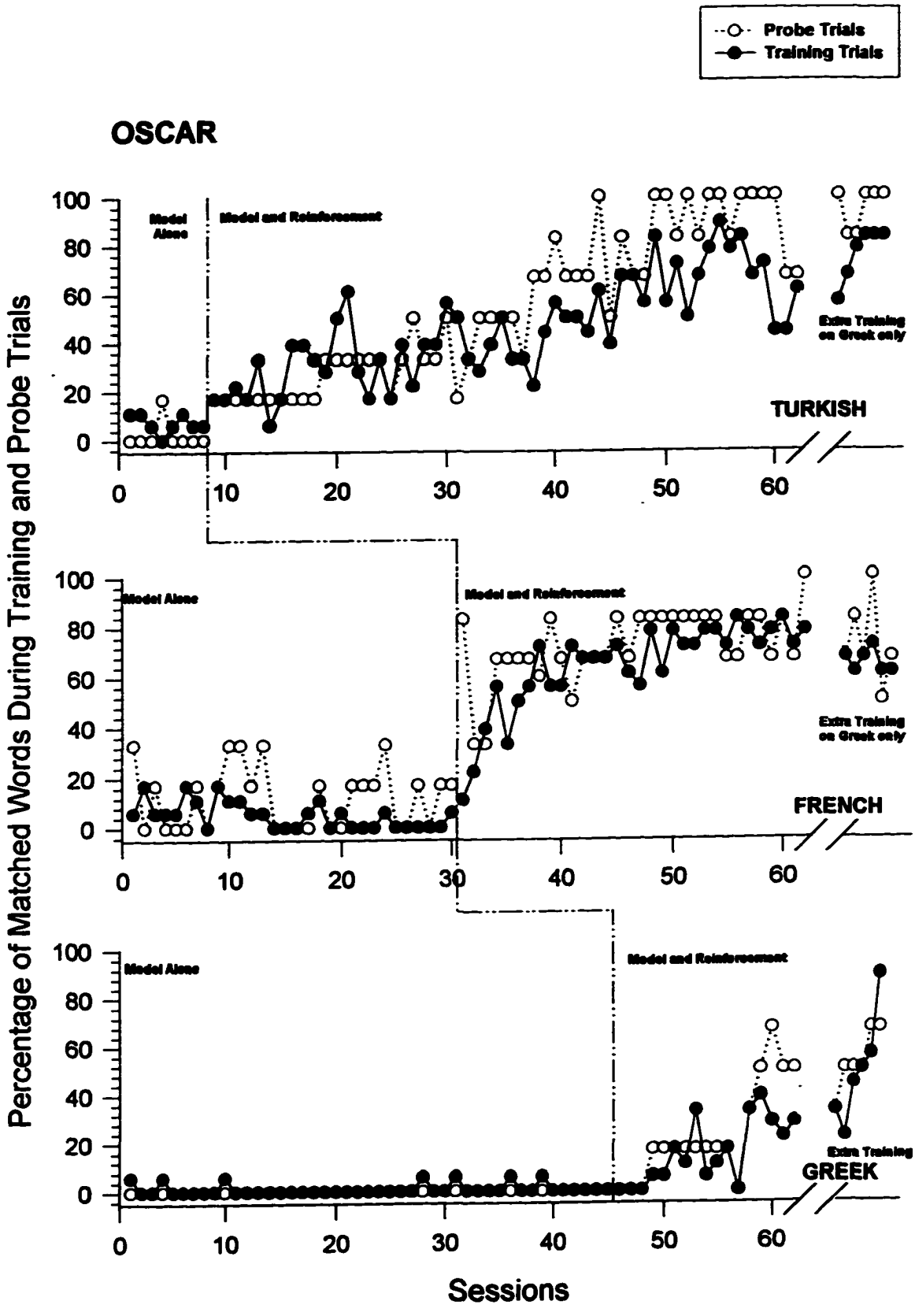
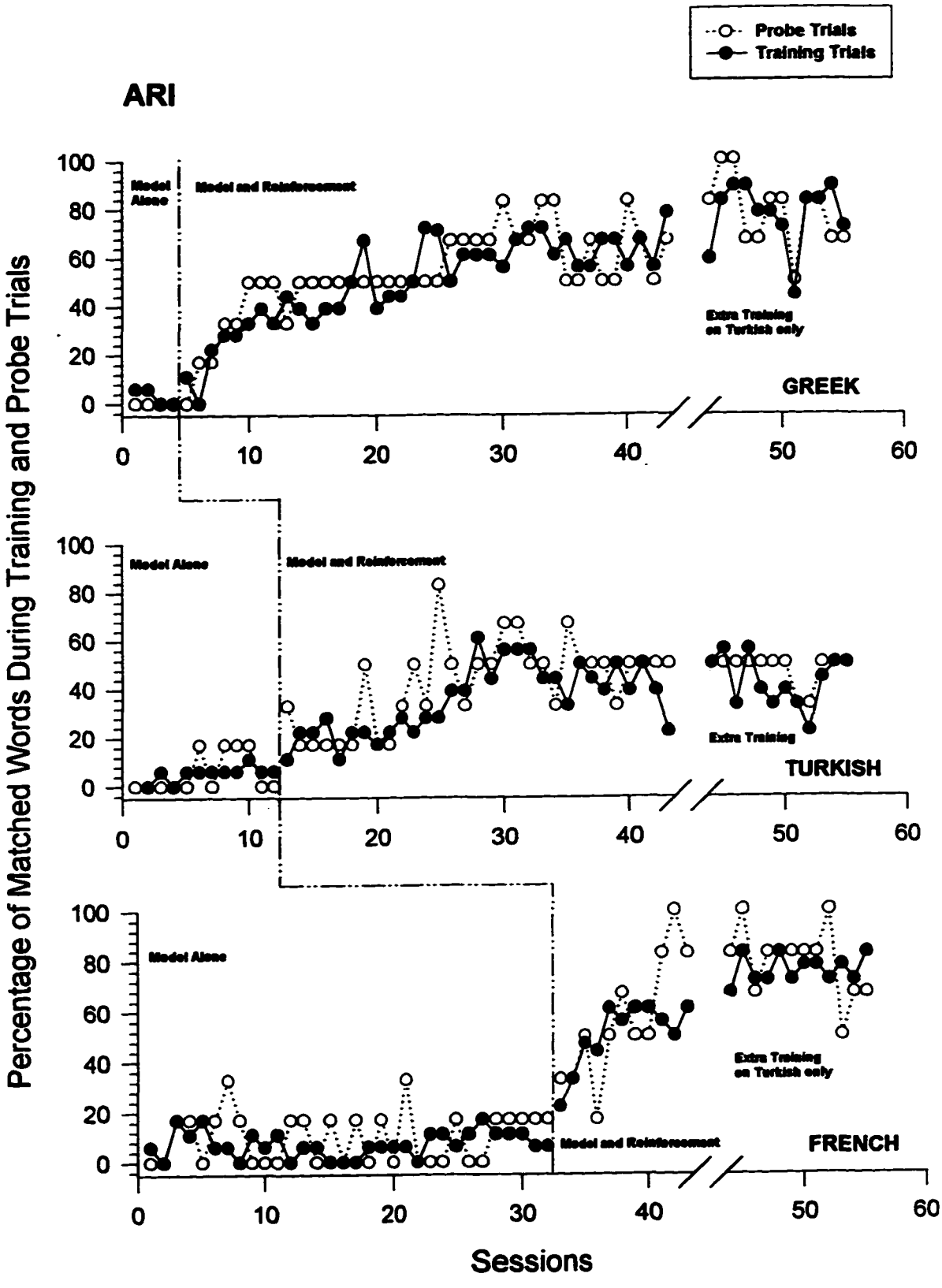


Figure 12. Percentage of matched whole words produced by Ari during training trials (closed circles) and probe trials (open circles) during the model-alone and the model-and-reinforcement experimental conditions and the extra training procedure across French, Greek, and Turkish languages. The point at which the model-and-reinforcement experimental condition was introduced is indicated by a vertical broken line.



Summary

As noted in the section on word matching during training trials, word matching had increased systematically during training trials across all three languages for Lori. As noted in the previous section on word matching during probe trials, word matching had also increased systematically during nonreinforced probe trials across all three languages for Lori. The same functional relations on word matching between training and probe trials were obtained with Oscar and Ari. As noted in the section on word matching during training trials, word matching had increased systematically during training trials across all three languages for Oscar and Ari. As noted in the previous section on word matching during probe trials, word matching had also increased systematically during nonreinforced probe trials across all three languages for Oscar and Ari.

Generalization to a Second Experimenter

As noted in the procedure section, a second experimenter conducted some of the sessions. Keep in mind that to compare data obtained during sessions conducted by the primary and the secondary experimenters, the secondary experimenter's data were obtained from one session and the primary experimenter's data were obtained from three sessions immediately preceding the session conducted by the second experimenter.

For Ari, generalization of imitation to the second experimenter was assessed by having the second experimenter conduct one session for each language prior to the introduction of the model-and-reinforcement experimental

condition and another at the end of the experiment. Thus, this resulted in one, two, and three such generalization data points during the model-alone experimental conditions for Greek, Turkish, and French languages, respectively. This also resulted in two and one such generalization data points during the model-and-reinforcement experimental conditions for Greek and Turkish languages, respectively. Additionally, there was only one session conducted by the second experimenter following the extra training procedure. This resulted in one data point for each language following the extra training procedure. For each language there was at least one opportunity to compare data obtained during sessions conducted by the primary and the secondary experimenters for each experimental condition and following the extra training procedure, except for the model-and-reinforcement experimental condition for French. No secondary experimenter's data were available for the model-and-reinforcement condition for French.

Comparison of data obtained during sessions conducted by the primary and the secondary experimenters was made by assessing whether they were congruent. In this case, congruence meant one of three findings: (1) The data obtained during the sessions conducted by the secondary experimenter fell within the range of the data obtained during the sessions conducted by the primary experimenter exactly. (2) During the model-alone experimental condition, data obtained during the sessions conducted by the secondary experimenter fell within the range of the data obtained during the sessions conducted by the primary experimenter or they fell below it. Thus, the level of

matching observed during the sessions conducted by the secondary experimenter was appropriately low for the model-alone experimental condition. (3) During the model-and-reinforcement experimental condition and following the extra training procedure, data obtained during the sessions conducted by the secondary experimenter fell within the range of the data obtained during the sessions conducted by the primary experimenter or they fell above it. Thus, the level of matching observed during the sessions conducted by the secondary experimenter was appropriately high for the model-and-reinforcement experimental condition and following the extra training procedure.

According to the above criteria, for Ari, during 92% of the 48 opportunities data were congruent regardless of the type of trial (training or probe), the experimental condition (model-alone and model-and-reinforcement), or the extra training procedure. For the other two children, Lori and Oscar, the second experimenter conducted only one session, and that session occurred following the extra training procedure. For both children, Lori and Oscar, there were total of 24 opportunities to compare data obtained during sessions conducted by the primary and the secondary experimenters. During 88% of the 24 opportunities data were congruent regardless of the type of trial (training or probe) or the child.

Discussion

Phoneme Matching

As noted in the phoneme matching section, with the introduction of the model-and-reinforcement condition, a systematic increase over the model-alone condition in phoneme matching across all three languages was produced during

the training trials for Lori, Oscar, and Ari. Because modeling occurred during both the model-alone and the model-and-reinforcement conditions, one may conclude that the delivery of tokens and praise contingent upon child phoneme matching during training trials produced the increase in child phoneme matching. A similar systematic increase in child phoneme matching was reflected in the probe trials, during which no reinforcement was provided. Because the phonemes used in both the training and probe trials were the same, one may conclude from these data that primary generalization of phoneme matching from one word context to another word context occurred. That is, the generalization that is shown from training to probe trials is the result of the similarity of the physical characteristics of the phonemes in the training and probe trials.

The primary-generalization data obtained in the present study are consistent with data obtained by researchers and clinicians in articulation therapy. These professionals have previously demonstrated generalization of targeted phonemes (a) from trained blends to untrained blends in children with articulation problems (McReynolds & Elbert, 1981); (b) from trained nonsense-syllables to untrained nonsense-syllables in children of typical development (Elbert & McReynolds, 1978; Waever-Spurlock & Brasseur, 1988); and (c) from trained word contexts to untrained word contexts in children of typical development (Powell & McReynolds, 1969), and in males with developmental disabilities (McLean, 1970). Similarly, the present study demonstrated primary generalization of targeted phonemes from trained word context to untrained word context.

Furthermore, Powell & McReynolds (1969) and McLean (1970) demonstrated that training the targeted phoneme in the initial position of the word context does not necessarily produce generalization of the same phoneme to a different position (final or medial) of the word context. In the present study, the targeted phonemes were in the initial position in all words. Because the position of the targeted phoneme in a given word context may influence the degree of generalization of a phoneme from one word context to another, this variable might be systematically analyzed in future studies of generalized vocal imitation.

Word Matching During Training Trials

As noted in the phoneme matching section, phoneme matching had increased systematically during training trials across all three languages for Lori, Oscar, and Ari. Furthermore, as noted in the word matching during-training-trials section, with the introduction of the model-and-reinforcement condition for imitation of phonemes, word matching had also increased systematically and to similar levels, during training trials across all three languages for Lori, Oscar, and Ari. In the present experiment token and social reinforcement was contingent upon child phoneme matching only. Nevertheless, none of the children ever uttered the phonemes in isolation. That is, the children always produced a chain of phonemes. Perhaps this was because of the children's learning history of imitating adult spoken words. Furthermore, there was no differential reinforcement for producing only the phoneme in isolation. Reinforcement of the phonemes always occurred in the presence of other phonemes in the chain.

Furthermore, although there was no differential reinforcement for matching the modeled word, the children's word matching during training trials increased simultaneously and systematically with the increases in phoneme matching. Therefore, one may conclude that the increase in percentage of word matching during training trials that occurred systematically with the introduction of reinforcement for phoneme matching is a case of generalized imitation.

Generalized imitation, according to Baer & Deguchi (1985) occurs when (a) nonreinforced imitations are maintained as long as other imitations are reinforced and (b) nonreinforced imitations persists despite continuous differential reinforcement. These two characteristics of generalized imitation were observed in the present experiment, such that (a) child word matching during training trials was maintained when phoneme matching was reinforced and (b) child word matching during training trials persisted even though there was continuous differential reinforcement of phoneme matching only. Moreover, generalized imitation in this case occurred within three different classes. That is, the reinforcement of the phonemes did not produce generalized imitation to all words modeled during training trials. Generalized imitation was observed only within the class of the pairs of phonemes receiving reinforcement. Although, vocal responses were shown to form one large vocal response class in the previous studies (i.e., Garcia et al., 1971; Poulson et al., 1993; and Young et al., 1994), in the present study, the vocal responses were broken down into three different response classes.

Word Matching During Probe Trials

As noted in the phoneme matching section, phoneme matching had increased systematically during nonreinforced probe trials across all three languages for Lori, Oscar, and Ari, representing primary generalization. Furthermore, as noted in the word matching during-training-trials section, word matching had increased systematically during training trials across all three languages for Lori, Oscar, and Ari, representing generalized imitation. Moreover, as noted in the word matching during-probe-trials section, word matching had also increased systematically and to similar levels of phoneme matching, during nonreinforced probe trials across all three languages for Lori, Oscar, and Ari. For the same reasons that the systematic increase in word matching during training trials was interpreted as a case of generalized imitation from training on phoneme matching, the systematic increase in word matching during probe trials is a further case of generalized imitation from training on phoneme matching. In this case, the generalization was to probe words that had never been associated with reinforcement.

Summary of Conclusions on Generalized Imitation of Words

As noted in the above section on word matching during training trials, word matching increased systematically with the introduction of the model-and-reinforcement condition across all three languages for Lori, Oscar, and Ari. Thus, it was concluded that reinforcement of phoneme matching produced generalized imitation of words during training trials. Similarly, as noted in the above section on word matching during probe trials, with the introduction of the

model-and-reinforcement condition during training trials, word matching during nonreinforced probe trials also increased systematically across all three languages for Lori, Oscar, and Ari. Thus, it was also concluded that reinforcement of phoneme matching during training trials produced generalized imitation of words during probe trials. It is interesting to note that probe trial generalized imitation occurred despite the fact that the phonemes embedded in these words were never directly associated with reinforcement. That is, the specific phoneme combinations in the words uttered by the children during probe trials had never been associated with the delivery of reinforcement, as had the specific phoneme combinations in the words used during training trials. In short, in the present experiment generalized imitation of words was observed on two levels, generalized imitation during training trials and generalized imitation during probe trials. Thus, it is especially interesting to note that the levels of matching during training and probe trials were very similar in these two cases.

Generalization to a Second Experimenter

As noted in the results section, generalization of imitation to the second experimenter was assessed by having the second experimenter conduct one session for each language prior to the introduction of the model-and-reinforcement condition and another at the end of the experiment for Ari. Thus, for Ari, there were three generalization sessions during the model-alone and model-and-reinforcement conditions and one generalization session following the extra training procedure. Because data that are obtained during sessions conducted by the primary and the secondary experimenters were congruent, one

may conclude that generalized-imitation training by the primary experimenter produced generalization of Ari's matching responses to the second experimenter.

There were no similar generalization data for the other two children. Nevertheless, as noted in the results section, post-treatment measures were obtained by the second experimenter following the extra training procedure for Lori and Oscar. For both children, data that are obtained during sessions conducted by the primary and the secondary experimenters were congruent. Thus, these post-treatment measures indicate that these children were able to imitate someone other than the primary experimenter.

General Discussion

In generalized imitation, nonreinforced-imitative responses are emitted as long as other imitative responses are associated with reinforcement. Thus, as Baer & Deguchi (1985) conclude, generalized imitation meets the definition of a functional response class. That is, when some members of a class of responses are associated with reinforcement, other members function as though they, too, had been associated with reinforcement. In the present experiment, functional response classes were observed in the sense that, when phoneme imitation was associated with reinforcement there was a systematic increase not only in phoneme imitation, but also in nonreinforced-word imitation across the three languages.

In the present study, generalized imitation training was a sufficiently robust procedure that it was effective despite large differences among children in

age, sex, native language, or regularity with which training sessions were delivered.

There were some observations in the present study that may be of interest in future generalized-vocal-imitation studies. Some of the phonemes and words used in the present study were particularly difficult for these children. In the present study, all three children reached their highest percentages of matching phonemes following the extra training procedure. Nevertheless, all three children needed the extra training procedure for only one or two phonemes, and they were the same phonemes: [ɣ] in Greek or [ɾ̌] in Turkish or both.

The words that children did not usually match were different for each child. Although, the children did not match some of the words during most of the sessions, their word matching on the difficult words increased toward the end of the experiment. Some of these difficult words were those that were used during training trials. Some of the words used during training trials were probably intrinsically harder to match than those used during probe trials. This may account for the higher percentages obtained during nonreinforced probe trials than during training trials on word matching during some of the sessions.

In earlier studies of generalized imitation it appeared that all imitative responses belonged to a single imitative response class. For example, Baer & Sherman (1964) demonstrated that a generalized imitative response class could be formed around four imitative responses consisting of head nodding, mouthing, strange vocalizations, and bar pressing. In that study, typically

developing young children were taught three imitative responses (head nodding, mouthing, and strange vocalizations) by social reinforcement. A fourth imitative response, bar pressing, never associated with reinforcement, was also imitated by the children when the other three responses continued to receive reinforcement. The authors found that nonreinforced-imitative behavior (bar pressing) systematically increased with the increase in the reinforced-imitative behavior. Indeed, in that study a single large imitative response class was formed.

By contrast, in a subsequent study, Garcia, Baer, & Firestone (1971) investigated generalized imitation within preselected topographical response boundaries and found that vocal-imitative responses formed a separate response class. In that study, four 8- to 14-year old severely retarded children were taught to imitate small-motor, large-motor, and short-vocal responses. A systematic increase in imitation was observed during training trials when the responses were followed by social reinforcement. Imitation during nonreinforced probe trials also systematically increased, even though that imitation was never associated with reinforcement. Moreover, a systematic increase in imitation during training and probe trials was observed only for the type of imitative response receiving reinforcement. Similarly, a systematic increase in imitation during training and probe trials was observed only with the introduction of the reinforcement condition for the other two types of imitative responses. Thus, generalized imitation occurred within topographical response boundaries of

small-motor, large-motor, and short-vocal responses. In the Garcia et al. study, the vocal imitative response class was not further analyzed into sub-classes.

In a further investigation, Poulson et al. (1993) demonstrated similar response-class formation within generalized imitation with infants. In this study, the authors demonstrated generalized imitation in 12- to 14-month old typically developing infants in which the topography of the imitative responses set the boundaries of response classes. Three types of responses, motor-with-toy, motor-without-toy, and vocal responses were modeled. The results of this study showed that, contingent upon reinforcement, infant imitation increased during training trials. A systematic increase in imitation was also observed during nonreinforced probe trials when imitation during training trials continued to be reinforced. Furthermore, a systematic increase in infant imitation during training and probe trials was observed with the introduction of the reinforcement condition for one type of imitative response, but not the other two types of imitative responses. Infant imitation during training and probe trials of the other two types of imitative responses remained at baseline levels. Systematically introducing the reinforcement condition for the other two types of imitative responses resulted in an increase only for the type of response receiving reinforcement. Furthermore, this increase occurred not only during training trials, but also during nonreinforced probe trials. In the Poulson et al. study, generalized imitation was observed within vocal and non-vocal response classes, but not across the three response classes.

In a systematic replication of Poulson et al. (1993), Young et al. (1994) obtained similar results with four autistic children. In this study, the three response topographies were vocal, pantomime, and toy-play. Edibles and contingent verbal praise were used as reinforcers for imitation. Young et al. found that the introduction of reinforcement for one imitative topography of response produced an increase in imitation of the same topography of response only, but not of the other two imitative topographies of response. During training trials, child imitation increased systematically with the introduction of the reinforcement condition. During nonreinforced probe trials, a similar systematic increase in imitation was also observed when reinforcement was introduced for training trials. In addition, a systematic increase in child imitation during training and probe trials was observed only for one imitative-response topography, but not for the other two imitative-response topographies. Child imitation during training and probe trials of the other two imitative-response topographies remained at baseline level. Similarly, a systematic increase in child imitation was observed only with the introduction of the reinforcement condition for the other two imitative-response topographies. In short, the results of this study replicate the results of the Poulson et al. study. That is, in the Young et al. study, generalized imitation was observed within vocal and non-vocal response topographies, but not across response topographies.

Similarly, in the present study generalized imitation was observed only for the type of response receiving reinforcement. For example, when imitation of French phonemes received reinforcement, imitation of French words increased

not only during training trials, but also during probe trials. Nevertheless, there was no increase in the percentage of imitation of Greek or Turkish words until imitation of Greek or Turkish phonemes received reinforcement.

In the above three previous studies (Garcia et al., 1971; Poulson et al., 1993; and Young et al., 1994) imitative vocal responding was found to form a separate response class from other non-vocal imitative responses. That is, reinforcing one set of imitative response did not necessarily result in the imitation of all models, regardless of the type of response modeled. Thus, the class of imitative responding may consist of several sub-classes. One such sub-class of generalized imitative responding frequently seen in the literature is vocal generalized imitation. In the present experiment, the vocal response class isolated in the previous studies of generalized imitation was shown to be able to be broken down further into three separate generalized imitative-vocal response classes formed around pairs of phonemes in French, Greek, and Turkish languages. Thus, phoneme pairs within language types defined the boundaries of vocal response-classes in generalized imitation in the present study.

When considered along with the findings of the other studies of generalized imitation within response classes, it is beginning to appear that generalized imitative response-classes may be broken down into any number of sub-classes, depending upon the number of different types of imitative responses being modeled and reinforced.

Generalized imitation has been an important construct in the learning account of language development (Baer, Guess, & Sherman, 1972; and

Schumaker & Sherman 1978). If the learning account had to rely only on reinforcement of successive approximations to adult speech and language by parents and other caregivers (Fry, 1966), that account would be difficult to defend. One would wonder whether all parents are skillful shapers of such complex repertoires. Dale (1976), for example, rejects the notion that parents and others shape language because linguists have shown that within the first four years of a child's life he/she has typically mastered all the fundamental aspects of language. It is not difficult to agree with Dale that shaping alone might take longer than four years to produce such a complex repertoire. It is precisely in accounting for the relative rapidity of language acquisition that generalized imitation plays such an important role. Rather than waiting for an opportunity to reinforce new bits of language behavior, parents and others can model larger segments of the repertoire and, thus, presumably, evoke larger chunks of behavior to reinforce. As one of the findings of their longitudinal study, Hart & Risley (1995) stated that the size of the children's recorded vocabulary was strongly associated with the size of their parents' recorded vocabulary. That is, the number of models provided to a child was associated with the number of utterances of that child. Thus, the frequency of modeling can determine the pace of utterances and thereby, their reinfrocement, thus, further increasing or decreasing the rapidity of language acquisition.

Concerning the acquisition of new speech and language, in the present experiment, a gradual increase in percentage of models imitated was shown. A more elegant analysis of generalized imitation might have been obtained if

accuracy of imitation had been measured. For example, Lovaas et al. (1966) and Brigham & Sherman (1968) measured accuracy of articulation in generalized imitation. In both studies accuracy of imitation was assessed by assigning points for correct articulation of letters and syllables. That is, the correct articulation of a letter was assigned one point and correct articulation of a syllable was assigned three points. In Lovaas et al.'s study two mute schizophrenic children were taught to imitate English words. Furthermore, after the child reached mastery criteria for imitating English words, Norwegian words were interspersed among those English words to assess generalization from training on English words to Norwegian words. The authors found that the children improved in the imitation of nonreinforced Norwegian words as long as the imitation of English words was reinforced. In a systematic replication of the Lovaas et al. study (1966), Brigham & Sherman (1968) demonstrated generalized imitation of Russian words with typically developing preschool children.

In these studies (Lovaas et al., 1966; and Brigham & Sherman, 1968), the authors set up a somewhat arbitrary system for measuring accuracy. Nevertheless, in both studies the interobserver agreement was higher than 80%. To obviate the need for interobserver agreement measures one might use an automated recording procedure, such as sound spectrography. A spectrograph produces a graphic representation of the fundamental frequencies of speech. Fundamental frequency refers to the number of times the glottis (the space between the vocal cords) opens each second to release the air built up in the lungs. Despite the advantages of using a spectrogram, a big disadvantage is

cost. Another disadvantage of spectrography is that it may be a threat to external validity. That is, very fine discriminations detected by a sophisticated spectrographic system may not necessarily be discriminated by the human ear. Parents do not usually have such a spectrographic system present in the child's environment. In natural settings parents rely on their sensory mechanisms, rather than on expensive equipment. If modeling and reinforcement of speech and language required such equipment, then parents could not play a very important role in language acquisition . Nevertheless, in future studies in generalized vocal imitation, the measurement of accuracy of imitation may extend the findings of the present study.

Generalized imitation is an important phenomenon in its own right, because it reliably demonstrates the emergence of imitative responses that have not been directly associated with reinforcement. There have been some attempts to explain the emergence of generalized imitation by familiar learning principles. One of the explanations pertains to reinforcement schedule effects and the other to stimulus control. Concerning schedule effects, Gewirtz and Stingle (1968) and Gewirtz (1971) attempted to explain generalized imitation as the result of intermittent schedules of reinforcement. That is, a reinforcer follows matching on some trials, but not others. Nevertheless, during generalized imitation training procedures these nonreinforced-imitative responses never produce reinforcement, whereas with an intermittent schedule of reinforcement, every imitative response has an equal chance of being reinforced. Thus, the schedule of reinforcement observed during generalized imitation training is not

an intermittent schedule, but a multiple schedule (i.e. FR1 EXT or VR EXT). Such multiple schedules usually produce discriminated behavior. Nevertheless, in generalized imitation both reinforced and nonreinforced imitative responses increase over time regardless of the reinforcement schedule. Another very important point is that an intermittent schedule of reinforcement accounts for the maintenance of already established imitative responding, but it does not account for the acquisition of new imitative responses.

Another attempt to explain generalized imitation involves stimulus control. There are several aspects of stimulus control involved in the generalized-imitation paradigm: (a) failure to discriminate reinforced from nonreinforced modeling stimuli, (b) use of instructions to imitate, and (c) existence of a pre-experimental history of the child's compliance with adult instructions.

The first aspect of stimulus control that may affect generalized imitation is the discriminability of the reinforced from the nonreinfroced stimuli. In generalized imitation, nonreinforced models are interspersed among reinforced models. Thus, one may argue that the child imitates all of the modeling stimuli because he/she cannot discriminate which response will be followed by reinforcement. Steinman (1970a, 1970b) and Steinman and Boyce (1971) showed that generalized imitation occurred even though typically developing children discriminated reinforced from nonreinforced modeling stimuli. For example, in the Steinman study (1970b) reinforced and nonreinforced responses were modeled by two different experimenters. One experimenter modeled only the reinforced and the other experimenter modeled only the

nonreinforced responses. There were two types of trials, single and choice trials. During single trials each experimenter modeled one response. During the choice trials, both experimenters modeled during each trial. During single trials, the typically developing children imitated both reinforced and nonreinforced modeled responses. During choice trials they imitated only the reinforced modeled responses. That is, children discriminated reinforced modeled response from nonreinforced modeled response. Nevertheless, when a single response was presented in a given trial, they imitated both reinforced and nonreinforced responses. Thus, one may conclude that generalized imitation does not occur because of a failure to discriminate. Because generalized imitation training typically takes place with single-trial presentation procedures, rather than choice-trial presentation procedures, in the present study single-trial presentation procedures were used. Furthermore, in the present study there was no attempt to assess whether the children discriminated reinforced from nonreinforced trials by measuring a response other than the imitative one.

The second aspect of stimulus control that may affect generalized imitation is the use of instructions to imitate. Some researchers have analyzed the effects of instructions on generalized imitation. For example, in the Steinman study (1970b) nonreinforced imitations were reduced by giving instructions to preschool children not to imitate nonreinforced imitative responses. Similarly, Waxler & Yarrow (1970) showed that reinforced and nonreinforced imitation decreased when nursery-school children were told that it was not necessary to imitate. Nevertheless, the presence of instructions, themselves, is not sufficient

to explain generalized imitation, because there are many studies of generalized imitation in which no instructions are provided (Metz, 1965; Garcia et al., 1971; Poulson et al., 1993; and Young et al., 1994). Thus, one may conclude that generalized imitation is a form of stimulus control that takes place regardless of the explicit use of instructions. In the present study, explicit instructions to imitate were used during training and probe trials.

The third aspect of stimulus control that may affect generalized imitation is the existence of a pre-experimental history of the child's compliance with adult instructions. Imitation is a sub-class of instructional control in general. Thus, the effect of modeling is similar to the effects of providing an instruction. In modeling, an instruction such as "Do this" may be implied. Thus, a child's history of compliance with adult instructions may facilitate imitation of adult models. In the present study all children were compliance with adult instructions before the implementation of this experiment.

Furthermore, the mere presence of an adult who has modeled a response may serve as a discriminative stimulus for imitation. Steinman (1970b) argues that it may be aversive for the child to wait through an inter-trial interval, rather than to comply with an adult's implied instruction to imitate. Thus, it is possible that the mere presence of an adult may influence the establishment of generalized imitation. In a test of this hypothesis, some studies showed a decrease in nonreinforced imitation when the experimenter left the room immediately after modeling (Peterson, Merwin, Moyer, & Whitehurst, 1971; Peterson & Whitehurst, 1971; Smeets & Striefel, 1973). When the experimenter

remained in the room after modeling the response, both reinforced and nonreinforced imitation occurred. Therefore, Steinman concluded that generalized imitation was merely an artifact of the use of adults and small children in studies of imitation. The implication was that generalized imitation was not a valid phenomenon for further study.

Subsequently, studies of generalized imitation have been carried out with subjects who are less susceptible to social and instructional control: infants (Poulson & Kymissis, 1988; Poulson et al., 1991; Poulson et al., 1993; Poulson et al., 1997; and Poulson, et al. 1997). Poulson and her students have been able to demonstrate the occurrence of generalized imitation in infants as young as 7- to 8-months of age (Gena et al., 1997). These studies were very important because they demonstrated generalized imitation in infants who have no pre-experimental history of compliance and who have not enough language to follow instructions. Thus, as pointed out by Baer and Deguchi (1985) the phenomenon of generalized (nonreinforced) imitation is robust, and it is amenable to scientific description and further experimental analysis.

APPENDIX

A copy of the consent form signed by the parents prior to the child's participation in the experiment.

Dear Parent:

Phone: (718) 997 3206

Department of Psychology

We are asking your permission to have your child participate in our study on vocal imitation in children. The study will be conducted in the Infant Laboratory of the Psychology Department at Queens College, 65-30 Kissena Boulevard, Flushing, New York. The title of the study is: Response-Class Formation within Generalized Vocal Imitation in Preschool Children. The purpose of our study is to examine whether the child imitates the words presented to him/her from three different languages as a result of reinforcing imitation of some of those words. This will be presented to the child as a game played with the experimenter and the child will receive a small trinket at the end of each session. The benefits that your child may receive from this study are: a) He/she will learn the meanings of some words from three different languages; b) He/she will be able to imitate a number of foreign words from three different languages which may facilitate learning a foreign language later in life; c) The study will be conducted in a turn-taking fashion that may ease his/her participation in school with a teacher.

Although we would appreciate your child's participation in approximately forty 30 min sessions over the course of two to five months, you are free to withdraw consent and to discontinue participation in our study at any time, with no negative consequences. Your child's participation in our study is completely voluntary and we will be available at any time to answer any inquiries about the study. Please keep in mind that the College has an approved Assurance of Compliance on file with the federal Department of Health and Human Services and you are entitled to review that document in the Office of Research and Sponsored Programs at Queens College. You are also entitled to a copy of the Consent document. A copy of the completed Consent Form will be kept in a supervised or locked area at all times.

Your child's real name will never appear on our data sheets. We will use a code name (e.g. NKF). When our study is terminated and you have been informed of the results, your child's name, address, and phone number will be removed from all our records. To best record your child's responses to the model's verbal behavior, we will videotape the sessions. The data and the tapes we will obtain will be used solely for research and professional research presentation purposes. They will be kept in a supervised or locked area at all times and no identifying information will be associated with them. At the end of the study the data and the videotapes will be maintained in locked areas for a period of at least seven years in case there is a need for further analysis. After that time the data will be discarded and the tapes erased.

Sincerely

_____ _____

Claire L. Poulson, Ph.D.
Associate Professor, Psychology

Date

I have read and understood this Consent Form and understand the nature of the study on vocal imitation that my child is about to participate in. I understand that I may withdraw my child at any time with no negative consequences. I understand that my child's anonymity and confidentiality will be preserved and that I have been informed about the procedures taken to assure confidentiality. I consent to the retention of information gathered during this study, to the publication of results based on that information given the assurance that my child's anonymity and confidentiality are preserved. I have a right to a copy of this consent form and may inspect a copy of the Assurance of Compliance With Health and Human Services regulations for Protection of Human Research Subjects filed by the The City University of New York and the Research Foundation of CUNY. I agree that my child _____ may participate in the above mentioned study, and I will allow videotaping.

_____ _____

Parent's Signature

Date

_____

Parent's Name

The City University of New York · 65-30 Kissena Boulevard
Flushing, New York 11367-1597 · Telephone (718) 997-3200

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