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COMMUNICATIVE STRATEGIES OF VISUALLY IMPAIRED INFANTS AND THEIR MOTHERS

The University of Oklahoma PH.D. 1980

THE UNIVERSITY OF OKLAHOMA

GRADUATE COLLEGE

COMMUNICATIVE STRATEGIES OF VISUALLY IMPAIRED INFANTS AND THEIR MOTHERS

A DISSERTATION

SUBMITTED TO THE GRADUATE FACULTY

in partial fulfillment of the requirements for the

degree of

DOCTOR OF PHILOSOPHY

By

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Parsons, Kansas

1980

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APPROVED FOR THE DEPARTMENT OF PSYCHOLOGY

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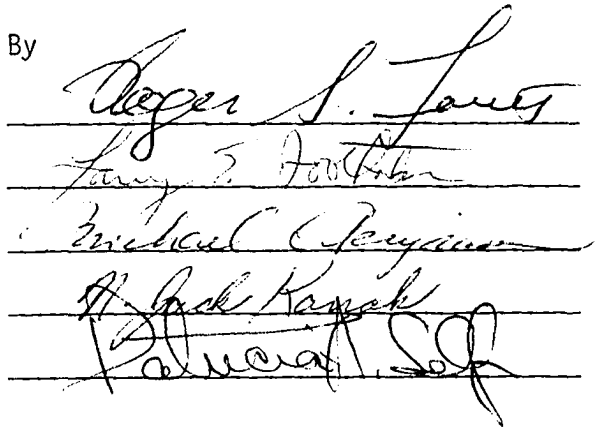

ACKNOWLEDGMENTS

I would like to state first the obvious: that the five infants and mothers who allowed me to observe them are this dissertation. Their patience, good humor and courage were truly remarkable, and I am most deeply indebted to them.

The Child Study Center (University of Oklahoma Health Sciences Center) of the Children's Memorial Hospital in Oklahoma City provided indispensable support by helping me to locate and contact subjects, by allowing me to use their facilities, and by providing advice and encouragement throughout the project. Special thanks are due to Gertrude Ford, Supervisor, and to the individual teachers and therapists assigned to the five subjects of this study.

Financial support came from several quarters. The Graduate College of the University of Oklahoma awarded a Dissertation Aid Grant specifically to enable me to accomplish this research, and then granted additional funds for the purchase of film and supplies. The Department of Psychology at the University of Oklahoma contributed to the travel expenses incurred by the project. The Bureau of Child Research at Parsons Research Center (University of Kansas), which hired me midway through this project, was extremely generous in allowing me free access to their computer facilities and numerous leaves of absence so that I could finish the research. The director of the

Research Center, Dr. James E. McLean, is to be thanked for this support.

I am indebted to a number of individuals for technical support and advice. First, I would like to thank the members of my dissertation committee: the Chairman, Dr. Roger S. Fouts, and Drs. Patti Self, Michael Akiyama, Larry Toothaker, and N. Jack Kanak. I would like to recommend my brother, Hugh Rowland, as a data analyzer par excellence and commend him for his patience and persistence in a tedious effort. Becky Finney, of the Computer Applications Unit of the Bureau of Child Research (University of Kansas) bent her skill and insight to the tasks of developing and altering computer software to tame the masses of data. Ruth Staten of the Bureau of Child Research, at Parsons Research Center, created order out of chaos by transforming my frenetic scribblings into perfectly presentable pages of prose, always with speed, accuracy and patience.

Finally, I must declare my thanks to parents and my friends. My parents, Clarissa and Richard Rowland, have provided unfailing support and encouragement throughout my graduate career. My friends, who need not be named, have tolerated the inconstancies which characterized my graduate years. I hope to return their faithfulness.

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Abstract

The development of five visually impaired infants between 10 months and three years of age was followed for six months. Films of mother-infant interactions were made in the subjects' homes at regular intervals throughout the six-month period to document the development of communicative skills within each dyad. The films were analyzed at 2-sec. intervals for seven categories of infant behavior and three categories of maternal behavior, comprising a total of 42 behavioral subcategories. Maternal behaviors were analyzed from the infant's perspective, so that only those maternal behaviors which could be sensed by a sightless infant were scored. The observational data were analyzed using lagged conditional probabilities to extract conditional relationships and cyclic dependencies among the scored behaviors.

The results suggest that the infants' rates of communicative behavior were within normal limits. Furthermore, the rates of individual infant behaviors fluctuated cyclically over time. However, their behavior was notably unresponsive to maternal intervention. Maternal behaviors rates, on the other hand, changed frequently in response to infant behaviors, but did not display mutually cyclic patterns.

Clinical implications include a greater emphasis on training parents in the appropriate patterning of their responses. A highly structured program of maternal response to infant vocalizations is suggested in the interest of enhancing the communicative use of vocalizations by the visually impaired infant.

The infants showed serious deviations from the sequence of communicative development espoused by pragmatic language theorists. Several of the constructs that Elizabeth Bates considers strongly related to language development were absent in the one subject who acquired any linguistic ability during the project. These included the production of conventional, ritualized gestures, the notion of an external referent, and combinatorial and symbolic play (all of which would require visual guidance according to traditional definitions). These discrepancies suggest that the pragmatic model of language development, as traditionally operationalized, does not adequately describe communicative development in the visually impaired population.

Introduction

The lack of research into the linguistic and communicative abilities of visually impaired persons no doubt reflects the fact that visually impaired individuals without concomitant handicaps generally acquire perfectly adequate language skills. This apparent facility of language acquisition in the face of a visual sensory deficit is somewhat surprising, given the fact that the visually impaired infant typically displays significant (though not permanent) delays in almost all developmental areas. These delays are manifested in gross motor development (Fraiberg, 1977), cognitive development (Hatwell, 1966; Miller, 1969), psychosocial development (Burlingham, 1965; Fraiberg, 1975), as well as in communicative development (Fraiberg, 1974). Although these deficits may be surmounted by early childhood, these areas of delay must impact upon each other in a complex fashion during infancy. We have yet to tease apart the relationships between cognitive, sensory-motor, social and language development in normal children, much less the effects of delays across all these developmental areas in visually impaired infants.

How does the visually impaired infant--who cannot passively acquire the association between mother's facial expressions, visual orientation

and speech, who cannot see that the soothing words and the caressing touch emanate from the same maternal source, who may not realize that mother is present at all if she lapses into silence--establish effective communicative interactions with his or her mother? For the mother's part, how does she maintain a satisfying interaction with an infant who does not establish or return visual regard and who may vocalize infrequently (Fraiberg, 1974)? It seems miraculous that the visually impaired infant develops language within a reasonable time frame at all!

This study was initially planned as an examination of language development and its relationship to cognitive, sensory-motor and social development in visually impaired infants. However, only one of the five subjects, who ranged in age from 10 mo. to 2 yrs, 8 mo. at the start of the project, developed any language by the end of the six-month study. Therefore, the focus of the project was shifted to encompass an examination of the preverbal communicative strategies of the visually impaired subjects, and the reciprocal communicative patterns of their mothers.

Basic to this study is the notion that prelinguistic communicative strategies are critical precursors of linguistic behavior and that communication between mothers and infants is bi-directional. Language is viewed as a behavior which is progressively differentiated from the infant's total behavioral repertoire, commencing at birth. This intuitively appealing view has recently been embraced anew in the linguistic and psycholinguistic literature in both the pragmatic and ethological

approaches to language acquisition. These perspectives and their implications for the current project are reviewed below.

Theoretical Perspective

During the past twenty years, theories of language acquisition have run the gamut from strict nativism to strict empiricism. For most of the 1960s, linguists, psycholinguists, and psychologists alike seemed to be obsessed with the syntactic aspects of language behavior (which was for all practical purposes equated with speech). The concept of language as an innate, biologically endowed ability was popularized by Chomsky (1957, 1959), whose theory spawned a generation of psycholinguists interested mainly in language universals and invariants in language acquisition, as displayed by adult speech (c.f. Chomsky, 1968; Slobin, 1970). In the nativist view, environmental and social variables were irrelevant to language acquisition and there was no need to postulate an orderly progression from general communicative competence to linguistic competence.

The learning-theoretical approach squarely opposed the nativist position, adhering for the most part to the principles set forth by Skinner in Verbal Behavior (1957). Learning theory emphasized environmental variables in language acquisition to the exclusion of innate variables. Early versions of what has been called the "babble-luck" theory simply asserted that the early vocal behavior of the infant (which was assumed to include all possible speech sounds) was selectively reinforced to insure closer and closer approximations of adult

speech. The learning position could predict differences in language acquisition due to differences in a child's environment, and it could also predict smooth transitions from one stage of language acquisition to the next. However, this position failed to account for the child's influence upon his or her environment. Thus the concept of linguistic behavior remained divorced from any concept of the reciprocity of communicative behavior in the child's prelinguistic world.

In the early 1970s, a relatively moderate, interactivist position was popularized by a group of cognitively oriented psycholinguists (Bloom, 1970; Ervin-Tripp, 1971; Schlesinger, 1971), who redirected attention to the semantic aspects of language and to the developmental sequences of language acquisition. The interactionist perspective underlying the cognitive-semantic approach is exemplified in Piagetian theory (Piaget, 1926, 1952). Piaget views development as an interaction of genetic endowment, physical maturation, environmental influences, and self-regulatory mechanisms. Linguistic (and other symbolic structures) are considered secondary to the cognitive structures which organize the child's reality. Piaget describes in detail the development of intention through preverbal activity patterns and postulates a progression from symbol to signal to sign in the development of language. The theory is most fruitful for our purposes in its implication of an orderly progression from preverbal cognitive and communicative structures to linguistic structures, and in its conception of language as one component of a larger symbolic system. Still, the social-interactive

aspects of language acquisition, which might very directly reflect communicative function, had not been incorporated into a language theory.

Within the past five years, interest has been revived in a functional approach to language development: Dore (1974, 1975) talks about "speech acts," while Halliday (1979) describes the "pragmatic functions" of language. Both Dore and Halliday are indebted to a book by Austin (1962), the title of which--How to Do Things with Words--speaks for itself. Austin used the term "performative" to describe the functional intent of a speaker's utterance. Obviously, if the intent of linguistic behavior is to be accommodated by a theory, then the context of the language behavior and the response to that behavior must also be accommodated. Thus, the effect of the speaker upon the environment was finally awarded status as an important variable in the acquisition of language.

The vocabulary of pragmatics is not yet standardized. Terms commonly found in literature include "presuppositions," "conversational postulates," and "communicative intents." Generally, two classes of performatives--the declarative (used to obtain attention) and the imperative (a request for action or object)--are discussed. These performative structures may be manifested via nonlinguistic behaviors (such as pointing, showing, reaching) as well as via linguistic behaviors. Dore (1975) traces the development of "speech acts" back through stages of "syntactic communication," and "presyntactic communication" to "prelinguistic

communication." Halliday (1979) identified four functions in the protolanguage of a child between his 9th and 12th months, which he labelled "instrumental" (object-oriented), "regulatory" (other person-oriented), "interactional" (other-and self-oriented), and "personal" (self- and object-oriented). Carter (1978) traced the genesis of specific phonological configurations of the prelinguistic child to specific performative behaviors such as pointing and reaching.

Further empirical support for this theory is offered by Bates, Benigni, Bretherton, Camaioni and Volterra (1977a) who conducted a longitudinal study of normal children from 9-13 mo. of age, assessing verbal and gestural communication, play behavior, sensorimotor and cognitive development. Their study was correlational and revealed a single gestural complex including pointing, giving, showing and ritualized requests, as well as a single language complex. Several of the gestural measures were good predictors of language development. Of the cognitive measures, imitation, tool use, and symbolic and combinatorial play were <u>all</u> good predictors of <u>both</u> gesture and language (the play measures were the best predictors). Cognitive measures of object permanence and spatial relationships, on the other hand, were very poor predictors of either gestural or verbal development. The authors interpret their data as support for a common substrate for both prelinguistic communication and language. This substrate could be described as a capacity for communication <u>via</u> conventional signs and is not necessarily cognitively based. Bates, et al. (1977b) found both

"protodeclarative" (the use of objects to attain adult attention) and "protoimperative" (the use of adults to obtain objects) schemes in 10-11 mo. subjects. These intentional and conventional, but nonverbal communicative acts were typical of what they termed the "illocutionary phase." This phase is preceded by the "perlocutionary phase," characterized by pre-intentional communicative events (such as fussing, crying) and is superceded by the "locutionary phase," characterized by truly verbal behavior. For the purposes of this study, the terminology of Bates, et al., will be adopted. Snyder's (1978) behavioral definitions of imperative and declarative performatives, which are based upon the Bates research, appear in Table 1 (p. 11).

At roughly the same time that the modern pragmatics literature appeared, several psychologists independently proposed an ethological approach to language acquisition (McNamara, 1972; Mahoney, 1975; Moerk, 1972). This approach is compatible with the pragmatics approach in that language is viewed as an extension of a preverbal communication system (functionally similar to nonhuman communication systems) between the child and the environment. Moerk (1972, 1974) views language and its acquisition as "embedded in the general stream of behavior," being progressively differentiated as a distinct activity, and affected by a very wide variety of teaching devices used primarily by the mother. Mahoney (1975) stresses the reciprocity of the social relationship in language learning, stating that the adult language model must receive feedback from the receiver to determine whether comprehension has occurred. This feedback is generally accomplished through a nonverbal

Table 1.

SNYDER'S BEHAVIORAL DESCRIPTIONS OF IMPERATIVE AND DECLARATIVE PERFORMATIVES (1978)

Imperatives
Child looks at adult.
Child looks at, extends arm towards object.
Child looks at and fusses at adult.
Child extends arm toward object, reaches, vocalizes, and/or points to object.
Child points to and/or reaches for object, then looks at adult.
Child points to and/or reaches for object, then looks at adult's hand.
Child performs act to get adult's attention first, then point to and/or reaches for object.
Child uses linguistic symbol to indicate desire for object.
Declaratives
Child uses direct manipulation to get adult's attention.
Child uses showing off to get adult to attend.
Child uses showing, giving and/or pointing to object to get adult to attend to it.
Child uses pointing and vocalizing to get adult to attend to object.
Child uses word to get adult to attend to object.

signaling system--one which is susceptible to disruption. He proposes that certain delays in speech development may be attributed to ineffective interaction strategies between the child and his or her environment. Clark (1978), in a similar vein, describes the development of language as a "progressive complication of the basic communicative function" (p. 234). According to Clark, intention does not exist in action, but is conferred upon action as the environment interprets it. Once meaning is attached to action, then intentional gestures implying action appear, followed by arbitrary sounds implying gestures.

The ethological approach was no doubt heavily influenced by a recent barrage of research revealing the extremely sophisticated communicative abilities of two types of subjects--the human neonate, and a wide variety of nonhuman species, most notably those of the order Primata (see Fouts, 1972; Gardner & Gardner, 1969; Premack, 1971; Rumbaugh, 1973). Parsimony seems to demand that early linguistic behavior be related to prelinguistic communicative patterns from both ontogenetic and phylogenetic perspectives.

Communication in Normal Mother-Infant Dyads

Obviously, most preverbal communicative sequences will be subsumed within the mother-infant relationship. Although other social-interactive relationships may also become fundamental to communication in particular cases, most of the research in preverbal communication has focused exclusively on the mother-child dyad, with the goal of assessing the linguistic environment of the language learner. Recently, several important volumes have appeared (Bullowa, 1979; Lewis & Rosenblum, 1977; Lock, 1978; Schaffer, 1977) compiling the research on the conversational aspects of mother-infant interactions, ranging from the relatively macro-level analyses of infant and maternal "states" of Lewis (1972) to the extremely fine-grained "micro-kinesic" studies of Condon and Sanders (1974). Much of this research is devoted to the analysis of vocal and visual exchanges between mother and infant.

Stern, Jaffe, Beebe and Bennett (1975) found that at about three months, infants displayed rather complex expressive activities, integrating body movement, gaze, facial expressions and vocalizations; however, the vocal expressions could not be meaningfully distinguished from movements of the mouth. They analyzed vocalizations of mother and infant as "sound-producing kinesic events" and also as precursors of

speech. They found two modes of vocal communication in their 3- to 4-month-old subjects: 1) the coactive mode, or simultaneous vocalizing; and 2) the alternating mode in which mother and infants took turns vocalizing. The coactive mode occurred twice as often as the alternating mode, which was more likely to appear in teaching situations. Stern, et al., propose that these two modes are both enduring communication modes. They suggest that at some point during the child's second year, the alternating mode of vocalization, however, should become the predominant mode. Bateson (1975) also studied vocal exchanges between mother and infant and found social interactions patterned similarly to adult conversation before the age of three months. She stresses the importance of the interactional context in which the infant is studied and the rule-governed nature of the mother-infant interaction.

One must remember that in a pattern of alternating, or even coactive vocalizations, the pauses between vocalizations are filled with listening. Even before vocalization patterns emerge, infants seem to be finely attuned to the sound of external vocalizations. Condon and Sanders (1974) found that the motoric behavior of neonates was synchronized with the sound segments of adult speech. In the words of Osofsky (1979), "Listening, or attentiveness to auditory stimuli, provides a means through which infants can participate in vocal communication behaviorally before they can initiate meaningful speech" (p. 528). A listening response to a partner's vocalization may be as powerful as a vocal response to a vocalization. Constant stimulation

on the mother's part, reflected by a failure to pause and listen, may be as damaging to mutual interaction patterns as is a lack of stimulation.

The regulation of visual regard is another potent variable in mother-infant interactions. Osofsky (1979) considers an infant's eyes to be the "most compelling of infant cues" (p. 534). Bateson (1975) contrasts the intermittent patterns of vocal-auditory behavior with the "near-constant communication in the visual modality" in mother-infant as well as in adult interactions. Eye contact may signal the listener's state of attending to the speaker, or it may serve as the speaker's request for attention. The establishment of joint reference (the referent intended by a speaker) is normally accomplished through visual monitoring (Bruner, 1975). A mother will closely follow her baby's line of regard in order to make the object of the baby's attention the topic of subsequent verbalizations directed to the infant (Collis & Schaffer, 1975). The relationship between the visual and vocal behavior of pre-verbal children within the same communicative interaction remains unclear, however (Schaffer, Collis & Parsons, 1977).

Jerome Bruner theorizes that in addition to vocal and visual behavior, the motoric routines of ritualized games are important to language development. Bruner (1974/75) asserts that "many of the organizing features of syntax, semantics, pragmatics, and even phonology have important precursors and prerequisites in the prespeech communicative acts of infants" (p. 255). His account of the passage from prelinguistic to linguistic concepts goes roughly as follows.

Linguistic concepts are first realized in action. Language develops as an instrument for regulating joint activity and attention during mother-infant play in particular. The development of play behavior involves learning segments of joint action in given action sequences, the construction of routines for assuring joint reference (such as eye contact, or following the partner's line of regard), the expectancy of order, and finally the elaboration of the rule structures of mutual play. These rule structures include give-and-take routines, the establishment of roles and the reversibility of role relationships. Distinct vocalizations may accompany different aspects of play behavior, such as receiving an object versus offering an object. This sort of play behavior draws the child's attention to communication itself, and the rituals of play become the object of attention, rather than instruments to another end. Grammar derives from this jointly regulated behavior as a set of culture-specific rules. Bruner feels that the acquisition of rules in these nonverbal exchanges better enables the child to "crack the code" of the verbal exchanges which regulate these games.

The Effects of Visual Impairment

We have at our disposal few reliable or objective assessments of the effects of blindness on infancy. The research in this area suffers from several problems. First, some of this research is really focussed on the function of the visual channel in normal subjects; these studies are thus designed to emphasize the deficits in blind children or adults. Partly in reaction to such studies, another trend in the blind literature is to prove that the blind child is as "good" as any other child; these studies tend to minimize the differences between blind and normal individuals. A methodological problem revolves around the fact that the population of totally blind individuals without concomitant handicaps is so limited that a sample of blind subjects almost invariably includes some subjects with at least light perception. Finally, the predominant etiologies of blindness within a given culture change over the years with advances in medical technology. Much of the available research was conducted with RLF (retrolental fibroplasia) and rubella victims. Each of these conditions is associated with specific damage other than blindness, damage which would have developmental ramifications independent of the associated lack of vision. Today, RLF and rubella are virtually nonexistent, so that today's "typical" blind infant (if such an entity exists) is very different from the typical blind infant of a decade ago.

The preponderance of research with blind individuals has emphasized perceptual-motor skills and personality development, with a recent spurt of interest in the cognitive abilities of post-sensory-motor children (see Warren, 1977, for a comprehensive review). The most striking differences between blind and sighted children post-infancy seem to occur in the cognitive and psycho-social realms. Perceptual abilities of the blind seem comparable to those of sighted children, with little difference in tactile discrimination (Gottesman, 1971) or auditory discrimination (Hare, Hammill & Crandell, 1970). This evidence confounds the popular notion that blind individuals develop miraculous sensory abilities in the nonvisual modes to compensate for their visual loss. The blind child may optimize his or her sensory abilities, but this generally takes considerable training and lengthy experience.

While early studies of cognitive abilities in blind children (no satisfactory scale of cognitive development in blind infants exists) indicated a two- to four-year lag in performance on Piagetian conservation tasks (Hatwell, 1966; Miller, 1969), Gottesman's work indicates that the developmental sequence of conservation abilities is normal (1973). Adi and Pulos (1978) found no significant lag in number conservation for blind children when they were very carefully matched with sighted children for age, sex, socio-economic status, grade level, and number of years in school. Lopata and Pasnak (1976) demonstrated that substance conservation in blind children could be accelerated by a combination of generic-experiential and skill-specific training. Hartlage

(1976) found that blind children grasped the implications of nonspatial linear syllogisms (A is better than B; B is better than C; which is worst?) as readily as signted children, but not the identical syllogisms couched in terms of spatial relationships. Kephart, Kephart and Schwartz (1974) administered a concept scale requiring children to verbally reconstruct various aspects of their environment. The concepts of blind subjects proved to be fragmented and distorted as compared to those of sighted children. A five-year-old blind child, for instance, would spontaneously describe a person using a mean of four body parts, compared to a mean of 12 body parts for sighted subjects of the same age. Such studies as these suggest that cognitive deficits or delays may reflect experiential deficits secondary to blindness rather than visual deprivation per se.

The communicative patterns of blind children, although not seriously deviant, are more limited than those of sighted children. The nonverbal components of language--gesture and facial expression in particular--are attenuated in congenitally blind individuals of all ages (Buchanan, 1978; Harper, 1978). Furthermore, speech defects are more prevalent among the blind than in the sighted population (Miner, 1963; Graham, 1966). There is some question, also, as to the semantic aspects of language in a blind individual (Dokecki, 1966). Generally, however, the linguistic ability of a blind child is at age-level or above.

The Visually Impaired Infant

Consider the following description of the typical sighted infant by Rheingold (1959): "By three months of age the infant gives a well-defined social response to the appearance of adults. He looks at them intently, smiles, becomes active, and vocalizes" (p. 68). Now consider these excerpts from Fraiberg (1977) describing her first clinical impressions of the seven most autistic of a group of 27 blind children:

> The mother was barely distinguished from other persons; her comings and goings went unnoticed. There were no cries to summon her, no sounds of greeting when she appeared, no signs of distress when she left . . . The hands did not reach out to attain objects or to get information about them (p. 10).

Although these seven children were the most deviant of the group, this sort of picture is not uncommon among blind infants. Sightless infants are often passive, "easy" babies, apparently contented to be left solitary, sitting with arms abducted, and fists clenched, rarely crying. On the other hand, most individuals who deal with blind children can describe at least one totally blind infant who, without apparent biological or environmental advantage, functions at age level, or even above age level in locomotor, language and social skills. The variability among these children is astonishing.

By far the preponderance of the research on blind infants has been conducted by Fraiberg (compiled in Fraiberg, 1977). Table 2 (p. 21)

Table 2

MILESTONES IN THE DEVELOPMENT OF THE BLIND INFANT

(Fraiberg, 1977)

4 weeks	Irregular smile to familiar voice.
	Tactile exploration similar to that of sighted infant.
2.5 mo.	Smiles regularly only to gross tactile stimulation (tickle).
	Smiles more frequently, but still irregularly, to human voice.
3 mo.	Tactile exploration becomes more discriminative and intentional (as in sighted infant).
5 - 8 mo.	Explores face of mother and familiar people: discriminates familiar from unfamiliar faces--only brief scanning of strangers' faces.
6 - 12 mo.	Listens selectively to familiar words.
6 mo.	Smile to human voice is still irregular, but is selective to mother's voice.
6 - 14 mo.	Responds to verbal requests.
6 - 16 mo.	Jabbers expressively.
7 - 15 mo.	Stranger-anxiety appears.
8 - 18 mo.	Imitates words.
9 - 12 mo.	Acoustical tracking and sound localization.
10 - 16 mo.	Person permanence appears (Piagetian Stage IV).
10 - 17 mo.	Creeping begins.
11 - 16 mo.	Separation protest appears.
12 - 20 mo.	Free walking begins.
12 - 32 mo.	Says two words.
13 - 27 mo.	Uses words to make wants known.
17 - 38 mo.	Uses two-word sentences.

represents a compilation of the developmental milestones achieved by blind and sighted infants in the various developmental areas as described by Fraiberg. Note the extended age ranges shown by the blind subjects for the acquisition of many of these milestones.

In the psycho-social realm, Fraiberg found that the development of human attachments proceeded fairly normally. The smile to familiar voices was irregular for a longer period than is normal, but it was appropriately selective to the mother. Stranger anxiety appeared within the normal age range, but separation anxiety was delayed, no doubt because of a delay in the acquisition of person-permanence. Proximity-seeking behaviors were also delayed, probably due to the person-permanence lag combined with the lag in mobility.

Locomotor development was characterized by a lag between postural readiness (which usually developed within a normal time frame) and mobility. The young sightless infants resisted the prone position, and when placed in this position did not lift the head or prop themselves up on their arms as sighted infants do. Sitting was achieved within normal ranges, but there was a very significant (6 month) lag in prehension. When the normal baby is reaching at midline (at about 5 months), the blind baby is not even engaging hands at midline. Prehension did not appear until ear-hand coordination, reflected by the ability to reach to a sound cue, occurred. The reach-to-sound cue appeared within normal limits (Freedman, Fox-Kolenda, Margileth & Miller, 1969) and apparently inspired the infants' first attempts at locomotion. Infants who had

been pushing themselves into a crawling position and spending sustained periods rocking back and forth with no attempt to move forward, suddenly began creeping or pulling-to-stand. The crawling step, however, is frequently skipped, with the blind youngster going directly from sit, to pull-to-stand, to walking.

Fraiberg describes the average blind infant as communicatively rather unresponsive. Although the basic facial expressions of normal infants seem to appear spontaneously (Eibl-Eibesfeldt, 1970), Fraiberg found them less subtle and contrastive than those of sighted infants. Furthermore, frowning seemed to appear only in babies with at least light perception. (Interestingly, a study of blind infant monkeys--Macaca fascicularis--by Berkson and Becker [1975] showed that they exhibited normal facial expressions except that the overall frequency was depressed, and threat faces and grimaces occurred particularly rarely.) Fraiberg noted that spontaneous vocalizations on the part of blind infants were sparse (she did not take objective measures), which is surprising, given Rheingold's (1959) evidence that infant vocalizations are subject to social reinforcement. Fraiberg speculates on the possible impairment of the mother's spontaneous utterances to her baby as a result of this deficit.

Fraiberg analyzed the communication system of blind infants as a system of "smile" and "hand" language that replaces the "eye" language of the normal infant. In Fraiberg's words (1971):

> . . . if we shift our attention from the face of the blind baby to his hands, we can read an eloquent sign language of seeking, wooing, preference, and recognition, which becomes increasingly differentiated during the first 6 months (p. 228).

Denied the normal facial, vocal and visual feedback from her baby, Fraiberg's mothers were often at a loss to understand their babies' cues. Once a mother was trained to understand her baby's sign system, however, the mother-infant reciprocity was manifested in the mutually expressive aspects of the mother's face and the infant's hands. In spite of these differences in early communicative behavior, however, the language development of the blind child was essentially normal. Fraiberg (1977) noted a one-month lag in producing two-word sentences, but blind infants actually anticipated sighted infants on the acquisition of several of the few Bayley language items which were applicable to the blind. The one significant deviation from normal language was the difficulty in using the pronouns I and me (occurring about age 2 1/2 - 3 yrs), which coincided with a lag in the ability to represent the self through toys in imaginative play.

A welcome addition to Fraiberg's research came recently from Urwin (1978), who presents in case-history form an examination of the pragmatics of communication between two blind infants, Stephen and Jerry, and their parents. Stephen was partially sighted. He was extensively coached in object play by his parents and was very much object-oriented. By the end of his first year, Stephen did not follow a point or gaze, or produce any clear gestures; nor did he proffer objects to his mother.

At about 14 months (after tutoring), Stephen began to give up objects and then to put them into his mother's offered hand, whereupon ritualized exchange sequences emerged. These sequences were subsequently paired with speech sounds and words. Although Stephen never did learn to use a pointing gesture, he began to use reaching as a request at about 19 months.

Jerry was totally blind, but very advanced in locomotor skills, taking several steps by 15 months of age. In contrast to Stephen's parents, Jerry's rarely utilized toys in play, preferring to engage Jerry in action rituals and vocal dialogue. Although Jerry generally played with toys on his own, exchange routines developed between 12 and 17 months. He had been dropping and retrieving objects for his own amusement in solitary play, and he now began to drop objects so that his mother would come over and give them back to him. He did not relinquish objects upon request until 20 months. As Jerry's mobility improved, he was able to participate very actively in the body play of ritualized games involving turn-taking and accompanied by nursery songs and chants. Jerry's mother would engage in lengthy vocal commentaries for his benefit as she worked in an adjoining room, and Jerry began to imitate speech with great accuracy.

Jerry first used words as requests for action at about 18 months, and his early vocabulary consisted largely of people's names, and words important to social exchanges. His speech was well-formed. In contrast, Stephen's initial vocabulary consisted largely of nominals (unusual for

a totally blind child) and his articulation was imperfect. By the age of 20 months, both infants had acquired large spoken vocabularies, and good language skills even though their acquisition of basic pragmatic behaviors such as giving, taking, pointing, and requesting was delayed.

The Research Questions

This project was designed to produce new information in the following areas: a) the ethological description of the behavioral repertoire of visually impaired infants; b) the predictive value and theoretical implications of the preverbal gestural complex of visually impaired infants with regard to language acquisition; and c) the clinical implications of early communication strategies between visually impaired infants and their mothers. Below are listed specific questions addressed in these areas.

Description

1. What are the behaviors (specifically communicative) of the visually impaired infant, and at what rates are they produced?

2. Which of these behaviors seem to be responsive to maternal behaviors, as evidenced by the analysis of contingent relationships between maternal and infant behaviors?

Prediction

1. Do visually impaired infants adhere to the same course of development in early communication as pragmatic theory describes for the sighted infant?

2. Does the preverbal communicative repertoire of the visually

impaired infant seem to be predictive of language acquisition, as dictated by pragmatic theory?

Clinical Implications

1. To which behaviors of the visually impaired infant do their mothers seem to be most responsive, as demonstrated by the contingent probabilities between behaviors?

2. How might maternal responsiveness be improved to enhance the communicative behavior of the visually impaired infant?

Method

Subjects

The Child Study Center (Children's Memorial Hospital, University of Oklahoma Health Sciences Center) in Oklahoma City referred as potential subjects infants who were enrolled in their preschool program and who met the fillowing criteria:

1. Totally blind or no more than minimal light perception at birth.
2. No concomitant sensory handicaps.
3. No older than 36 mo. by 9/15/78.

The first five infants whose parents consented to participate in the project were accepted as subjects. Only one set of parents interviewed declined to participate.

Table 3 (p.30-1) profiles the subjects in terms of the most salient social, medical and clinical variables. It is important to note that the characteristics of the subject sample are highly variable. The three younger subjects (A, B and C), who were within six months of the same age, were totally blind. Subjects D and E, though within three months of the same age, were considerably older than A, B, and C, and also had much better sight than they did at birth. Though this variability among subjects is regrettable, the sample is deemed representative of the general population of visually impaired infants. Severe

Table 3. Subject Profile

Subject and Sex				
A - Female	B - Female	C - Female	D - Female	E - Male
Birthdate				
12-13-77	17-20-77	6-11-77	5-19-76	2-20-76
Age at Inititation of Project				
11 mo.	15 mo.	16 mo.	2 yr., 6 mo.	2 yr., 8 mo.
Family Income				
Low-middle	Low	Low	Low-middle	Low
Home				
Urban	Urban	Rural	Urban	Rural
Ordinal Position in Family				
2nd of 2	1st Of 1 (but 4th of 4 under 21 yr. in extended family)	3rd of 3	1st of 3	2nd of 2
Others in Home (besides siblings)				
Mother, Father	Mother, 2 Aunts, Uncle, Grandmother, other relatives move in and out	Mother	Mother, Father	Mother, Father
Current Vision				
Responds to bright lights	None	No visual response	Visual tracking, locates large items across room	Visual tracking, locates small items up to 4 ft. away

Table 3, continued

Visual Diagnosis				
Visual impairment: cortical basis	Congenital anophthalmia	Bilateral optic hypoplasia	Visual impairment: cortical basis	Cortical blindness
Age at Diagnosis of Visual Impairment				
6 mo.	Birth	Prior to 9 mo.	15 mo.	6 mo.
Concomitant Handicaps				
Generalized hypotonia	None	None	Hypertonicity, all extremities; hypotonicity, trunk; microcephaly	None
Age at First Evaluation by CSC				
10 mo.	3 mo.	9 mo.	7 mo.	13 mo.
Vision at Time of Referral to CSC				
No consistent response: may see shadows	None	No visual response	Light perception	Occasional response to light
Age at Onset of Therapy				
11 mo.	4 mo.	10 mo.	8 mo.	14 mo.

visual impairment is rarely an isolated handicap, so that it is quite rare to find an infant who sustains a severe visual impairment without concomitant sensory or motoric handicaps.

Apparatus

A Sankyo XL-400S Super-8 sound movie camera was used to film mother-infant interactions at a speed of 24 frames per second. The auditory cue marking each 2-second interval was dubbed onto the films using several different makes of Super-8 sound movie projector that had recording capability for both of the available sound tracks. (The original sound track was preserved by dubbing it onto the secondary sound track and the auditory cue was dubbed only onto the primary sound track.) Film analysis was accomplished on a Kodak Ektasound Moviedeck 265 projector, which has projection speeds varying from 18 to 24 frames per second.

Procedure

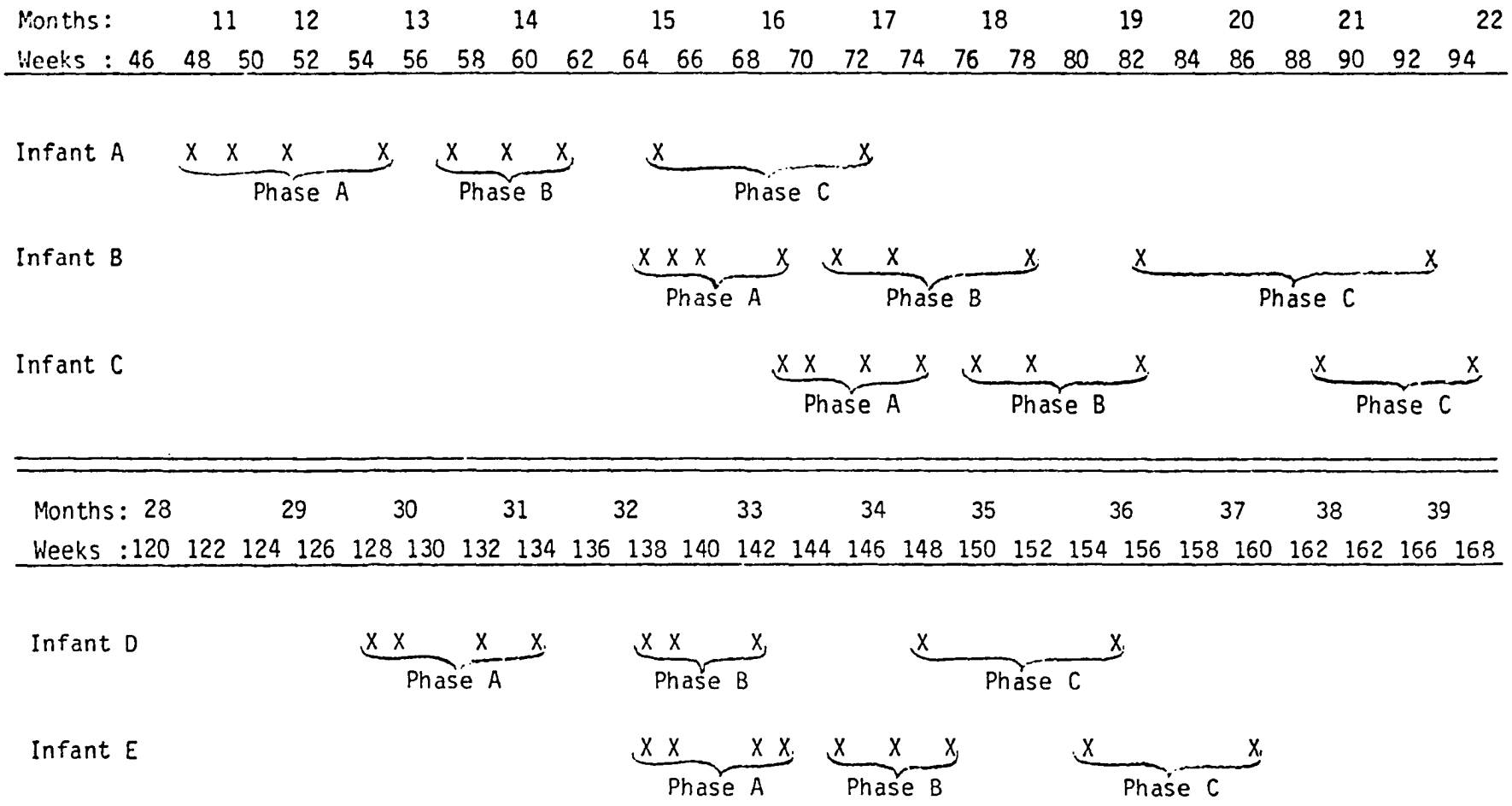
The data were collected in the subjects' homes in order to enhance the ecological validity of the observations. Subjects were visited seven times at approximately two-week intervals for four months. Two additional visits were made at approximately month-long intervals. Each mother-infant pair was thus followed for six months. At each visit, two 3-minute reels of Super-8 sound color film were made, with the exception of the first and last visits, when four reels were made. Mothers were instructed to play with their infants in as normal a fashion as possible. The purpose of the research project had been fully explained to the

mothers, so that they were aware that communication behavior was the focus of the study. Thus the mothers' behavior may have been affected in two ways during these sessions: 1) the desire to encourage communicative behavior, particularly vocalization, by their infants might have increased the intensity of the mothers' behavior; or 2) the inhibitions that normally arise when a camera is pointed at a subject might have decreased the intensity of the mothers' behavior. None of the mothers exhibited severe anxiety initially, and the relatively lengthy duration of the project enabled rapid habituation to the observer's presence and to the phenomenon of being on-camera. With the exception of subject D, the infants seemed completely oblivious to the presence of the observer and the sound of the movie camera. Subject D, who had returning useful sight, was attracted by the bright flood light and enjoyed staring at it.

Initially, all films involved mother and infant interaction around a standard set of toys (not available in the subject's homes) which were brought by the observer. It became apparent, however, as the project progressed, that equally useful and important information was available from interactions that were not centered around inanimate stimuli. Accordingly, part way into the project, an effort was made to collect one film of toy-centered interactions and one of non-toy interactions at each home visit. A total of 22 films were shot of each mother-infant pair. Of these, four proved unusable due to camera difficulties. Due to scheduling difficulties, one session was held at the Child Study Center for each of subjects B, C, D and E. Table 4 (p. 34) shows the ages of each subject at each film session.

Table 4.

AGES OF SUBJECTS AT EACH OBSERVATION



At each session, mothers were asked to recall any new behaviors (communicative or otherwise) which had been acquired by their children since the previous session. In addition, the motor, perceptual and cognitive subscales of the Callier-Azusa Scale (Stillman, 1977) and the communicative behavior inventory compiled by Bates, et al. (1977a), were administered, utilizing maternal information, the experimenter's observations, and information from the CSC assessments.

The only intervention strategy involved in the project was the provision of feedback, which was accomplished by showing the films to the mothers and to the infants' teachers at the CSC. Mothers (and any other family members present during home visits) were shown their own films as they became available (starting about two months after the first visit), after each session's filming had been completed. Two sessions with the CSC personnel were held during the project, at which time selected films of each mother-infant pair were shown to teachers and therapists involved with any of the infants.

Analysis

Film Analysis

Code development. The observational coding system was developed specifically for this project and has not been used elsewhere, The rationale for the code evolved from the following considerations:

1) The communicative behaviors of mother and infant were of primary interest.

2) From the maternal point of view, almost any infant behavior might be considered expressive, at least on a perlocutionary level; therefore, almost all gross behavior categories of the infant were scored.

3) From the perspective of the blind infant, however, many of the potentially communicative behaviors of the mother--such as facial expression and visual regard--are functionally nonexistent. Therefore, the scoring of maternal behaviors was limited to those observable maternal behaviors which could be sensed by a sightless infant. (No doubt the infants responded in some way to certain other maternal stimuli such as breath, body temperature and odor. These variables could not be observed, however, and are not under the mothers' voluntary control as communicative stimuli.)

4) Given the pragmatic perspective which formed the theoretical basis of the study, and given the fact that the subjects were communicating at an illocutionary level at best (only one subject exhibited any verbal or locutionary behavior at all), the preverbal performatives were expected to be of special interest. However, the number of conventional gestures observed was so low that it became obvious that a much more molecular level of analysis was required than had originally been anticipated.

5) Since Fraiberg's work (cited above) had indicated that the manual activity of the blind infant was particularly expressive, it seemed appropriate to concentrate attention on the manual responses of

the subjects, expecting to find the rudiments of conventional gesture in nonconventional, idiosyncratic expressive activity.

The resulting code and code check list (which were developed during the process of analyzing the first sets of films) appear in Appendices A and B. Each of the seven categories of infant behavior and three categories of maternal behavior are comprised of mutually exclusive and exhaustive subcategories of behavior. As the code was administered, observers also documented the number of vocal imitations by both mother and infant, listed linguistic utterances by the infant, and described the infants' gestures on additional data sheets. In addition, subjective descriptions of behaviors of particular interest that were not adequately described by the code check list were compiled. Since two of the subjects were beginning to use their sight, certain behaviors peculiar to these two mother-infant pairs were scored even though they were inapplicable to the other subjects. Definitions of all behavior codes appear in the glossary (Appendix A).

Observational interval. A 2-second observation interval for analysis was chosen after the first few films had been viewed. This interval length represented a best attempt to limit behaviors to one per category per interval. Most behaviors scored were ones that would endure for at least two seconds. Behaviors were scored only once per interval, no matter how often they occurred. Thus, technically speaking, a modified frequency count was used, although it was rare that more than one discrete instance of a behavior occurred during a given interval.

Within each behavior category, only one subcategory could be scored per interval, with the exception of the Infant Hand category. Therefore, within each category, subcategories were given priority rankings, and if two subcategories of behavior were displayed within the same interval, only the one with the higher priority was scored. Priority was determined by communicative value; thus spontaneous, positive, expressive behaviors were ranked highest, followed by reactive expressive behaviors, followed by negative expressive behavior, self-directed behavior, and finally the "other" or nonbehavior subcategories (see Glossary, Appendix A for specific rankings). In the Infant Hand category, the "reach" and "release" subcategories could be scored in addition to one other subcategory within the same interval, since these represent momentary activities almost invariably preceded or followed by other manual activities within a 2-second interval.

The 2-second observation interval resulted in an average 70 to 75 intervals per film, with each interval representing 10 behavior codes. A total of approximately 90,000 data points were collected over the course of the project.

Observer Reliability

Observer Reliability was assessed on 20% of the films analyzed, using the formula 100 x (# agreements/# agreements + disagreements). An agreement constituted the same subcategory score within the same interval by both observers. Reliability was assessed for each subject and for each behavior category. After at least 80% reliability was

achieved per subject, per category, the remaining films for each subject were randomly assigned to the two observers, with Observer 1 scoring 60% of the films. Reliability scores appear in Appendix C.

Films were first viewed continuously at normal speed (24 fps), then continuously at slow speed (18 fps), and finally they were analyzed at the slower speed, stopping the film at the auditory cue every two seconds to administer the observational code. Observers could rewind the film to review intervals whenever necessary and could review an interval at normal speed if this seemed helpful. The behavior categories that caused the greatest inter-observer disparity were the auditory ones. Although these were the most objective categories (since auditory stimuli are either "on" or "off"), it was sometimes difficult to determine which partner had made a sound or when a sound began or ended, while viewing the film at slow speed and with constant stops and starts. Therefore, all films were reviewed a second time at normal speed to verify auditory category scores. At this time also, other categories were reviewed and if questions had arisen during the first scoring process, they were settled at this time.

Statistical Analysis

For each subject, the data were grouped into three Phases (A, B, and C), each representing two month's worth of filmed observations. Unfortunately, the number of observations differed across Phases, with most observations made in Phase A for purposes of the observational

code development, and fewest in Phase C, which encompassed only the two follow-up visits (see Table 4, p. 34). Within each Phase, data were subdivided into "Toy" versus "No Toy" conditions.

The data were first analyzed for frequency of behaviors, using the BMDP-2F Frequency Count Routine. The raw frequencies revealed that a number of the behavioral subcategories did not occur in sufficient number across subjects to warrant more complex analyses. Hence, the decision was made to collapse the following subcategories of behavior:

Subcategories combined	to form	Category
Maternal Tactile: Caress Restrain Direct		Maternal Touch
Maternal Auditory-Vocal: Linguistic, positive Linguistic, negative Linguistic, other Nonlinguistic		Maternal Vocalization
Infant Auditory-Vocal: Linguistic Nonlinguistic		Infant Vocalization

In each of these three categories, one subcategory predominated, but the lower-frequency subcategories occurred with sufficient frequency that it was considered prudent to include them in analyses, even though they could not be analyzed individually. The remaining low-frequency subcategories, which could not be meaningfully combined with other subcategories, were excluded from further analysis. At this point, additional frequency counts were made of a select group of concurrent behaviors which are listed below, with their definitions.

Concurrent Vocalization:	Maternal Vocalization + Infant Vocalization
Maternal High-Involvement State:	Maternal Vocalization + Maternal Touch
Maternal Low-Involvement State:	No Maternal Activity
Infant Low-Involvement State:	No Manual Activity + No Approach/Avoidance + No Facial Expression + No Vocalization + No Nonvocal Sound

Maternal Behavior Patterns (All combinations of maternal behavior categories)

The individual behavior categories, Concurrent Vocalizations, and the Involvement States were subsequently analyzed for cyclic patterns and interdependencies over time using a lagged conditional probabilities program, "LAGS," developed by Sackett (1979). This nonparametric technique compares the contingent probability of a target behavior, given the antecedent occurrence of a criterion behavior at any specified time or event lag, with its expected or noncontingent probability of occurrence over an entire series of sequential observations. Z-scores are computed to assess the significance of the difference between the conditional, or observed probability (P_O) and the unconditional, or expected probability (P_E). Lag profiles may then be plotted to illustrate the auto-contingencies within behaviors or the cross-contingencies between behaviors over any number of event or time lags. Since the observation intervals used in this study were of uniform duration, since the interval was shorter than the durations of most behaviors

scored, and since only one event was scored per category per interval, there was no practical difference between time and event lags. For simplicity's sake, therefore, the data were analyzed as event data, and the program was set to lag from all occurrences of criterion behaviors ("level-triggered").

This technique is extremely costly and easily produces unmanageable amounts of data. Furthermore, "fishing expeditions" into the dependencies of a large number of behaviors emitted by interacting individuals are bound to yield numerous chance relationships. Therefore, the LAGS analyses were used only to investigate pairs of behaviors which were expected to be highly temporally related, either by virtue of the theoretical assumptions of the investigation, or as the result of actual observations of the mother-infant interactions. Thus, a very limited set of cross-contingencies was examined. These were:

Criterion Behavior	Target Behavior
Maternal Low-Involvement State	Infant Vocalization
Maternal High-Involvement State	Infant Vocalization Infant Low-Involvement State
Maternal Vocalization	Infant Low-Involvement State
Maternal Vocalization Maternal Touch Maternal Nonvocal Sound	Infant Vocalization Infant Positive Facial (Smile) Infant Gesture Infant Reach for Toy Infant Manipulate Toy Infant Nonvocal Sound
Infant Low-Involvement State	Maternal High-Involvement State
Infant Vocalization, Infant Smile, Infant Manipulate Toy	Maternal Vocalization Maternal Touch Maternal Nonvocal Sound

Criterion Behavior	Target Behavior
Infant Gesture	Maternal Vocalization Maternal Touch
Infant Reach for Toy	Maternal Vocalization
Infant Nonvocal Sound	Maternal Touch Maternal Nonvocal Sound

Certain LAGS analyses could not be carried out for particular subjects in particular Phases or conditions if the raw frequency of the criterion behavior was too low (minimum frequency = 30) or if the expected probability of a target behavior was too low (minimum P_E = .05). Certain behaviors occurred almost exclusively in the Toy conditions and had to be analyzed in Toy sequences separately in order to bolster their expected probability to acceptable levels. Therefore, if either criterion or target behavior was Maternal Nonvocal Sound, Infant Reach for Toy, Infant Manipulate Toy, or Infant Nonvocal Sound, the LAGS analysis was conducted only on the Toy sequences within a Phase. The remaining behaviors were analyzed across Toy and No Toy sessions combined for each Phase. All LAGS analyses were carried out with lags of one interval (lag-1) as well as with lags of five intervals (lag-5) and were carried out for 15 lags (30 seconds for lag-1 and 150 seconds for lag-5). The lag-5 analyses were set to average the conditional probabilities across each lag of five intervals.

The data generated by this study were very difficult to manage except descriptively. The measurement of concurrent behaviors and the inequality of observations across subjects, Phases and conditions

combined to make the meaningful application of test statistics impossible. Given the extreme disparity among the subjects in terms of age, locomotor ability, visual impairment, and sociability, the data seem most sensibly viewed as five intense case studies. Visual inspection of the lag profiles and behavior frequency tables for each subject may provide the most fruitful grounds for interpretation of the data.

Results

Only data from individual mothers and infants are presented in this section. All tables and discussion comparing data across subject pairs occur in the Discussion and Conclusions section. Pre- and post-project scores for the Callier-Azusa subscales are displayed in Appendix D (pp. 238 - 243), and behavioral descriptions of all new gestures produced by each subject on film appear in Appendix E (pp. 244 - 253). Lag profiles for the autocontengencies of individual infant and maternal behaviors and concurrent vocalizations are graphically displayed in a series of figures in Appendix F (pp. 254 - 265).

The data for each mother-infant pair are treated separately, and tables and figures related to these data appear following the Data Summary for each pair. The tables display occurrence rates for the originally scored behavior categories, and for the individual behaviors and behavior states subjected to LAGS analysis. Additional tables present the transitional probabilities between mother and infant and infant and mother behaviors at the first lag. All observed and expected probabilities reported in the text are associated with z-scores ≥ 3.30, indicating a two-tailed $p \leq .001$. This very stringent criterion for significance was adopted in an effort to minimize the very high probability of Type-I error engendered by the LAGS analysis. In the text,

P_{Ln} refers to the observed (or conditional probability at lag_n. $P_{Ln_1\text{-}n_2}$ refers to the observed probability averaged across lag_{n_1} through lag_{n_2}. All lag profiles are graphically displayed in the series of figures following the data tables for each pair. The lag-5 profiles added very little information beyond that obtained from inspection of the lag-1 profiles. However, occasionally a low-frequency criterion behavior which could not be analyzed at the single-interval lags could be analyzed at the five-interval lags (since more data are analyzed at each lag). Only in these cases are lag-5 profiles plotted or discussed.

Pair A

Infant A was 11 months of age at initial observation, and had just begun attending the Child Study Center (CSC) Preschool Program. She had no useful vision, suffered from generalized hypotonia, and was developmentally delayed in all areas. She sat only with support, had poor head control, and would hold objects only passively, and for no more than a few seconds. Though she did not react adversely to adult attempts to interact with her, she seemed happy to be left alone, playing with her hands and babbling. Interestingly, she demonstrated excellent head turn and eye orientation to auditory cues; these abilities, combined with the appeal of her enormous blue eyes (which showed no aberrant movements), no doubt made en face interactions with her somewhat more "normal" than with most blind infants.

Infant A responded rapidly to twice-weekly sessions at CSC and to home programs, making steady progress over the course of the project. After six months (at almost 17 mo.), she was playing with her hands at midline, and played independently with toys. She could sit unsupported in a high chair, would tuck her legs under her and rock in a crawling position, and moved around the floor a little by rolling and scooting. Her auditory localization skills were excellent and manual exploratory behavior was becoming more purposeful and frequent. She vocalized

loudly and fairly frequently, producing a belly laugh that never failed to surprise the naive observer. She seemed to understand a few verbal phrases and responded to vocal intonation. However, she remained a passive baby with general developmental delays.

Tables 5 and 6 (pp. 55 and 56) present the proportional occurrences of each of the originally scored behaviors for Pair A. Notable is the lack of Spontaneous Manual Gestures and the high rate of Touch Self on the part of the infant, and the lack of Vocal Imitations by both mother and infant.

Table 7 (p. 57) presents proportional occurrences for Pair A of the 11 categories chosen for intensive analysis. Lag-1 conditional probabilities for Infant A behaviors appear in Table 8 (p. 58), for Maternal behaviors appear in Table 9 (p. 59), and for reciprocal Involvement States appear in Table 10 (p. 60). Figures 1-8 (pp. 61 - 68) graphically depict cross-contingencies found in Pair A interactional sequences.

The Mother's Effect on the Infant: Pair A

Maternal Tactile Behavior (see Fig. 1, p. 61). The rate of Maternal Touching was extremely high (a mean of 100% for No-Toy intervals and 76% for Toy intervals), due to the inability of Infant A to support herself in any sort of upright position. The only apparent effect of this behavior was a persistent decrease in Infant Toy Manipulation in Phase C ($P_{L1} = .107$).

Maternal Auditory/Vocal Behavior (see Fig. 2, p. 62). Maternal

Vocalizations appeared in a mean of 44% of intervals, with a mean of 70% in No-Toy conditions and 23% in Toy conditions. Following this criterion, the probability of Infant Nonvocal Sounds increased after a 20-sec. delay in Phase B (P_{L10} = .228). The relationship could not be assessed in Phase C. Infant Vocalizations were not affected in Phases A and B, but their probability decreased persistently in Phase C (P_{L1} = .306). In Phase A, the probability of Infant Smile was enhanced commencing 14 seconds following the criterion (P_{L7} = .093); in Phase B the enhancement of Infant Smile was immediate but brief (P_{L1} = .154), while enhancement was immediate and sustained in Phase C (P_{L1} = .157). The rate of Infant Low-Involvement increased cyclically following Maternal Vocalization in Phase A (P_{L1} = .389), and increased persistently in Phase C (P_{L1} = .364), with no relationship evident in Phase B.

Maternal Auditory/Nonvocal Behavior (see Fig. 3, p. 63). Maternal Nonvocal Sounds occurred in 74%, 55% and 39% of Toy sequences in Phases A, B and C, respectively. The only apparent effects of this criterion were delayed, cyclical increases in Infant Nonvocal Sound and Toy Manipulation occurring at 30 sec. postcriterion (P_{L15} = .397 for Nonvocal Sound; P_{L15} = .397 for Toy Manipulation) in Phase C.

Maternal Low-Involvement (see Fig. 4, p. 64). Maternal Low-Involvement increased from 1% in Phase A to 4% and 13% in Phases B and C, respectively, coinciding with the infant's increased postural control. The lag-5 profiles for Phase B shows an immediate decrease in Infant Vocalizations following this criterion (P_{L1} = .036), while in Phase C

(where a much higher density of this criterion occurred), Infant Vocalizations showed a persistent increase at 24 sec. post-criterion (P_{L12} = .521).

Maternal High-Involvement (see Fig. 4, p. 64). Mother A showed High-Involvement in a mean of 42% of all intervals. The rate of Infant Vocalizations following this behavior was unaffected in Phases A and B, but was depressed in Phase C (P_{L1} = .298). High Maternal Involvement was followed by cyclic increases in Infant Low-Involvement in Phase A (P_{L1} = .386) and by persistent increases in this state in Phase C (P_{L1} = .387).

The Infant's Effect on the Mother: Pair A

Infant Auditory/Nonvocal Behavior (see Fig. 5, p. 65). Infant A's ability to produce Nonvocal Sounds increased along with her ability to manipulate toys, occurring in 9%, 14% and 29% of Toy sequences in Phases A, B and C, respectively. This criterion was followed by decreases in Maternal Touch in all Phases (P_{L1} = .756 for Phase A; P_{L15} = .752 for Phase B; P_{L1} = .129 for Phase C). Maternal Nonvocal Sound showed cyclical depressions post-criterion in Phase A (P_{L1} = .537) and in Phase B (P_{L15} = .376), with an immediate but transitory decrease in Phase C (P_{L1} = .242).

Infant Auditory/Vocal Behavior (see Fig. 6, p. 66). Infant Vocalizations occurred in an average of 30% of all intervals. Maternal Touch increased in a cyclical fashion following this criterion in Phases A

(P_{L1} = .983) and B (P_{L1} = .956), but no clear relationship appeared in Phase C. Maternal Vocalizations were depressed for 6 sec. post-criterion in Phase A (P_{L3} = .325). In Phase B, Maternal Vocalizations showed cyclical increases (P_{L1} = .744), while in Phase C, Maternal Vocalizations showed cyclical decreases (P_{L1} = .224). In Phase C, Infant Vocalizations were followed by cyclical increases in Maternal Nonvocal Sounds (P_{L1} = .488), which reflect a cyclic autocontingency of this Maternal behavior.

Infant Positive Facial Expression (see Fig. 7, p. 67). Infant A smiled in an average 8% of total intervals, and in 15% of No-Toy sequences versus 3% in Toy sequences. Infant Smiles were followed by an immediate transitory decrease in Maternal Touch in Phase A (P_{L1} = .838) and persistent increases in Maternal Touch in Phases B (P_{L1} = .976) and C (P_{L1} = 1.000). Maternal Vocalizations showed persistent increases post-criterion across all Phases (P_{L1} = .514 for Phase A; P_{L1} = .929 for Phase B; P_{L1} = .409 for Phase C).

Infant Spontaneous Manual Gesture. Infant A produced Manual Gestures in only 1% of total intervals, too rarely to be subjected to LAGS analyses.

Infant Manipulate Toy (see Fig. 8, p. 68). Infant A's rate of Toy Manipulation increased from 9% to 13% to 29% across the three Phases. Maternal Touch following this criterion showed persistent decreases in Phases A (P_{L1} = .789) and C (P_{L1} = .133), and across the first 10 sec. of Phase B in the lag-5 profile ($P_{L1\text{-}5}$ = .619). Rate of Maternal Vocalizations was depressed at 20 sec. following Toy Manipulation in Phase A

(P_{L10} = .176). No relationship between these behaviors was found in Phase C, and analysis was not appropriate in Phase B. Maternal Nonvocal Sounds following this criterion showed cyclical alternations of decreases and increases in Phase A (P_{L1} = .500), while in Phase B, the lag-5 profile showed an increase across the second 10 sec. (P_{L5-10} = .706). In Phase C, Maternal Nonvocal Sounds were depressed for 12 sec. post-criterion (P_{L1} = .200).

Infant Reach for Toy. Although Infant A's auditory localization was good, she did not seem to reach on sound cue. Her rate of Reach for Toy was an average 0% across all Phases.

Infant Low-Involvement (see Fig. 4, p. 64). Infant Low-Involvement occurred at an average rate of 27% across Phases, with a 37% rate in No-Toy and a 20% rate in Toy conditions. In all phases, this state was followed by an increased probability of Maternal High-Involvement (P_{L8} = .446 for Phase A; P_{L9} = .719 for Phase B; P_{L1} = .800 for Phase C), which became increasingly persistent across Phases.

Concurrent Vocalizations: Pair A

Concurrent Vocalizations occurred in 9%, 14% and 10%, respectively, of Phases A, B and C for Pair A. This coactive vocalization showed cyclical autocontingencies in all three Phases (see Appendix F, p. 265).

Data Summary: Pair A

Infant A was on the whole extremely passive and unresponsive for her age, but she showed considerable improvement over the course of the

project (by the end of which she was almost 17 mo. of age). Her manipulative skills improved and increased responsiveness to Maternal Vocalizations was manifested in the increasingly rapid Smile response, with a decrease in Vocalization and an increase in Infant Low-Involvement states indicating increased attending skills by Phase C. An increase in pro-active behavior was evidenced by the progression from a Phase B decrease in Vocalization following Maternal High-Involvement to a delayed increase 30 sec. after this Maternal state in Phase C. By this last Phase, Maternal High-Involvement was followed by persistently high rates of Infant Low-Involvement, with an equally strong pattern of increases in the reverse relationship. Infant A's passivity was reflected in a high rate of Low-Involved states.

Mother A responded to her infant's passivity with a rather high level of activity. Although individual behavior rates did not distinguish this mother from the others, a look at her typical behavior combinations does (see Table 36, p.173). Maternal Low-Involvement states virtually never occurred at first. In Phases A and B, three-component combinations of Nonvocal, Vocal and Tactile behavior occurred in 14% and 13% of total intervals. By Phase C, when Infant A had developed a little more postural independence, Maternal Low-Involvement states appeared in 13% of intervals, while the three-component pattern dropped to 7% of intervals.

Mother A did show an attenuation of activity level following her infant's Toy activities, generally decreasing Tactile and Nonvocal

stimulation. Her response to Infant Smile became very strong by Phase B, with persistent Vocal and Tactile activity. Her response to Infant Vocalizations fluctuated considerably, however, showing no consistent Vocal response, and a curious increase in Nonvocal Sounds following Infant Vocalizations in Phase C. Concurrent Vocalizations occurred at a fairly constant rate across the Phases, demonstrating cyclical auto-contingencies.

The general impression is of a perlocutionary infant becoming increasingly pro-active and intentional in manipulative skills, but not in expressive skills. The mother seemed to respond more appropriately to her infant's manipulative play (showing attenuation of High-Involvement states) than to expressive behavior, where the only consistent response was a strong reaction to her infant's smiles.

Table 5. RAW DATA: PROPORTION OF INTERVALS CONTAINING EACH BEHAVIOR FOR INFANT A

	PHASE A			PHASE B			PHASE C		
	No Toys	Toys	Total	No Toys	Toys	Total	No Toys	Toys	Total
INFANT BEHAVIORS									
Nonvocal Sound	.00	.09	.06	.00	.14	.07	.00	.29	.15
Linguistic Vocalization	.00	.00	.00	.00	.00	.00	.00	00	.00
Nonlinguistic Vocalization	.26	.26	.26	.30	.14	.22	.42	.41	.41
Vocal Imitation of Mother	.00	.00	.00	.00	.00	.00	.00	.00	.00
Head Gesture	.00	.00	.00	.00	.00	.00	.00	.00	.00
Inappropriate Visual Orientation	NA	NA	NA	NA	NA	NA	NA	NA	NA
Positive Facial Expression(Smile)	.10	.03	.05	.19	.01	.10	.17	.04	.10
Negative Facial Expression	.00	.11	.08	.08	.04	.06	.01	.13	.07
Spontaneous Manual Gesture	.00	.03	.02	.00	.01		.01	.01	.01
Explore Space	.00	.01	.01	.00	.07	.04	.04	.05	.04
Elicited Manual Gesture	.00	.00	.00	.00	.00	.00	.00	.00	.00
Reach for Mother	.00	.00	.00	.00	.00	.00	.04	.00	.02
Reach for Toy	.00	.00	.00	.00	.02	.01	.00	.01	.00
Release Mother	.00	.00	.00	.00	.00	.00	.00	.00	.00
Release Toy	.00	.01	.00	.00	.00	.00	.00	.00	.00
Explore Mother	.00	.00	.00	.00	.00	.00	.02	.00	.01
Explore Toy	.00	.01	.01	.00	.13	.06	.00	.05	.03
Manipulate Mother	.00	.00	.00	.00	.00	.00	.00	.00	.00
Manipulate Toy	.00	.09	.06	.00	.13	.06	.00	.29	.15
Hold Mother	.00	.00	.00	.00	.00	.00	.01	.00	.00
Hold Toy	.00	.22	.15	.00	.02	.01	.00	.00	.00
Withdraw Hand from Mother	.00	.00	.00	.00	.00	.00	.00	.00	.00
Withdraw Hand from Toy	.00	.01	.01	.00	.06	.03	.00	.05	.03
Push Away Mother	.00	.00	.00	.01	.00	.01	.01	.01	.01
Touch Self	.26	.41	.37	.25	.26	.25	.42	.42	.42
Hand: Other/Nothing	.76	.39	.50	.76	.35	.56	.49	.13	.31
Approach Mother	.00	.00	.00	.01	.00	.01	.01	.02	.02
Avoid Mother	.00	.00	.00	.01	.00	.01	.01	.00	.00
Toy Stereotypy	.00	.00	.00	.00	.00	.00	.00	.00	.00
Body Stereotypy	.00	.00	.00	.00	.00	.00	.00	.00	.00
Self-Abusive Stereotypy	.00	.00	.00	.00	.00	.00	.00	.00	.00

Table 6. RAW DATA: PROPORTION OF INTERVALS CONTAINING EACH BEHAVIOR FOR MOTHER A

	PHASE A			PHASE B			PHASE C		
	No Toys	Toys	Total	No Toys	Toys	Total	No Toys	Toys	Total
MATERNAL BEHAVIORS									
Caress	.20	.06	.10	.05	.00	.02	.41	.23	.32
Restrain	.03	.05	.05	.02	.06	.04	.03	.03	.03
Tactile Direction	.76	.79	.78	.93	.78	.86	.56	.27	.41
Visual Direction	NA	NA	NA	NA	NA	NA	NA	NA	NA
Positive Linguistic Vocalization	.00	.01	.01	.00	.01	.00	.00	.00	.00
Negative Linguistic Vocalization	.00	.00	.00	.00	.00	.00	.00	.00	.00
Other Linguistic Vocalization	.47	.20	.28	.88	.21	.54	.45	.11	.28
Nonlinguistic Vocalization	.19	.05	.10	.05	.09	.07	.07	.01	.04
Vocal Imitation of Infant	.00	.01	.01	.01	.01	.01	.01	.00	.00
Nonvocal Sound	.15	.74	.56	.12	.55	.33	.12	.39	.26

Table 7. BEHAVIOR CATEGORIES SELECTED FOR LAGS ANALYSES: PAIR A
(PROPORTION OF INTERVALS CONTAINING EACH BEAHVIOR CATEGORY)

	Phase A			Phase B			Phase C		
	No Toy	Toy	Total	No Toy	Toy	Total	No Toy	Toy	Total
INFANT BEHAVIORS:									
Nonvocal Sound	.00	.09	.06	.00	.14	.07	.00	.29	.15
Vocalization	.26	.26	.26	.30	.14	.22	.42	.41	.41
Positive Facial (Smile)	.10	.03	.05	.19	.01	.10	.17	.04	.10
Manual Gesture	.00	.03	.02	.00	.01	.00	.01	.01	.01
Manipulate Toy	.00	.09	.06	.00	.13	.06	.00	.29	.15
Reach for Toy	.00	.00	.00	.00	.02	.01	.00	.01	.00
Low-Involvement State	.46	.26	.32	.40	.30	.35	.25	.05	.15
MATERNAL BEHAVIORS:									
Tactile	.99	.90	.93	1.00	.84	.92	1.00	.53	.76
Vocalization	.66	.26	.39	.93	.31	.61	.52	.12	.32
Nonvocal Sound	.15	.74	.56	.12	.55	.33	.12	.39	.26
Low-Involvement State	.00	.02	.01	.01	.07	.04	.01	.25	.13
High Involvement State			.38			.60			.29

Table 8. PAIR A: THE MOTHER'S EFFECT ON THE INFANT

	MOTHER'S BEHAVIOR AT INTERVAL X-1	P_0: INFANT'S BEHAVIOR AT INTERVAL X					
		Auditory Nonvocal	Auditory Vocal	Positive Facial	Manual Gesture	Manipulate Toy	Reach for Toy
PHASE A	Tactile		.273	.043	----	.073	----
	Auditory/Vocal	.048 -	.230	.064	----	.048	----
	Auditory/Nonvocal	.064	.243	----	----	.064	----
PHASE B	Tactile		.233	.109	----	.080	----
	Auditory/Vocal	.078 -	.251	.154 +	----	.094	----
	Auditory/Nonvocal	.096	.114	----	----	.114	----
PHASE C	Tactile		.422	.138	----	.107 -	----
	Auditory/Vocal	----	.306 -	.157 +	----	----	----
	Auditory/Nonvocal	.265	.373	----	----	.217	----

P_0 = Observed Probability

+ = $P_0 > P_E$, $p \leq .001$

- = $P_0 < P_E$, $p \leq .001$

---- = Insufficient observations for analysis.

Table 9.

PAIR A: THE INFANT'S EFFECT ON THE MOTHER

		P_0: MOTHER'S BEHAVIOR AT INTERVAL X		
INFANT'S BEHAVIOR AT INTERVAL X-1		Tactile	Auditory Vocal	Auditory Nonvocal
PHASE A	Auditory/Nonvocal	.756 -		.537 -
	Auditory/Vocal	.983 +	.337	.733
	Positive Facial	.838 -	.514 +	----
	Manual Gesture	----	----	
	Manipulate Toy	.789 -	.211	.500 -
	Reach for Toy		----	
PHASE B	Auditory/Nonvocal	$.752_{1-5}$ -		$.376_{1-5}$ -
	Auditory/Vocal	.956	.744 +	$.522_{1-5}$
	Positive Facial	.976 +	.929 +	----
	Manual Gesture	----	----	
	Manipulate Toy	$.619_{1-5}$ -	$.227_{1-5}$	$.454_{1-5}$
	Reach for Toy		----	
PHASE C	Auditory/Nonvocal	.129 -		.242 -
	Auditory/Vocal	.805	.224 -	.488
	Positive Facial	1.000 +	.409 +	$.022_{1-5}$ -
	Manual Gesture	----	----	
	Manipulate Toy	.133 -	.100	.200 -
	Reach for Toy		----	

P_0 = Observed Probability

+ = $P_0 > P_E$, $p \leq .001$

- = $P_0 < P_E$, $p \leq .001$

---- = Insufficient observations for analysis.

Table 10. PAIR A: STATES OF INVOLVEMENT

PHASE A	P_0: Infant's State at Interval X		P_0: Mother's State at Interval X:
	Low-Involvement	Vocalization	High-Involvement
Mother's State at Interval X-1:			Infant's State at Interval X-1:
Low-Involvement		$.057_{1-5}$ -	Low-Involvement .436
High-Involvement	.386 +	$.231_{1-5}$ -	
Vocalization	.389 +		

PHASE B			
Mother's State at Interval X-1:			Infant's State at Interval X-1:
Low-Involvement		$.036_{1-5}$ -	Low-Involvement .633
High-Involvement	.370	$.256_{1-5}$ -	
Vocalization	.371		

PHASE C			
Mother's State at Interval X-1:			Infant's State at Interval X-1:
Low-Involvement		.491	Low-Involvement .800
High-Involvement	.387 +	.298 -	
Vocalization	.364 +		

P_0 = Observed Probability

+ = $P_0 > P_E$, $p \leq .001$

P - = $P_C < P_E$, $p \leq .001$

---- = Insufficient observations

Fig. 1: EFFECT OF MATERNAL TOUCH ON SELECTED INFANT BEHAVIORS: PAIR A

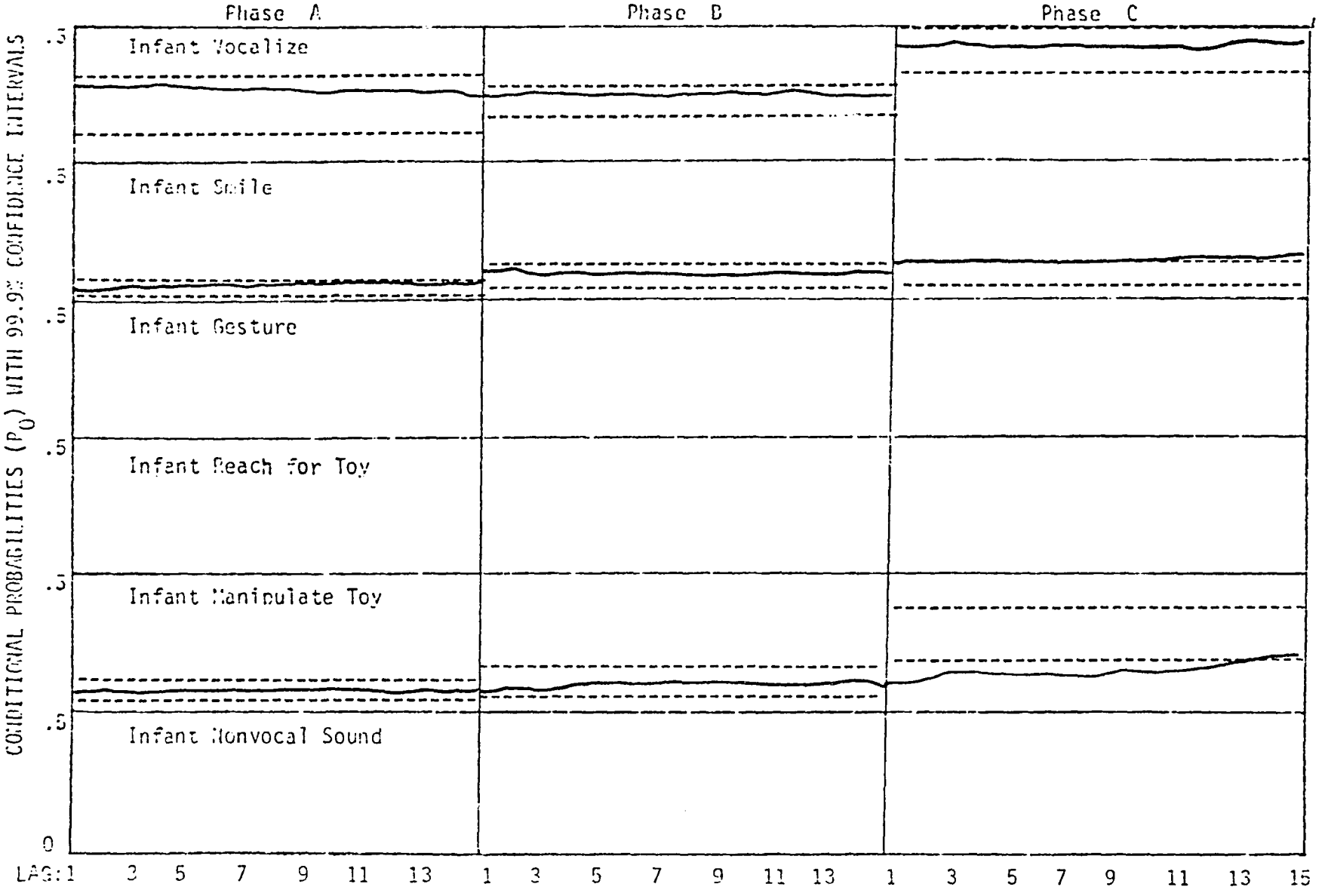


Fig. 2. EFFECT OF MATERNAL VOCALIZATION ON SELECTED INFANT BEHAVIORS: PAIR A

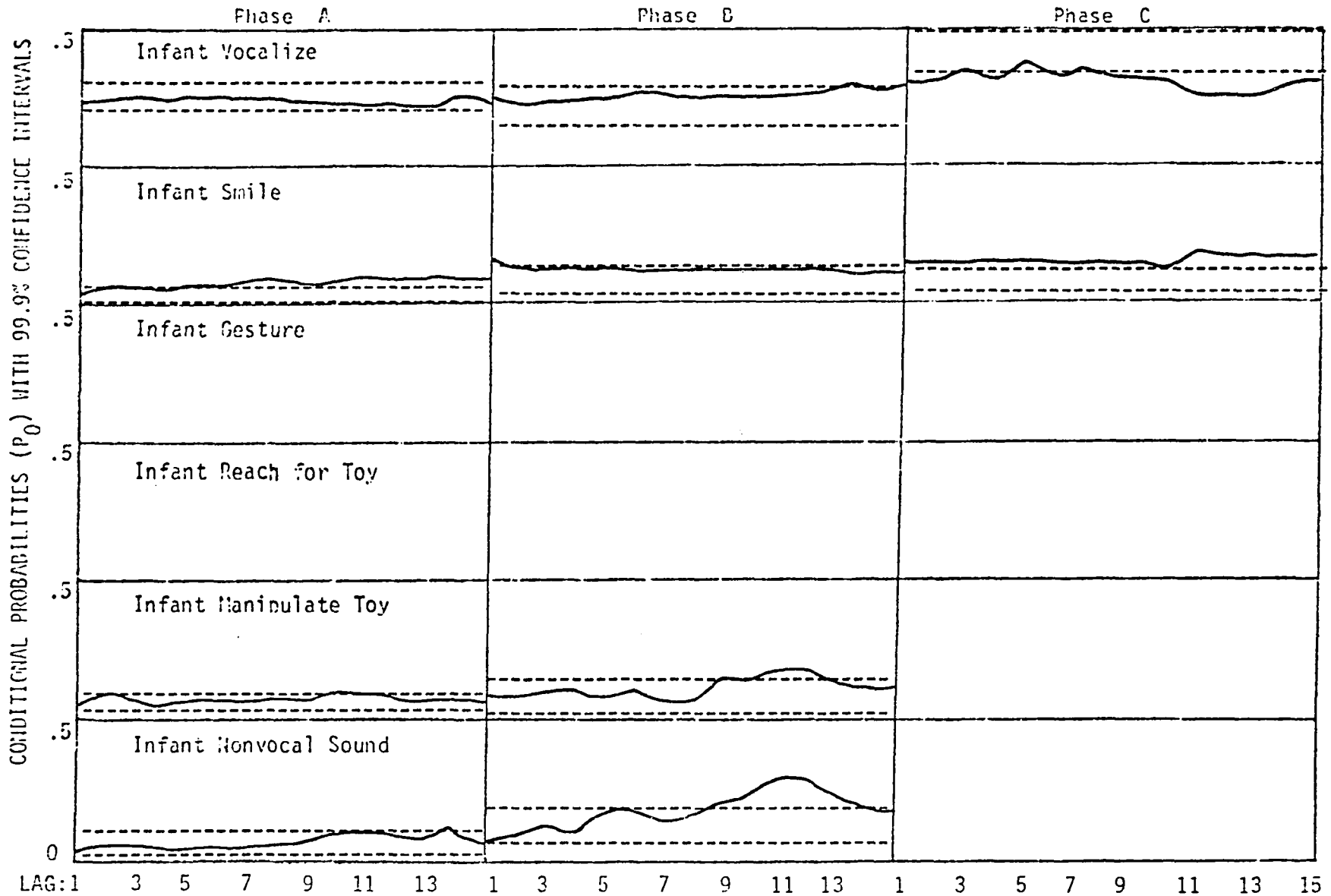


Fig. 3. EFFECT OF MATERNAL NONVOCAL SOUND ON SELECTED INFANT BEHAVIORS: PAIR A

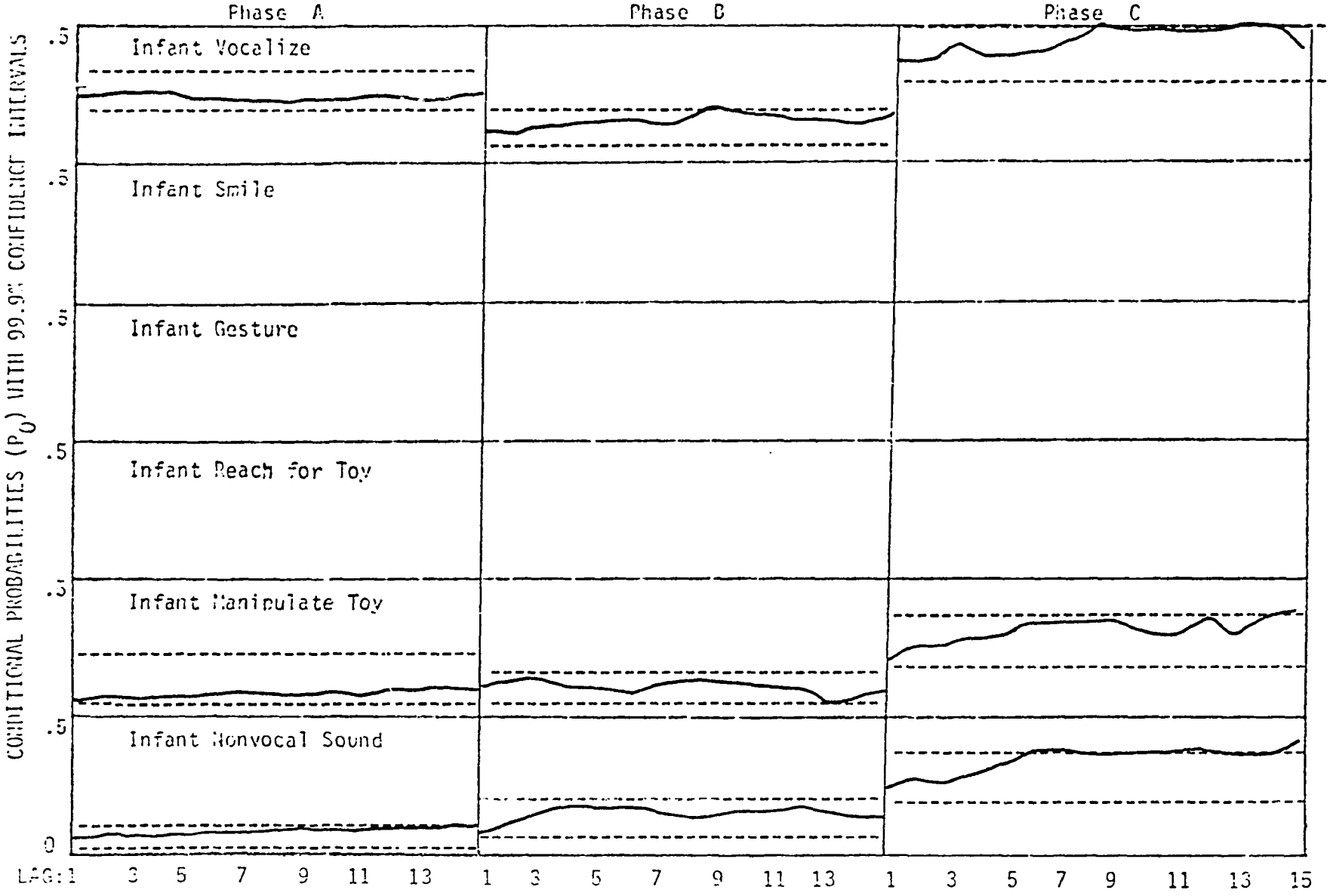


Fig. 4. STATES OF INVOLVEMENT: PAIR A

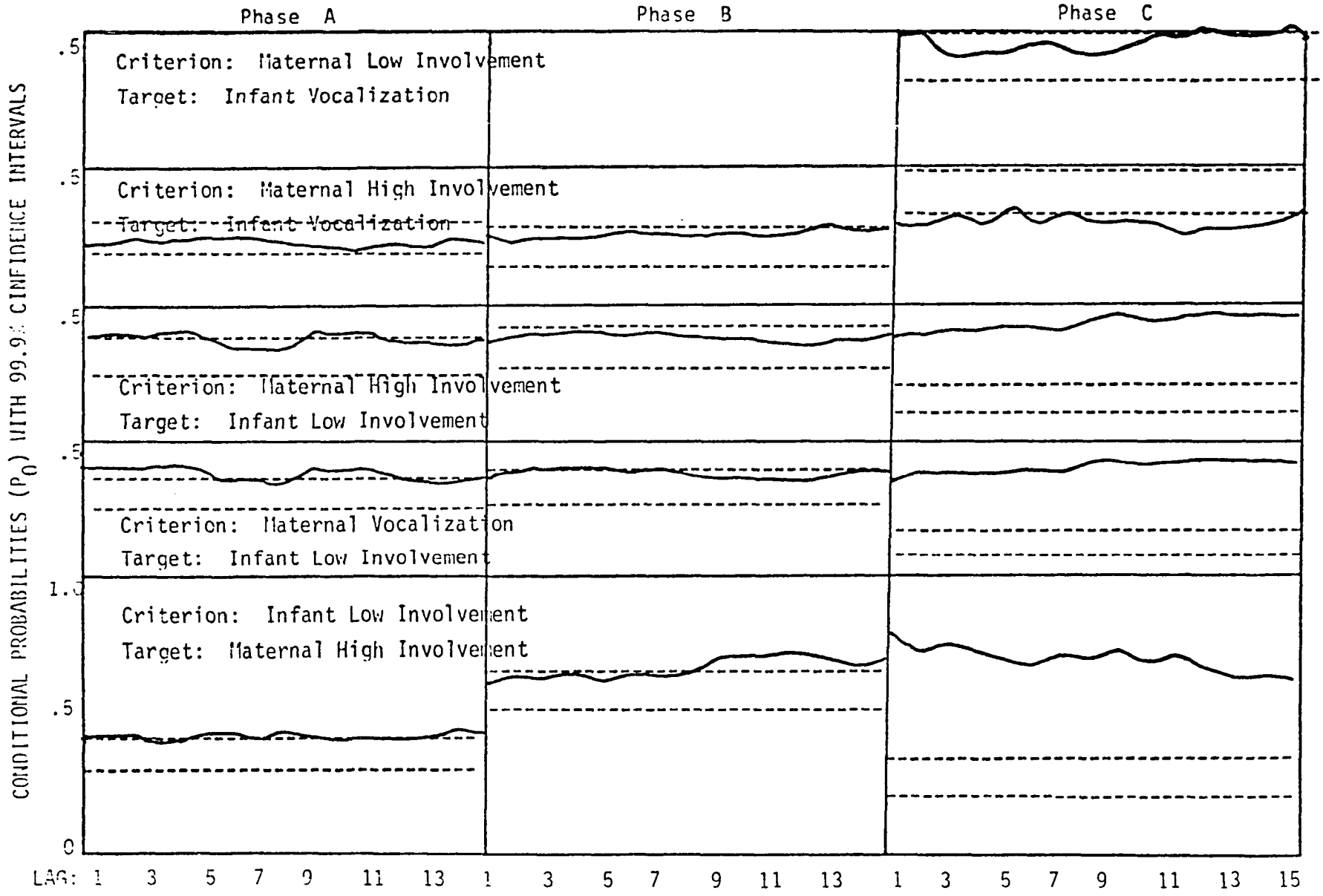
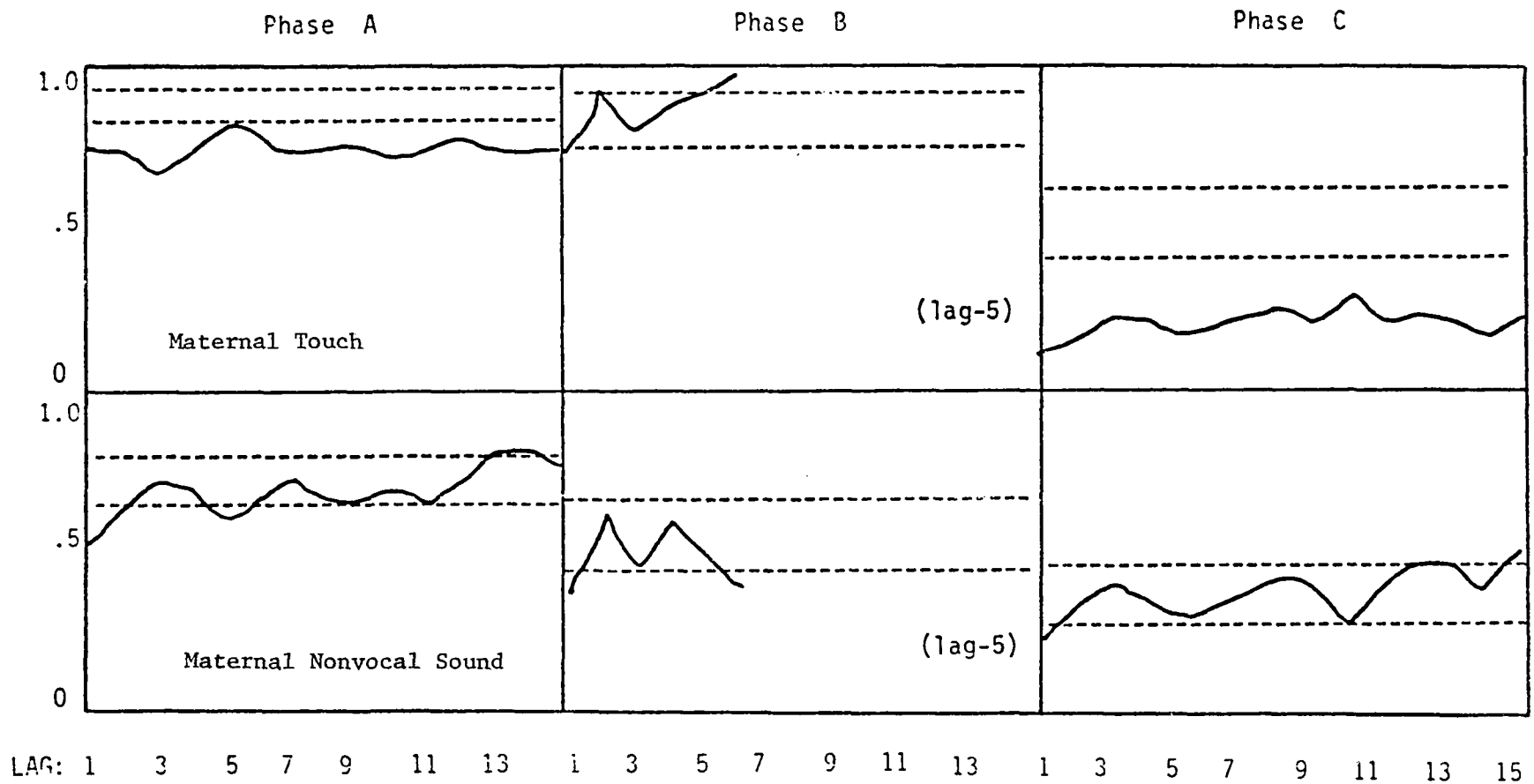


Fig. 5. EFFECT OF INFANT NONVOCAL SOUND ON SELECTED MATERNAL BEHAVIORS: PAIR A



CONDITIONAL PROBABILITIES (P_0) WITH 99.9% CONFIDENCE INTERVALS

Fig. 6. EFFECT OF INFANT VOCALIZATION ON SELECTED MATERNAL BEHAVIORS: PAIR A

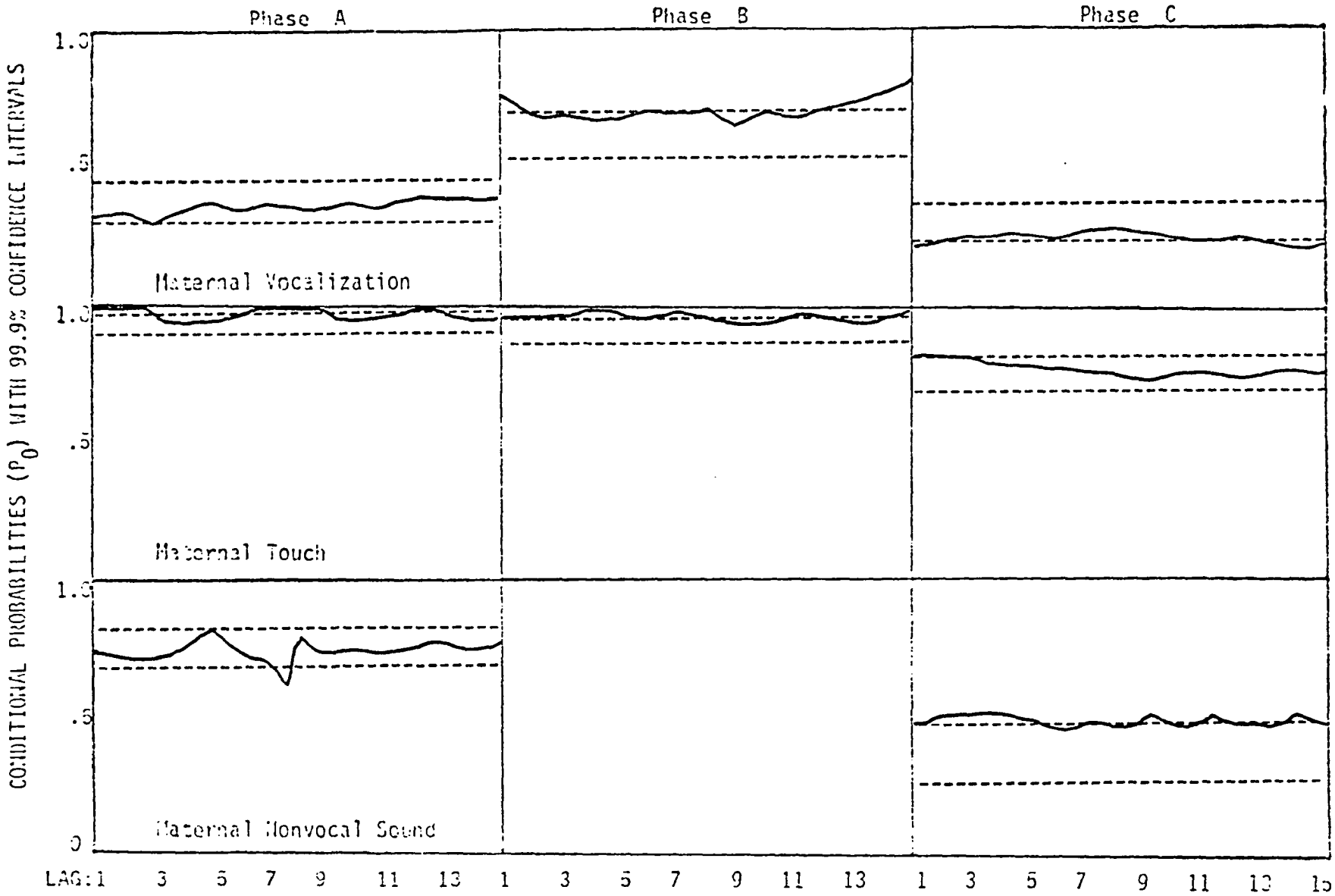


Fig. 7. EFFECT OF INFANT SMILE ON SELECTED MATERNAL BEHAVIORS: PAIR A

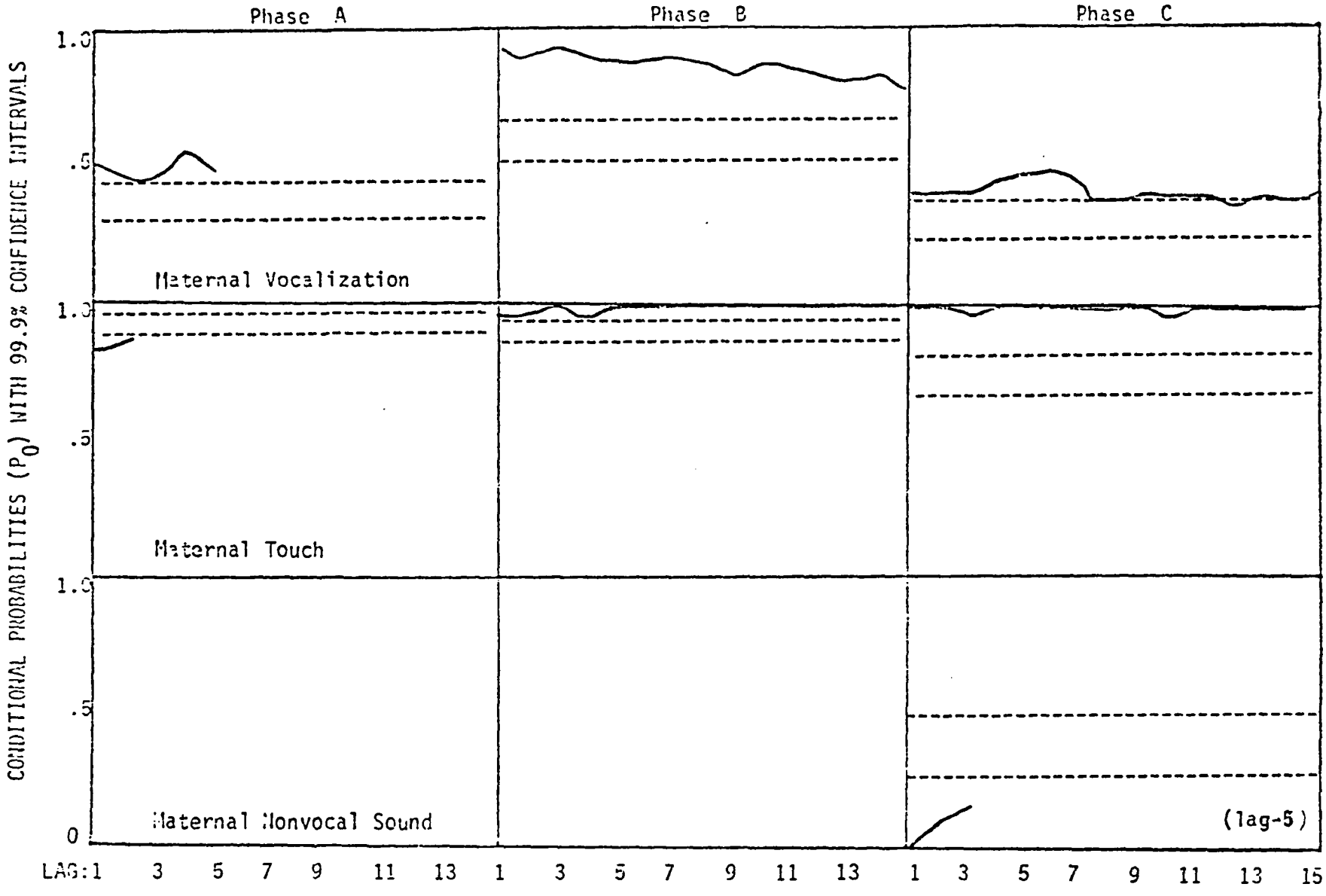
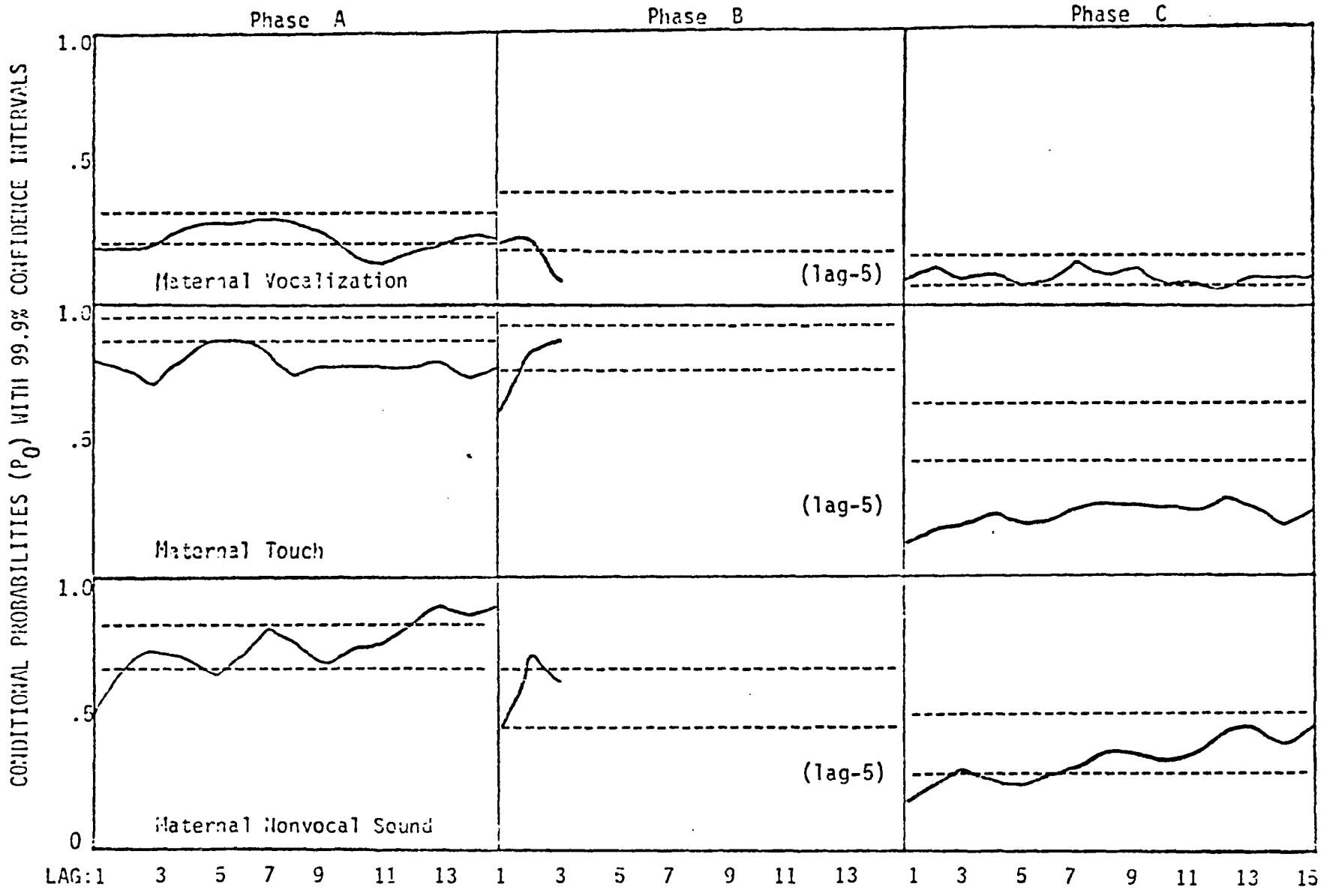


Fig. 8. EFFECT OF INFANT MANIPULATE TOY ON SELECTED MATERNAL BEHAVIORS: PAIR A



Pair B

Infant B was 15 months old at initial observation. She demonstrated striking behavioral parallels with Urwin's subject, Jerry. Born without eyes, her blindness was evident from the start, and educational programming began at 4 months. Infant B was by far the most advanced of the subjects in terms of social, motor and language skills. At first contact, she was trying eagerly to stand up and walk (although she did not crawl yet). She would stand unassisted momentarily, and as she began to lose her balance, would throw herself forward fearlessly, giggling, confident that she would be safely caught. She imitated some words as well as non-linguistic vocalizations such as coughing and sneezing. She could touch several body parts and wave good bye on command, the beginning of a rapidly growing repertoire of elicited manual gestures that she performed as games. Infant B's family indicated that she was not very interested in toys, and it was obvious that her delight in human contact was insatiable. By the end of the project, Infant B (at 21 mo.) had taken as many as six steps by herself and had been "cruising" around the house for several months. She had a large repertoire of elicited manual gestures and could find many body parts on other people as well as on her own body. She "talked" on the telephone, had a vocabulary of about 20 words used in up to three-word combinations, and comprehended about 40 words and

phrases. She also sang and danced to music. An environmental variable that set Infant B apart from the other subjects was the size of her family. She was raised in a large extended family, as the only baby out of at least six individuals aged 16 or over, all of whom delighted in playing with her. Thus, Infant B interacted virtually ceaselessly with a relatively large number of people. This family situation, combined with the fact that her handicap was evident at birth, no doubt contributed to her rapid development.

Tables 11 and 12 (pp. 79 and 80) present the rates of occurrence for each of the originally scored behaviors for Pair B. Notable for their presence are the following behaviors: Caress and Vocal Imitation by the mother; and Linguistic Vocalizations, Vocal Imitations, Manipulation of Mother, and Elicited Manual Gestures by the infant. Table 13 (p. 81) presents proportional occurrences for Pair B of the 11 categories chosen for intensive analysis. Lag-1 conditional probabilities for Infant B behaviors appear in Table 14 (p. 82), those for Maternal behaviors appear in Table 15 (p. 83), and those for reciprocal Involvement States appear in Table 16 (p. 84). Figures 9 - 18 (pp. 85 - 94) graphically depict cross-contingencies demonstrated by sequences of interactions for Pair B.

The Mother's Effect on the Infant: Pair B

Maternal Tactile Behavior (see Fig. 9, p. 85). Mother B touched her infant in a mean of 53% of the intervals (ranging from 21% to 78%), with means of 68% for No-Toy sequences and 32% for Toy sequences. A

marked overall drop in touching in Phase C (35% across conditions) was no doubt related to Infant B's attainment of real mobility by that Phase.

Maternal Touch was followed by an increase in Infant Vocalizations in Phase B at 30 sec. (P_{L15} = .341). In Phase C, an increase in Vocalizations occurred at 16 sec. post-criterion (P_{L8} = .299). In Phase C, the lag-5 profile showed a cyclicity continuing for 100 sec. post-criterion. Maternal Touch immediately increased the probability of Infant Smile for at least 30 sec. post-criterion in all three Phases (P_{L1} = .305 for Phase A; P_{L1} = .309 for Phase B; P_{L1} = .359 for Phase C). Infant Toy Manipulation decreased following Maternal Touch in Phases A (P_{L1} = .092) and B (P_{L1} = .262 at lag-5), but showed a brief increase after 18 sec. in Phase C. Infant Reach for Toy decreased cyclically in Phase A at 8 sec. (P_{L4} = .096) and in Phase C increased at 16 sec. (P_{L8} = .175). This probably reflects the growing independence of Infant B, who at the beginning of the study would abandon almost any toy in favor of interacting with a person.

Maternal Auditory/Vocal Behavior (see Fig. 10, p. 86). Maternal Vocalizations occurred in 47% to 88% of the intervals (mean = 66%), with a mean of 78% for No-Toy and 53% for Toy sequences. Infant B was remarkably unresponsive to these vocalizations, however. In Phase A, Maternal Vocalization presaged a delayed decrease in Infant Nonvocal Sound at 26 sec. post-criterion (P_{L13} = .123) and in Infant Toy Manipulation at 22 sec. post-criterion (P_{L11} = .098), but other infant behaviors were

unaffected. In Phase B, no infant behaviors were affected, while in Phase C, Infant Smile suddenly showed an increase persisting for 6 sec. post-criterion (P_{L1} = .365). Maternal Vocalization did not affect the probability of Infant Low-Involvement states.

Maternal Auditory/Nonvocal Behavior (see Fig. 11, p. 87). In the Toy condition, the proportion of intervals containing Maternal Nonvocal Sounds decreased from 33% to 22% to 18% (mean = 24%) over Phases A, B and C, respectively; while in the No-Toy condition, the proportions increased from 2% to 3% to 7% (mean = 4%) over the three Phases. The low frequency of this behavior in Phase B precluded lag analysis.

In Phase A, Maternal Nonvocal Sounds were followed by a persistent increase in Infant Reach for Toy (P_{L1} = .322), as was the case in Phase C (P_{L1} = .154), where this relationship was cyclical. Obviously, Infant B had developed reach-to-sound-cue by the start of the project. In Phase A, the probability of Infant Manipulate Toy decreased immediately following Maternal Nonvocal Sound (P_{L1} = .093), while in Phase C, it showed an immediate increase (P_{L1} = .179) that exhibited cyclical properties. In Phase A, Maternal Nonvocal Sound was followed by a decreased probability of Infant Smile (P_{L1} = .017), and by a delayed depression of this behavior after 18 sec. in Phase C (P_{L9} = .026). In Phase C, Infant Auditory Nonvocal Sounds exhibited cyclical increases following this criterion. The recurrence of cyclical responses following this criterion reflects the cyclic autocontingency of that maternal behavior.

Maternal Low-Involvement (see Fig. 12, p. 88). The incidence of Maternal Low-Involvement increased from 10% in Phase A intervals to 15% in Phase B and 25% in Phase C, with a mean of 32% in Toy conditions and 8% in No-Toy conditions. In all three Phases, this criterion preceeded a persistent decrease in Infant Vocalizations which was cyclical in Phases A (P_{L1} = .106) and C (P_{L1} = .284) and persistent (over 140 sec.) in Phase B (P_{L1} = .124).

Maternal High-Involvement (see Fig. 12, p. 88). Incidence of Maternal High-Involvement states decreased from 51% to 43% to 24% of the intervals in Phases A through C. This criterion preceeded cyclical increases in Infant Vocalizations in Phase A after 12 sec. (P_{L6} = .272). In Phase B, Infant Vocalizations increased across seconds 12-16 (P_{L6} = .352); and in Phase C, this behavior showed an immediate cyclical increase (P_{L1} = .277). In Phase C, decreases in Infant Low-Involvement states appeared at 10 sec. post-criterion.

The Infant's Effect on the Mother: Pair B

Infant Auditory/Nonvocal Behavior (see Fig. 13, p. 89). Infant B produced Nonvocal Sounds in 17% to 40% of the Toy intervals. This criterion was followed by a cyclical pattern of increased Maternal Nonvocal Sounds in Phase A (P_{L3} = .418), but not in Phases B or C. Maternal Touch decreased immediately following this criterion in Phase A (P_{L1} = .362), but then increased following second 22 (P_{L11} = .655). In Phase B, no consistent relationship appeared between this criterion

and Maternal Touch or Vocalization, while in Phase C, Maternal Touch increased for seconds 10 - 16 post-criterion (P_{L6} = .361).

Infant Auditory/Vocal Behavior (see Fig. 14, p. 90). Infant B vocalized for a mean 26% of all intervals with a mean of 33% in No-Toy sequences, and 10% in Toy sequences. Following this criterion, Maternal Touch increased persistently in Phases A (P_{L1} = .744) and B (P_{L1} = .731), but not in Phase C (P_{L1} = .400). Maternal Vocalizations increased persistently following this criterion in Phases A (P_{L1} = .842) and C (P_{L1} = .775), and cyclically in Phase B (P_{L5} = .732). Maternal Nonvocal sounds decreased 14 sec. post-criterion in Phase A (P_{L8} = .211).

Infant Positive Facial Expression (see Fig. 15, p. 91). Infant B smiled in a mean 23% of intervals, with a mean of 35% in No-Toy and 10% in Toy conditions. Infant Smile was immediately followed by increased Maternal Touching in all Phases (P_{L1} = .840 in Phase A; P_{L1} = .940 in Phase B; P_{L1} = .490 in Phase C). An increased probability of Maternal Vocalizations followed this criterion in all Phases (P_{L1} = .853 for Phase A; P_{L1} = .843 for Phase C) although not until 10 sec. post-criterion in Phase B (P_{L5} = .730). Maternal Nonvocal Sounds following Infant Smile were persistently depressed in Phase A (P_{L1} = .043), and the lag-5 profile for Phase C showed a depression at 10 sec. post-criterion ($P_{L5\text{-}10}$ = .035).

Infant Spontaneous Manual Gesture (see Fig. 16, p. 92). Infant B produced Spontaneous Manual Gestures in a mean of 6% of intervals, with means of 6% in No-Toy and 3% in Toy conditions. The maternal response

following these gestures showed a distinct progression through the three Phases, from a decrease in responses in Phase A to an increase in Phase C. In Phase A, this criterion was followed immediately by decreases in Maternal Touch (P_{L1} = .419) and Maternal Vocalizations (P_{L1} = .674). In Phase B, the lag-5 profiles showed an increase in Maternal Vocalizations across seconds 1 - 20 (P_{L1-5} = .426) and increases in Maternal Touch commencing 10 sec. after criterion (P_{L5-10} = .835).

Infant Manipulate Toy (see Fig. 17, p. 93). Infant Toy Manipulation occupied 22%, 57% and 14% of Toy intervals in Phases A - C, respectively. Following this criterion, Maternal Touch decreased persistently in Phase A (P_{L1} = .328) but not in Phases B or C. Maternal Vocalization showed cyclical depressions post-criterion in Phase A (P_{L1} = .483), with no relationship in Phase B, and cyclical depressions again in Phase C (P_{L10-15} = .382).

Infant Reach for Toy (see Fig. 18, p.94). Infant B reached for toys in 17%, 35% and 8% of Phase A, B and C Toy intervals, respectively. The lag-5 profile in Phase C showed decreases in Maternal Vocalization starting 20 sec. after criterion (P_{110} = .347).

Infant Low-Involvement (see Fig. 12, p. 88). Infant B was in a state of Low-Involvement for a mean of 13% of all intervals, with a mean of 11% for No-Toy and 14% for Toy conditions. This criterion state was followed, paradoxically, by immediate decreases in Maternal High-Involvement in Phase A (P_{L1} = .442) and Phase B (P_{L1} = .269). In Phase C, however, this state was followed by an increase in Maternal High-

Involvement at 6 sec. post-criterion (P_{L3} = .341) and then for seconds 20 - 30.

Concurrent Vocalizations: Pair B

For Pair B, Concurrent Vocalization occurred in an average 16% of total intervals. Autocontingencies showed a cyclical pattern of increased probability in Phase B (P_{L1} = .357) and persistent increases in Phases A (P_{L1} = .396) and C (P_{L1} = .548) (see Appendix F, p.265).

Data Summary: Pair B

Infant B was the only subject to attain any linguistic abilities by the end of the project. Although her rates of spontaneous gestures and vocalizations were not remarkably high, her production of elicited gestures, her vocal imitative abilities, and her few linguistic utterances set her apart from the other children. Unusual also was her mastery of rule-governed social exchanges, which were fostered in various turn-taking games. Infant B responded with Smiles and Vocalizations to Maternal Touch, while her response to Maternal Vocalization was less well developed. In the early Phases, Maternal Touch was followed only by a decrease in Toy-related activities; but by Phase C, a Smile response had appeared. The response to Maternal Nonvocal Sounds indicated the attainment of ear-hand coordination prior to the onset of the project, and manipulative skills probably did not improve remarkably over this period. Infant B was very dependent upon social-interactive behavior and her vocalizations decreased following Maternal Low-Involvement states while Maternal High-

Involvement states were followed by higher rates of Vocalizations and decreased rates of Infant Low-Involvement states.

Mother B touched her infant less than the other mothers, the advanced locomotor skills of the infant prompting the mother to extract herself from her infant's grasp so as to encourage her to approach independently. A relatively high rate of Maternal Vocalization was, no doubt, mandated by the necessity of maintaining auditory contact with the infant during these periods of physical detachment. The increasing independence of Infant B was reflected in a high rate of Maternal Low-Involvement states and a progressive decrease in Maternal High-Involvement states across Phases (see Table 13). The response of Mother B to her infant's manipulative activities showed no clear pattern, perhaps reflecting the lack of importance attached to such activities in the home. Mother B responded to Infant Smiles and Vocalizations with consistent increases in Vocal and Tactile stimulation except for an attenuated Tactile response in Phase C. Her response to Infant Gestures was initially poor, but a Vocal response seemed to have developed by the latter Phases. Mother B's behavior following Infant Low-Involvement states was interesting. In Phases A and B, the maternal activity level seemed to drop to a similar low-involved state, but in Phase C, this infant state was followed after considerable delay by an increase in Maternal High-Involvement states. The rate of concurrent and isolated vocalizations remained stable across all Phases, with a high proportion

of the Infant's vocalizations occurring concurrently with mother's, while most of mother's Vocalizations occurred during infant silences.

This infant was clearly in transition between illocutionary and locutionary stages of communicative behavior, and she provides gratifying support for Bates' expansionist view of the development of communicative competence. As can be seen in Table 48, most of Infant B's early gestures were unaccompanied by other expressive behavior, but as time progressed, the percent of isolated gestures decreased and the percent of gestures accompanied by smiles, vocalizations, or smiles and vocalizations steadily increased. This portrait of the progressive complication of the gestural complex in the one subject to achieve linguistic behavior is indeed appealing.

Table 11. RAW DATA: PROPORTION OF INTERVALS CONTAINING EACH BEHAVIOR FOR INFANT B

	PHASE A			PHASE B			PHASE C		
	No Toys	Toys	Total	No Toys	Toys	Total	No Toys	Toys	Total
INFANT BEHAVIORS									
Nonvocal Sound	.03	.20	.12	.00	.41	.12	.01	.17	.09
Linguistic Vocalization	.03	.01	.02	.05	.00	.04	.01	.05	.03
Nonlinguistic Vocalization	.29	.10	.19	.29	.07	.23	.31	.07	.18
Vocal Imitation of Mother	.05	.00	.02	.04	.00	.03	.01	.02	.01
Head Gesture	.02	.01	.02	.02	.01	.02	.01	.00	.00
Inappropriate Visual Orientation	NA	NA	NA	NA	NA	NA	NA	NA	NA
Positive Facial Expression(Smile)	.36	.13	.23	.23	.08	.19	.47	.09	.26
Negative Facial Expression	.04	.00	.02	.08	.03	.06	.00	.00	.00
Spontaneous Manual Gesture	.05	.08	.07	.09	.01	.09	.05	.01	.03
Explore Space	.00	.00	.00	.00	.00	.00	.31	.38	.35
Elicited Manual Gesture	.06	.00	.03	.11	.00	.08	.06	.00	.03
Reach for Mother	.28	.14	.20	.08	.00	.05	.10	.04	.06
Reach for Toy	.00	.17	.10	.00	.35	.10	.01	.08	.05
Release Mother	.05	.01	.03	.03	.00	.02	.00	.00	.00
Release Toy	.00	.04	.05	.00	.11	.04	.01	.05	.03
Explore Mother	.07	.02	.04	.04	.00	.03	.00	.00	.00
Explore Toy	.00	.03	.02	.00	.01	.00	.03	.07	.06
Manipulate Mother	.33	.10	.20	.24	.00	.17	.25	.13	.18
Manipulate Toy	.00	.22	.12	.00	.57	.17	.03	.14	.09
Hold Mother	.07	.04	.05	.07	.00	.05	.00	.00	.00
Hold Toy	.00	.04	.02	.00	.01	.00	.00	.01	.01
Withdraw Hand from Mother	.01	.00	.00	.00	.00	.00	.00	.00	.00
Withdraw Hand from Toy	.00	.00	.00	.00	.00	.00	.00	.00	.00
Push Away Mother	.00	.00	.00	.00	.00	.00	.00	.00	.00
Touch Self	.02	.03	.03	.06	.00	.04	.06	.01	.03
Hand: Other/Nothing	.18	.23	.21	.34	.17	.29	.25	.18	.21
Approach Mother	.25	.08	.16	.08	.00	.05	.19	.11	.15
Avoid Mother	.00	.00	.00	.01	.00	.01	.00	.00	.00
Toy Stereotypy	.00	.00	.00	.00	.00	.00	.00	.00	.00
Body Stereotypy	.00	.00	.00	.00	.00	.00	.00	.01	.01
Self-Abusive Stereotypy	.00	.00	.00	.00	.00	.00	.00	.00	.00

Table 12. RAW DATA: PROPORTION OF INTERVALS CONTAINING EACH BEHAVIOR FOR MOTHER B

	PHASE A			PHASE B			PHASE C		
	No Toys	Toys	Total	No Toys	Toys	Total	No Toys	Toys	Total
MATERNAL BEHAVIORS									
Caress	.16	.06	.10	.05	.00	.04	.02	.01	.01
Restrain	.00	.02	.01	.01	.00	.01	.01	.00	.01
Tactile Direction	.62	.45	.53	.71	.21	.56	.47	.21	.33
Visual Direction	NA	NA	NA	NA	NA	NA	NA	NA	NA
Positive Linguistic Vocalization	.00	.00	.00	.00	.00	.00	.00	.00	.00
Negative Linguistic Vocalization	.00	.00	.00	.00	.00	.00	.00	.00	.00
Other Linguistic Vocalization	.72	.53	.61	.63	.45	.58	.64	.45	.53
Nonlinguistic Vocalization	.16	.08	.11	.07	.02	.06	.11	.05	.08
Vocal Imitation of Infant	.06	.02	.04	.01	.00	.01	.05	.03	.04
Nonvocal Sound	.02	.33	.19	.03	.22	.08	.07	.18	.13

Table 13. BEHAVIOR CATEGORIES SELECTED FOR LAGS ANALYSES: PAIR B
(PROPORTION OF INTERVALS CONTAINING EACH BEHAVIOR CATEGORY)

	Phase A			Phase B			Phase C		
	No Toy	Toy	Total	No Toy	Toy	Total	No Toy	Toy	Total
INFANT BEHAVIORS:									
Nonvocal Sound	.03	.20	.12	.00	.40	.12	.01	.17	.09
Vocalization	.32	.11	.21	.34	.07	.27	.32	.12	.21
Positive Facial (Smile)	.36	.13	.23	.23	.08	.19	.47	.09	.26
Manual Gesture	.05	.08	.07	.09	.01	.09	.05	.01	.03
Manipulate Toy	.00	.22	.12	.00	.57	.17	.03	.14	.09
Reach for Toy	.00	.17	.10	.00	.35	.10	.01	.08	.05
Low-Involvement State	.07	.18	.13	.17	.11	.15	.10	.13	.12
MATERNAL BEHAVIORS:									
Tactile	.78	.53	.64	.77	.21	.61	.50	.22	.35
Vocalization	.88	.61	.72	.70	.47	.64	.75	.50	.61
Nonvocal Sound	.02	.33	.19	.03	.22	.08	.07	.18	.13
Low-Involvement State	.01	.17	.10	.04	.41	.15	.09	.38	.25
High Involvement State			.51			.43			.24

Table 14. PAIR B: THE MOTHER'S EFFECT ON THE INFANT

	MOTHER'S BEHAVIOR AT INTERVAL X-1 \ P_0: INFANT'S BEHAVIOR AT INTERVAL X	Auditory Nonvocal	Auditory Vocal	Positive Facial	Manual Gesture	Manipulate Toy	Reach for Toy
PHASE A	Tactile		.227	.305 +	.049	.092 -	.119
	Auditory/Vocal	.130	.242	.268	.058	.107	.158
	Auditory/Nonvocal	.153	.076	.017 -	.059	.093 -	.322 +
PAHSE B	Tactile		.326	.309 +	.078	$.262_{1-5}$	----
	Auditory/Vocal	.320	.261	.199	.093	.380	.300
	Auditory/Nonvocal	----	----	----	----	----	----
PHASE C	Tactile		.229	.359 +	----	.106	.106
	Auditory/Vocal	.105	.253	.365 +	----	.067	.067
	Auditory/Nonvocal	.179	.103	.151	----	.179 +	.154 +

P_0 = Observed Probability

+ = $P_0 > P_E$, $p \leq .001$

- = $P_0 < P_E$, $p \leq .001$

---- = Insufficient observations for analysis.

Table 15.

PAIR B: THE INFANT'S EFFECT ON THE MOTHER

		P_0: MOTHER'S BEHAVIOR AT INTERVAL X		
INFANT'S BEHAVIOR AT INTERVAL X-1		Tactile	Auditory Vocal	Auditory Nonvocal
PHASE A	Auditory/Nonvocal	.362 -		.275
	Auditory/Vocal	.744 +	.842 +	.341
	Positive Facial	.840 +	.853 +	.043 -
	Manual Gesture	.419 -	.674 -	
	Manipulate Toy	.328 -	.483 -	.350 -
	Reach for Toy		----	
PHASE B	Auditory/Nonvocal	.214		.214
	Auditory/Vocal	.731 +	.602	----
	Positive Facial	.940 +	.612	----
	Manual Gesture	.581	$.806_{1-5}$+	
	Manipulate Toy	.114	.432	.091
	Reach for Toy		.314	
PHASE C	Auditory/Nonvocal	.194		.194
	Auditory/Vocal	.400	.775 +	----
	Positive Facial	.490 +	.843 +	$.144_{1-5}$
	Manual Gesture	$.426_{1-5}$+	$.778_{1-5}$+	
	Manipulate Toy	$.133_{1-5}$	$.400_{1-5}$	$.181_{1-5}$
	Reach for Toy		$.427_{1-5}$	

P_0 = Observed Probability

+ = $P_0 > P_E$, $p \leq .001$

- = $P_0 < P_E$, $p \leq .001$

---- = Insufficient observations for analysis.

Table 16. PAIR B: STATES OF INVOLVEMENT

PHASE A

Mother's State at Interval X-1:	P_0: Infant's State at Interval X: Low-Involvement	Vocalization
Low-Involvement		.106 -
High-Involvement	.113	.248
Vocalization	.120	

Infant's State at Interval X-1:	P_0: Mother's State at Interval X: High-Involvement
Low-Involvement	.442 -

PHASE B

Mother's State at Interval X-1:		
Low-Involvement		.164 -
High-Involvement	.097	.284
Vocalization	.146	

Infant's State at Interval X-1:	
Low-Involvement	.269 -

PHASE C

Mother's State at Interval X-1:		
Low-Involvement		.124 -
High-Involvement	.149	.277 +
Vocalization	.133	

Infant's State at Interval X-1:	
Low-Involvement	.239

P_0 = Observed Probability

\+ = $P_0 > P_E$, $p \leq .001$

P - = $P_0 < P_E$, $p \leq .001$

---- = Insufficient observations

Fig. 9. EFFECT OF MATERNAL TOUCH ON SELECTED INFANT BEHAVIORS: PAIR B

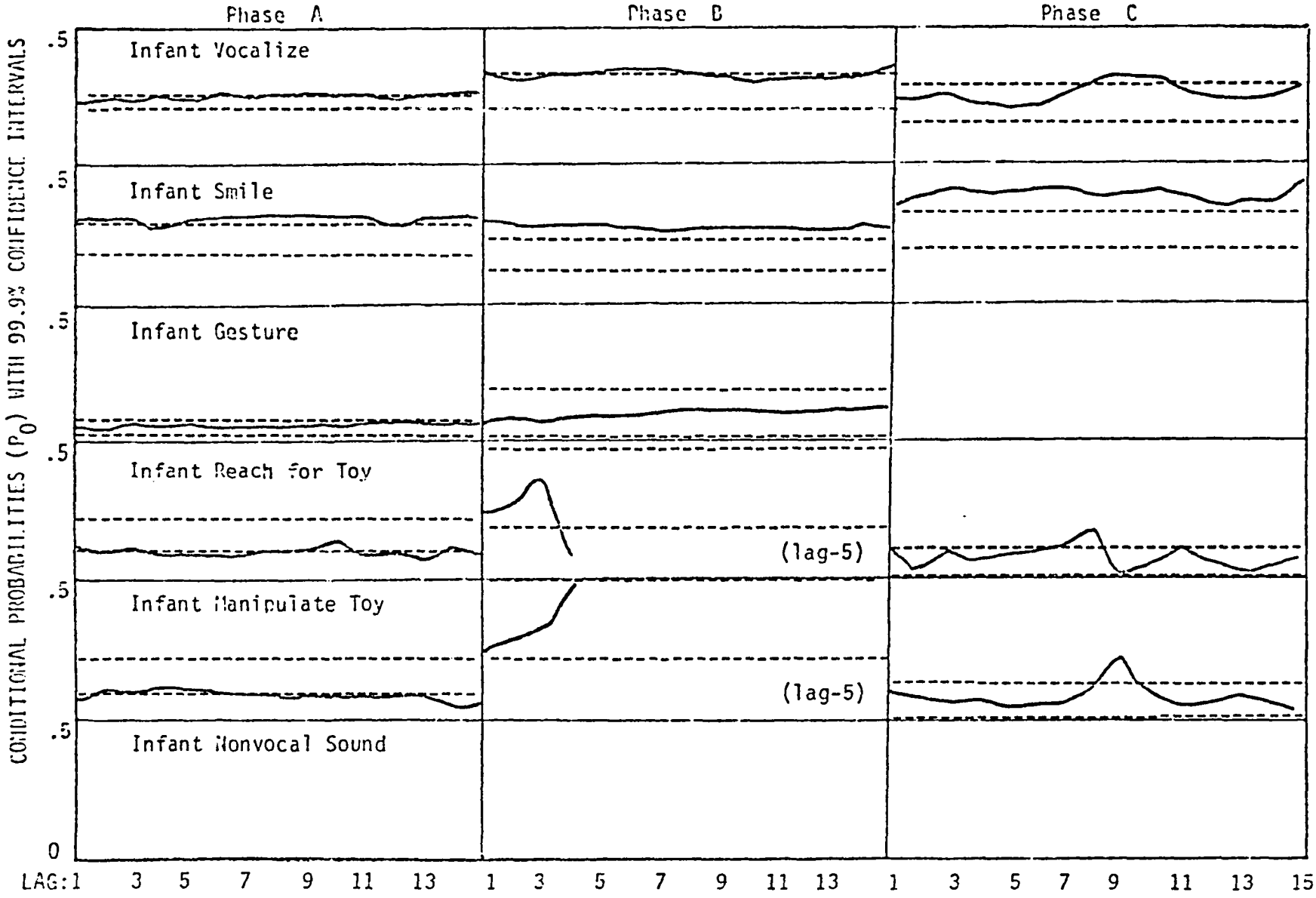


Fig. 10. EFFECT OF MATERNAL VOCALIZATION ON SELECTED INFANT BEHAVIORS: PAIR B

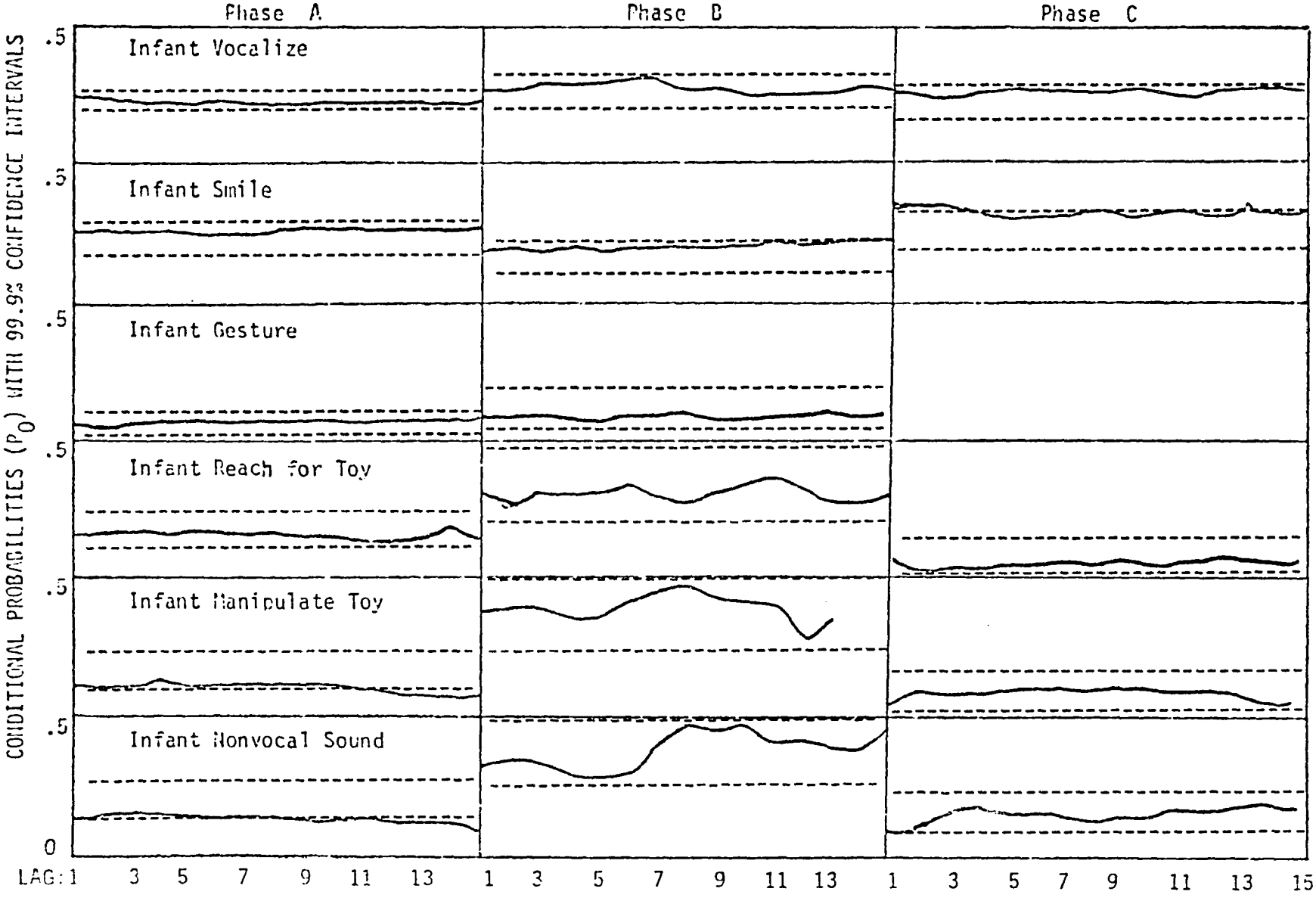


Fig. 11. EFFECT OF MATERNAL NONVOCAL SOUND ON SELECTED INFANT BEHAVIORS: PAIR B

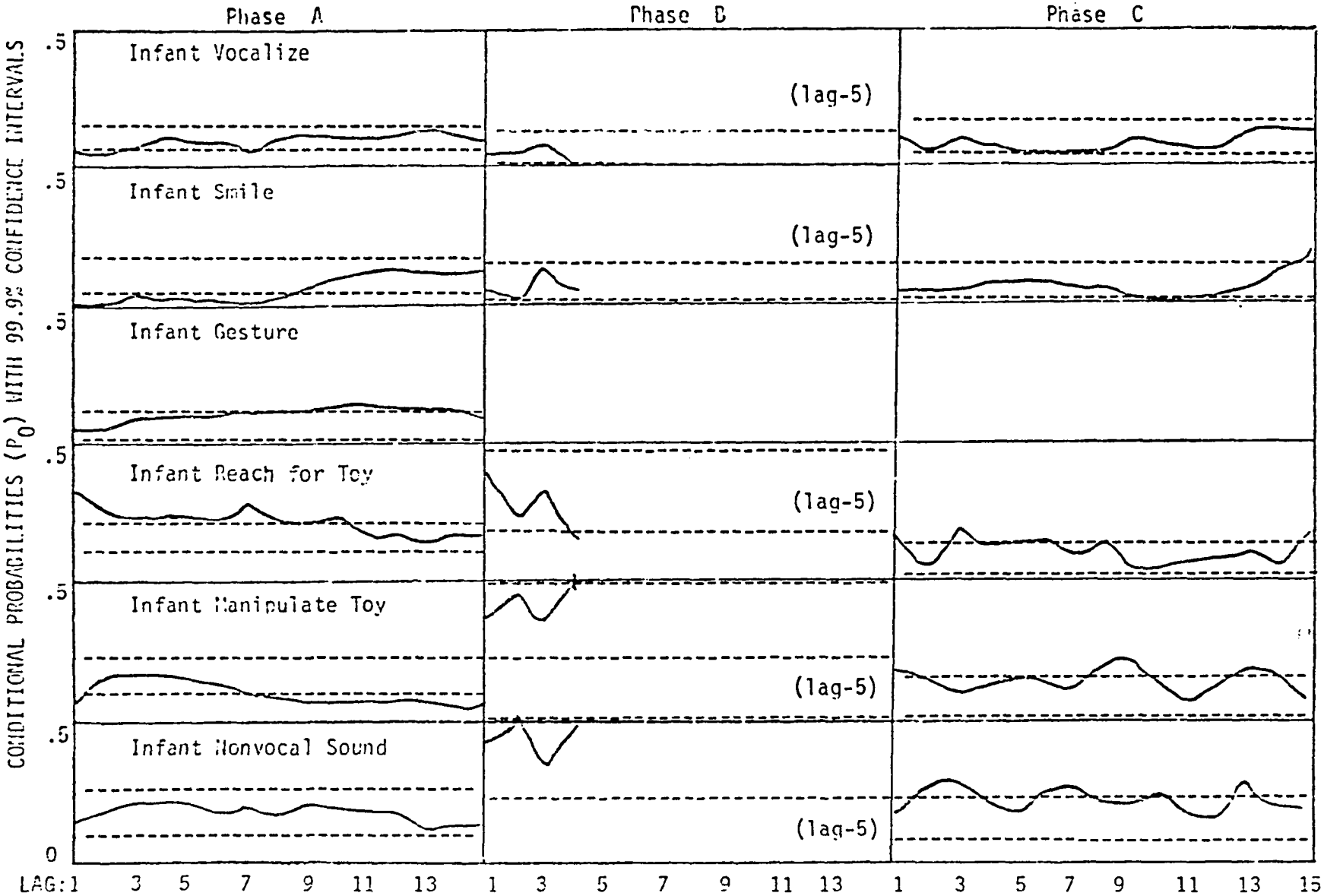


Fig. 12. STATES OF INVOLVEMENT: PAIR B

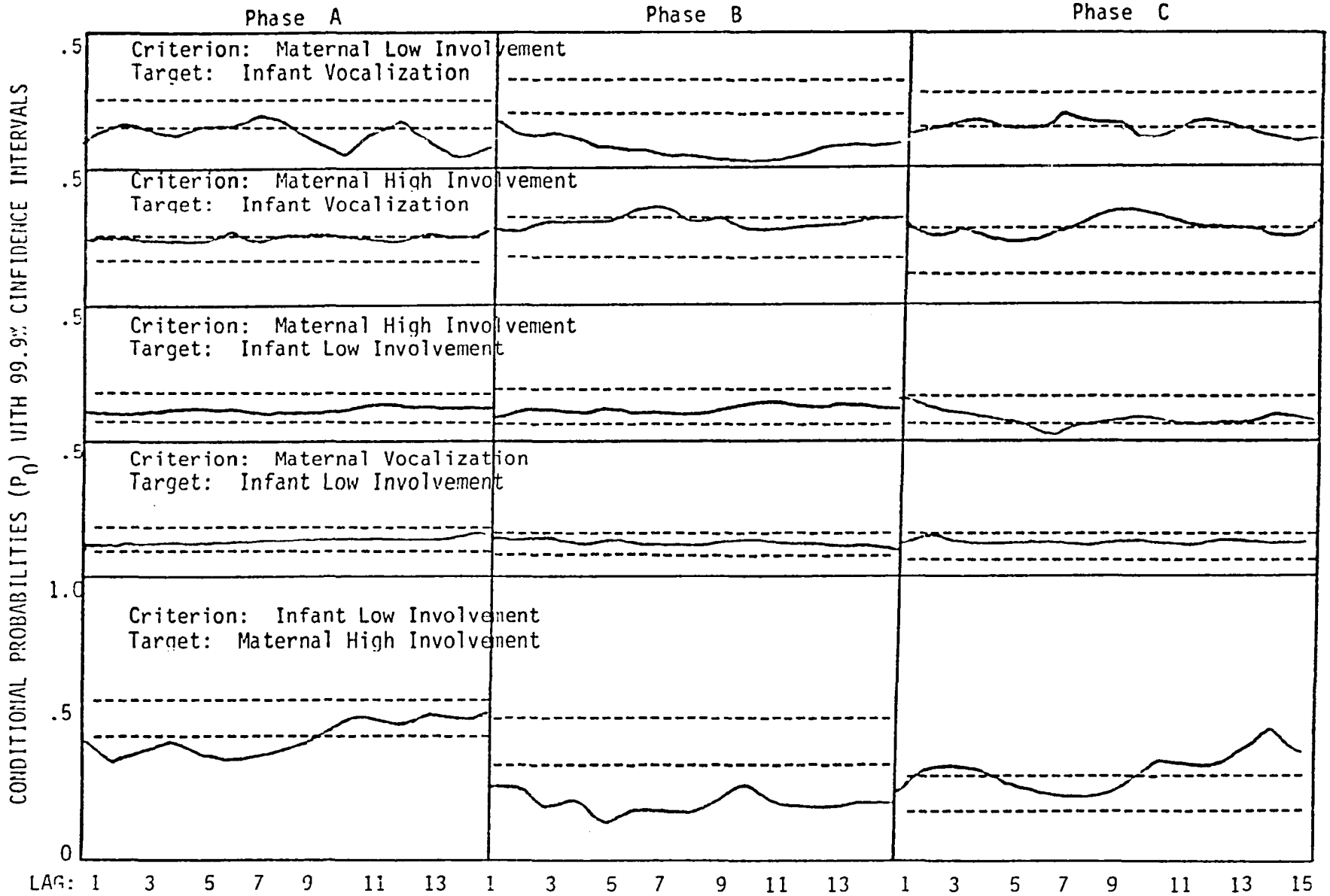
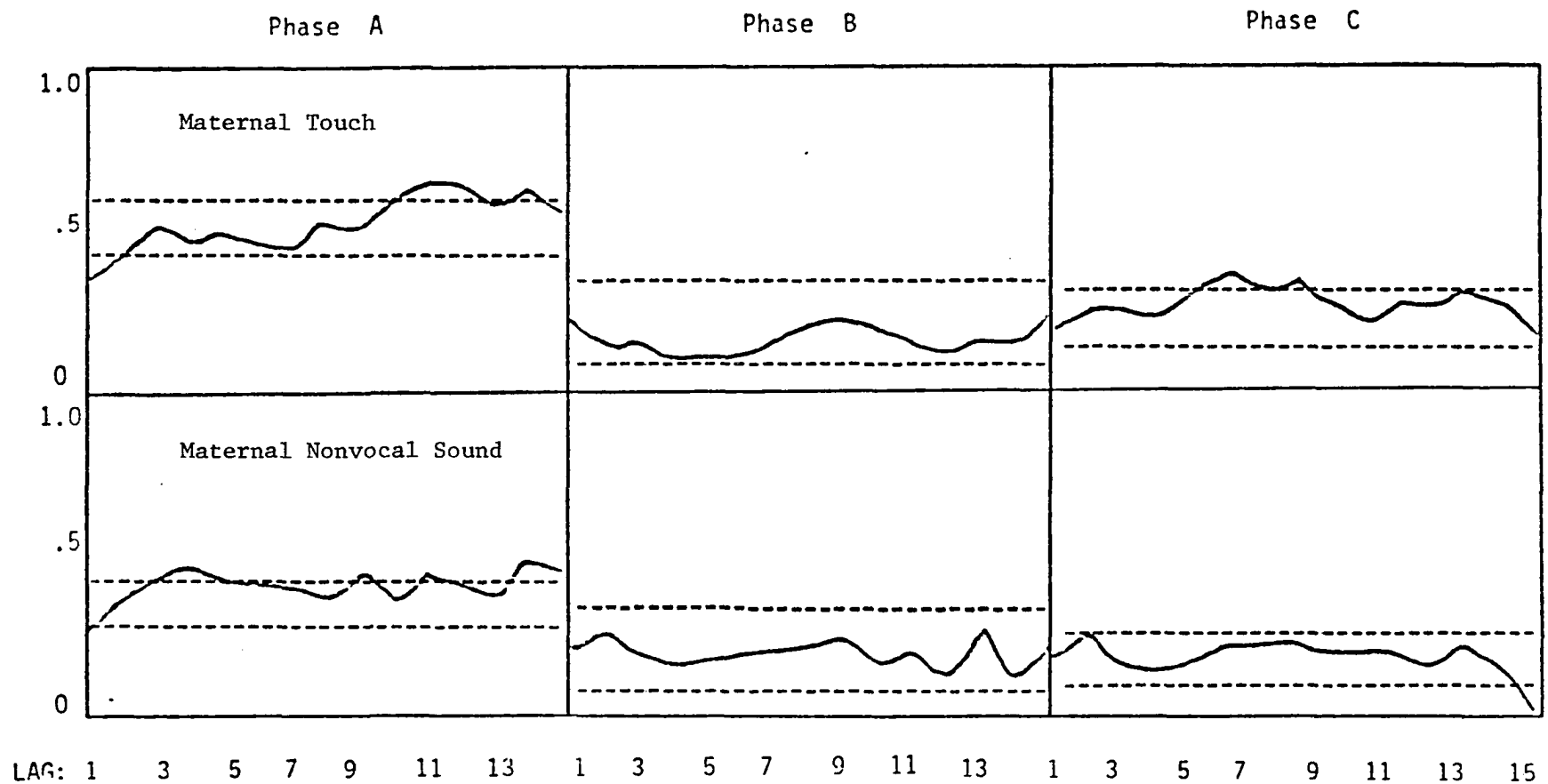


Fig. 13. EFFECT OF INFANT NONVOCAL SOUND ON SELECTED MATERNAL BEHAVIORS: PAIR B



CONDITIONAL PROBABILITIES (P_0) WITH 99.9% CONFIDENCE INTERVALS

Fig. 14. EFFECT OF INFANT VOCALIZATION ON SELECTED MATERNAL BEHAVIORS: PAIR B

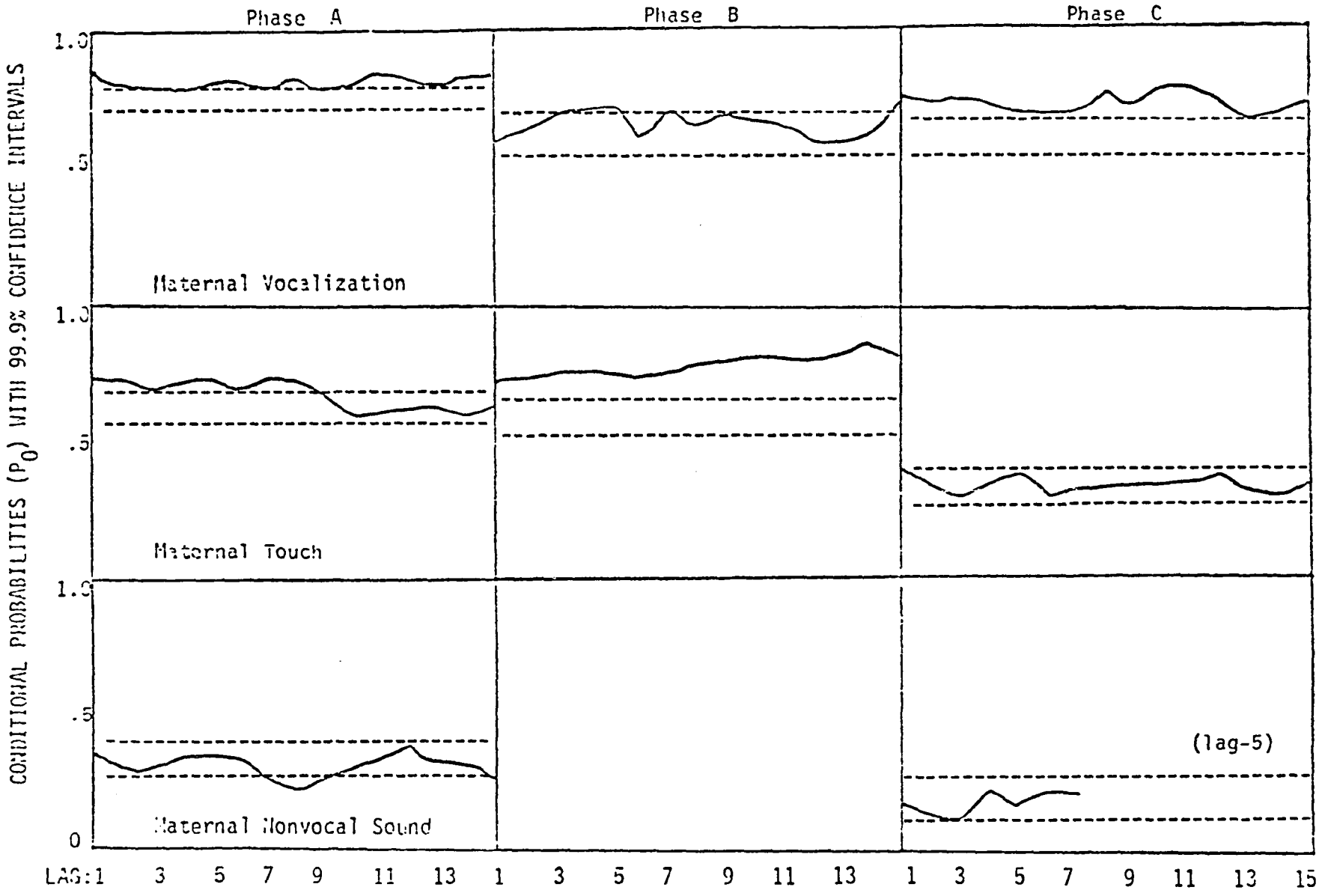


Fig. 15. EFFECT OF INFANT SMILE ON SELECTED MATERNAL BEHAVIORS: PAIR B

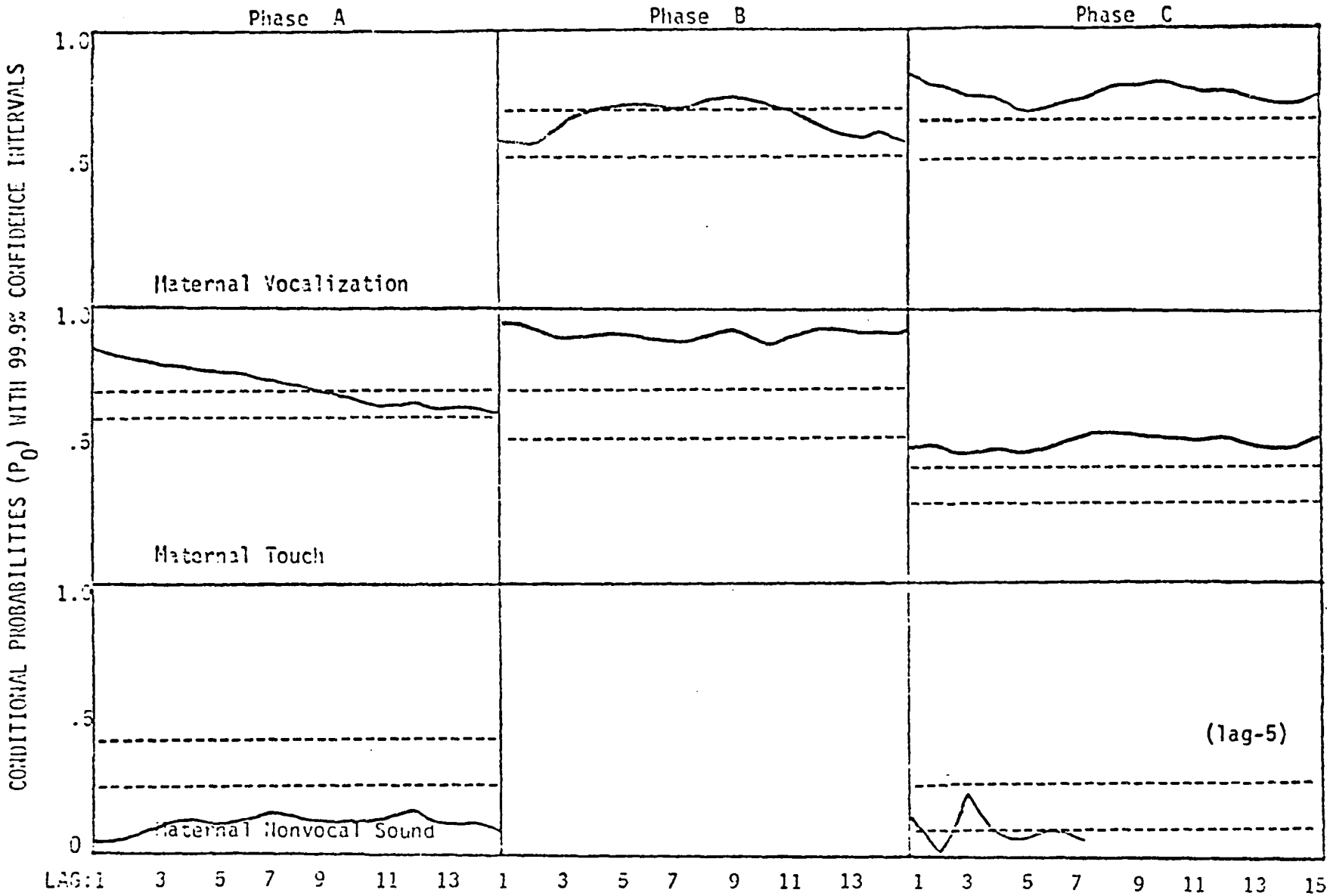
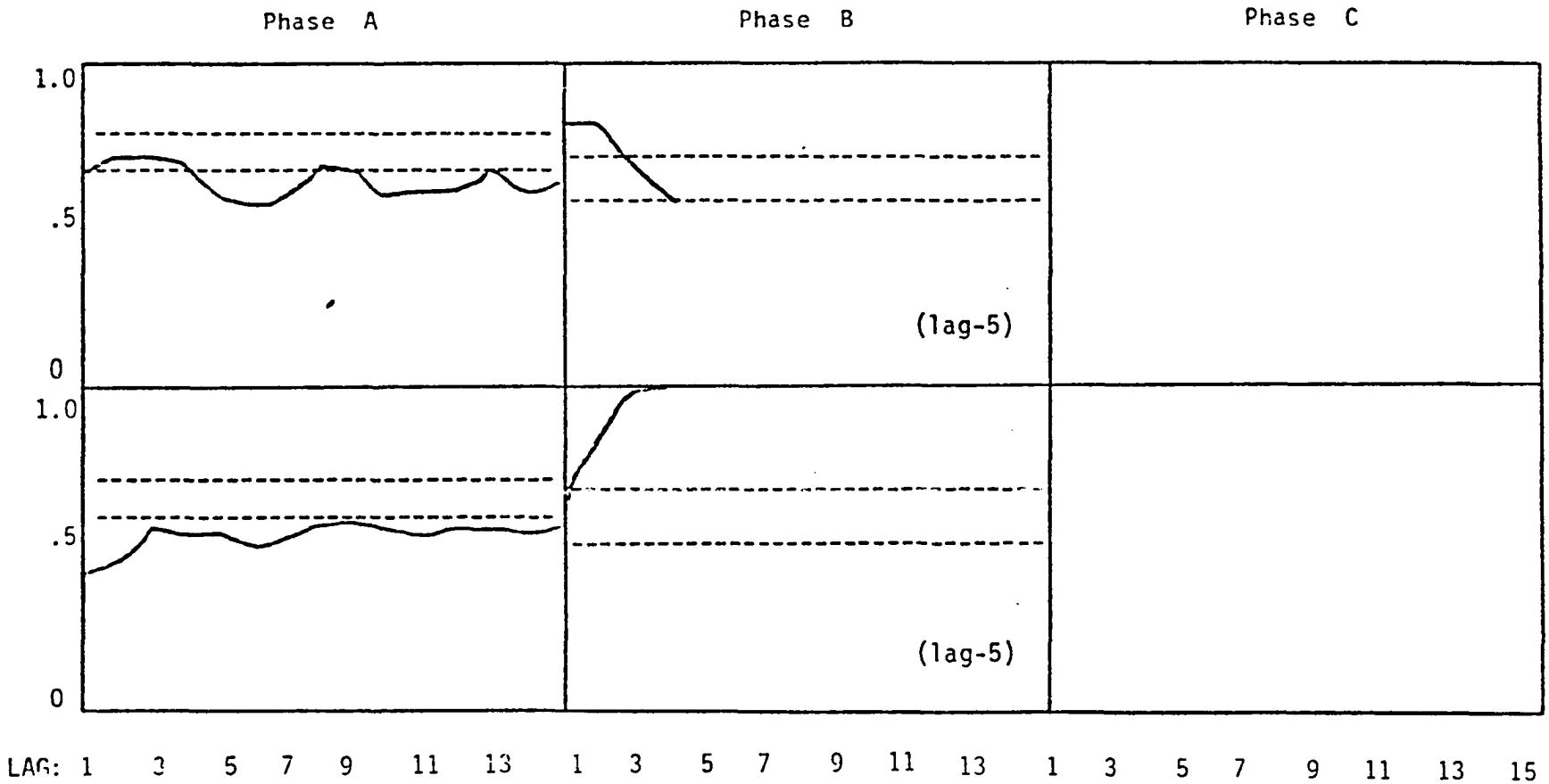


Fig. 16. EFFECT OF INFANT GESTURE ON SELECTED MATERNAL BEHAVIORS: PAIR B



CONDITIONAL PROBABILITIES (P_0) WITH 99.9% CONFIDENCE INTERVALS

Fig. 17. EFFECT OF INFANT MANIPULATE TOY ON SELECTED MATERNAL BEHAVIORS: PAIR B

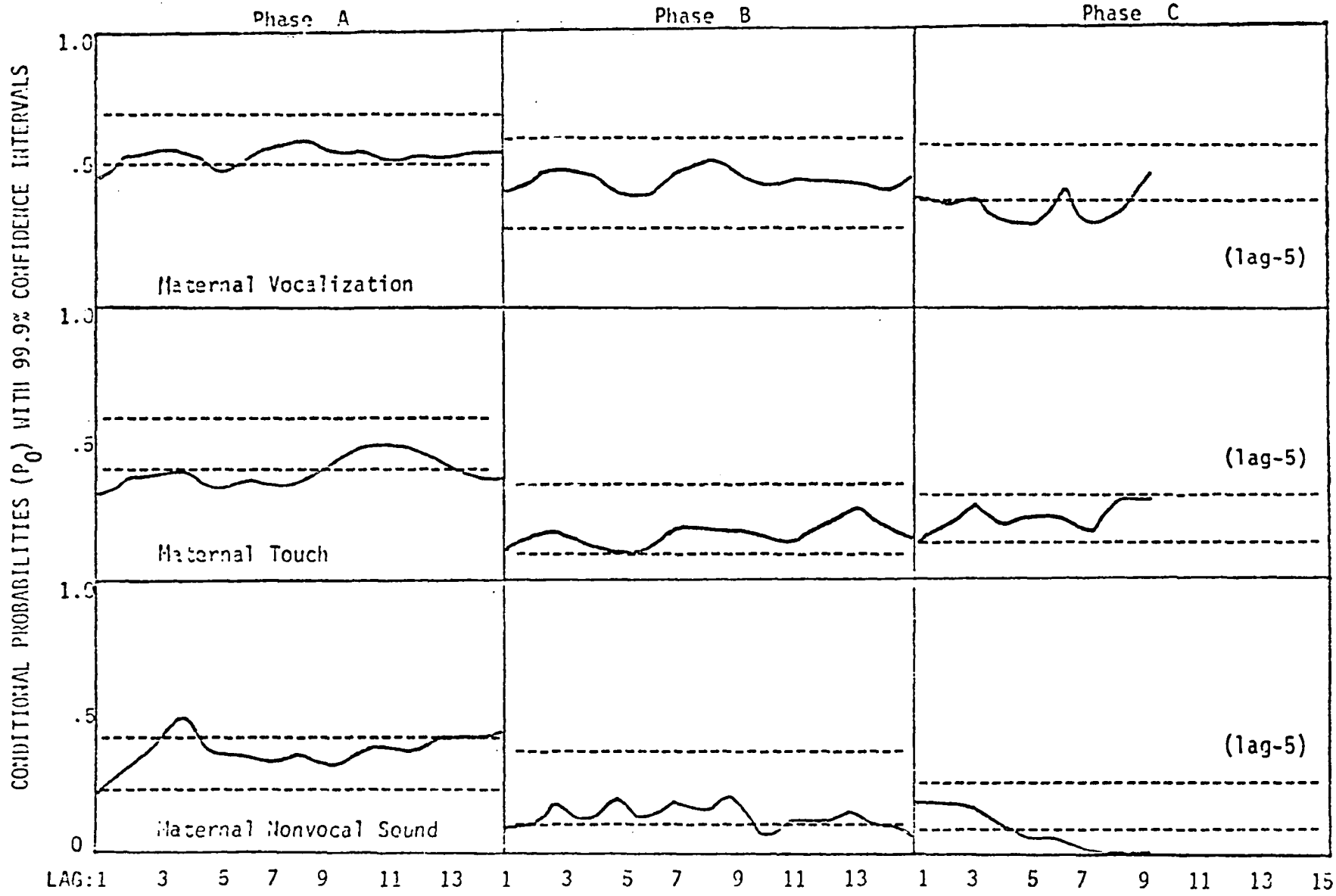
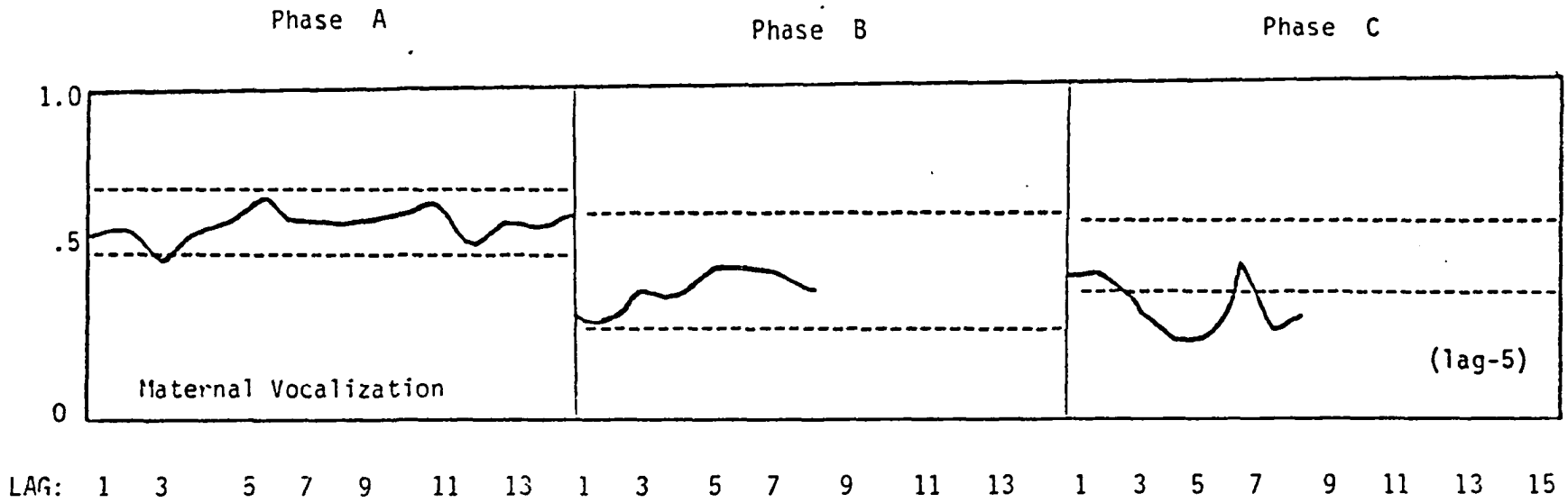


Fig. 18. EFFECT OF INFANT REACH FOR TOY ON SELECTED MATERNAL BEHAVIORS: PAIR B



CONDITIONAL PROBABILITIES (P_0) WITH 99.9% CONFIDENCE INTERVALS

Pair C

At 16 months, Infant C, who had no visual response, was developmentally delayed in all areas. She was a passive, contented baby. She was able to sit unassisted and had once sat up by herself. Once in sitting position, however, she periodically engaged in self-stimulatory rocking and hand-flapping against her face. She could push herself up into a crawling position and let herself down, and she seemed responsive to auditory stimulation, but did not localize sound well. Tactile exploration was proceeding well; she explored her mother's mouth as she talked, seemed to explore toys well and responded to different shapes. She enjoyed solitary vocal play and would sometimes fake a cough, apparently to attract her mother's attention. Mother C played several standard games with her infant, most notably "patty-cake." Nystagmoid movements of Infant C's eyes and her rather poor orientation to auditory cues no doubt interfered with en face interactions, although she was very accepting of interaction with strangers as well as with her mother. Because they lived in a rural area, Infant C was seen at the Child Study Center on a monthly basis and her programs were carried on by a local special-education preschool and by her mother.

By the end of the project (at 22 mo. of age), Infant C had begun to move around the house by rolling. She could sit herself up, lie back down, rock back and forth in a crawling position, and would bear her own

weight for 15 minutes when placed in a standing position. She explored faces very carefully, searched well in any direction both to a sound cue and in quest of temporarily abandoned (silent) toys. Her range of vocalizations had increased, and she had begun to say "mama," but not communicatively. She still, however, presented significant overall developmental delay.

Tables 17 and 18 (pp.104 and105) present rates of occurrence for each of the originally scored behaviors for Pair C. Note the relatively high rate of Touch Self, and the presence of some Elicited Manual Gestures (mostly clapping to "patty-cake") and Body Stereotypy for the Infant. Note also the relatively high frequency of Nonlinguistic Vocalizations for the Mother and the increase in Maternal Caress over the Phases. Table 19 (p.106) presents the rates of occurrence of the 11 categories chosen for intensive analysis. Lag-1 conditional probabilities for Infant C behaviors appear in Table 20 (p.107), those for Mother C behaviors appear in Table 21 (p.108), and those for reciprocal Involvement States appear in Table 22 (p.109). Figures 19 - 28 (pp.110 - 119) graphically illustrate cross-contingencies found in Pair C interactions. (In Phase C, observations were too few to enable meaningful lags analyses.)

The Mother's Effect on the Infant: Pair C

Maternal Tactile Behavior (see Fig. 19, p. 110). Maternal Touch occurred with increasing frequency over the three Phases, occupying 40%, 72% and 88% of intervals in Phases A, B and C, respectively. A mean of

51% of Toy intervals contained Maternal Touch, as opposed to a mean of 95% in No-Toy intervals. Following Maternal Touch, Infant Smiles increased persistently in Phase A (P_{L1} = .210), but not in Phases B or C. The probability of Infant Toy Manipulation decreased following this criterion both in Phase A (P_{L1} = .165) and in Phase B (P_{L1} = .074). No other infant behaviors demonstrated any relationship to Maternal Touch.

Maternal Auditory/Vocal Behavior (see Fig. 20, p.111). Maternal Vocalizations occupied from 23% to 89% of intervals, with a mean overall occurrence in 56% of intervals. Maternal Vocalizations preceeded a transitory Phase A decrease in Infant Nonvocal Sounds (P_{L1} = .212), and in Toy Manipulation (P_{L1} = .212). In Phase B, both of these Infant behaviors decreased at 22 sec. post-criterion (P_{L1} = .595 for Nonvocal Sound; P_{L1} = .514 for Toy Manipulation). Infant Vocalizations showed a delayed increase following this criterion: in Phase A, increases occurred in seconds 16, and 26-28 (P_{L8} = .229), and in Phase B the increase occurred at sec. 8 (P_{L4} = .143). Infant Smiles increased persistently following Maternal Vocalization in Phase A (P_{L1} = .198) and over seconds 4 - 10 in Phase B (P_{L2} = .324). In Phase A, Infant Gestures showed a delayed increase, commencing at 14 sec. post-criterion (P_{L7} = .095), while in Phase B, Infant Gestures showed a cyclical increase post-criterion (P_{L1} = .255). Following Maternal Vocalization, Infant Low-Involvement states increased in frequency for Phase A only (P_{L1} = .288).

Maternal Auditory/Nonvocal Behavior (see Fig. 21, p. 112). Maternal Nonvocal sounds occurred in 45%, 32% and 14% of Phases A, B and C, respectively. This criterion preceeded immediate decreases in Infant Nonvocal Sounds (P_{L1} = .206) and cyclical decreases in Infant Vocalizations (P_{L1} = .121), Infant Smiles (P_{L1} = .060), and Infant Manipulate Toy (P_{L1} = .153) in Phase A. Infant Reach for Toy, however, showed no relationship to Maternal Nonvocal Sound in this Phase. In Phase B, Infant Nonvocal Sounds and Toy Manipulation decreased for 4 sec. post-criterion (P_{L1} = .130 for Nonvocal Sounds; P_{L1} = .087 for Manipulate Toy) with a related decrease in Infant Reach for Toy immediately following this criterion (P_{L1} = .283).

Maternal Low-Involvement (see Fig. 22, p. 113). Maternal Low-Involvement states occurred with decreasing frequency, appearing in 33%, 19% and 1% of total intervals in Phases A, B and C, respectively. Virtually all occurrences of this state were in Toy conditions. This criterion state preceeded a persistent decrease in Infant Vocalizations in Phase B (P_{L1} = .000).

Maternal High-Involvement (see Fig. 22, p. 113). Maternal High-Involvement states occurred in 24%, 47% and 68% of intervals in Phases A, B and C, respectively. In Phase A, this maternal state preceeded a persistent increase in Infant Low-Involvement (P_{L1} = .355), and a delayed increase (in seconds 14 - 18) in Infant Vocalizations (P_{L7} = .245). In Phase B, this criterion was also followed by a delayed increase in Infant Vocalizations in seconds 4 - 10 (P_{L2} = .138), but showed no relationship to Infant Low-Involvement.

The Infant's Effect on the Mother: Pair C

Infant Auditory/Nonvocal Behavior (see Fig. 23, p. 114). Infant C produced Nonvocal Sounds in 34%, 38% and 4% of Toy sequences A, B and C, respectively. By Phase C, the infant's teacher had started to discourage her toy play in an attempt to increase her social play, which may explain the dramatic decrease in this behavior in that Phase. In Phases A and B, Infant Nonvocal Sound preceeded a persistent decrease in Maternal Touch (P_{L1} = .138 in Phase A; P_{L1} = .096 in Phase B). A decrease in Maternal Nonvocal Sound also followed this criterion in both Phases A (P_{L1} = .228) and B (P_{L1} = .096). In both Phases, these decreases were cyclical in pattern. Most analyses in Phase C were impossible due to a reduced number of observations.

Infant Auditory/Vocal Behavior (see Fig. 24, p. 115). Infant C vocalized in 18%, 8% and 32% of total intervals in Phases A, B and C, respectively. Following this criterion, the lag-5 profile for Phase B showed an increase in Maternal Touch ($P_{L1\text{-}5}$ = .958), but no effects appeared in Phase A. In both Phases A and B, Maternal Vocalizations increased post-criterion. In Phase A (P_{L1} = .488), this increase was cyclical, as in B, where only the lag-5 profile was available ($P_{L1\text{-}5}$ = .633). Following Infant Vocalizations, Maternal Nonvocal Sound decreased in Phases A and B (P_{L1} = .370 in Phase A), although only the lag-5 profile was available in Phase B (P_{L15} = .022).

Infant Positive Facial Expression (see Fig. 25, p. 116). Infant Smile increased in rate from 15% to 23% to 52% of Phases A, B and C

intervals, respectively, with a mean of 47% in No-Toy intervals and a mean of 18% in Toy intervals. Infant Smile preceeded immediate and persistent increases in Maternal Touch and Maternal Vocalizations in Phases A and B (for Maternal Touch, P_{L1} = .552 in Phase A and .970 in Phase B; for Maternal Vocalization, P_{L1} = .514 in Phase A and .682 in Phase B). Maternal Nonvocal Sounds decreased post-criterion in Phase A after 8 seconds (P_{L4} = .310), but could not be analyzed in Phases B or C.

Infant Spontaneous Manual Gesture (see Fig. 26, p. 117). Infant Gestures appeared in an average 9% of total intervals. Following Infant Gesture, Maternal Touch increased in Phase B (P_{L1} = .512), but not in Phase A, where a decrease in Touch appeared at 20 sec. post-criterion (P_{L10} = .306). Maternal Vocalizations increased immediately following this criterion in both Phases A (P_{L1} = .512) and B (P_{L1} = .740).

Infant Manipulate Toy (see Fig. 27, p.118). Infant C manipulated toys in 38% and 40% of Phase A and B intervals, respectively, but dropped to 3% in Phase C. As explained above, Infant C's toy play had decreased in Phase C after discouragement by her teacher. Following Infant Toy Manipulation, Maternal Touch decreased persistently in Phases A (P_{L1} = .140) and B (P_{L1} = .130). In Phase A, Maternal Vocalizations decreased persistently post-criterion (P_{L1} = .172), and in Phase B, decreased at 16 seconds post-criterion (P_{L8} = .163). Maternal Nonvocal Sounds decreased following this criterion persistently in Phase A (P_{L1} = .167) and cyclically in Phase B (P_{L1} = .087).

Infant Reach for Toy (see Fig. 28, p. 119). Infant C reached for toys in an average 17% of Toy sequences across all Phases. In Phase A, this criterion was followed by an immediate transitory decrease in Maternal Vocalizations (P_{L1} = .150), and a similar decrease appeared in the lag-5 profile for Phase B (P_{L15} = .158). In Phase A, Infant Reach for Toy showed a cyclical autocontingency.

Infant Low-Involvement (see Fig. 22, p. 113). The Infant Low-Involved state appeared in an average of 17% of all intervals. In Phase A, Maternal High-Involvement increased persistently following Infant Low-Involvement (P_{L1} = .423). In Phase B, however, Maternal High-Involvement showed a delayed but persistent decrease commencing at 12 sec. post-criterion (P_{L6} = .367). In Phase C, Maternal High-Involvement states decreased immediately following Infant Low-Involvement (P_{L1} = .467), but thereafter showed cyclical increases.

Concurrent Vocalization: Pair C

Concurrent Vocalizations occurred in 7%, 5% and 23% of total intervals in Phases A, B and C, respectively. In Phases A and C, Concurrent Vocalizations showed cyclical autocontingencies (see Appendix F, p.265). Analysis was not possible in Phase B.

Data Summary: Pair C

Infant C was fairly expressive and was just beginning to use her expressive behaviors intentionally. Although her turn-taking skills did not become highly developed, she did become more participatory in games

with her mother over the course of the project. Although she came to explore and act upon her immediate environment more and more, her inability to initiate social interactions prevented her natural vocal and gestural repertoire from acquiring truly communicative significance. Infant C's only expressive response to Maternal Touch was an increase in Smiles, whereas Maternal Vocalizations were followed by a wider variety of responses including decreased Toy activities, and increased Smiles, Vocalizations and Gestures. Although this repertoire of responses to Maternal Vocalizations was encouraging, a decrease in Vocalizations following Maternal Low-Involvement states attested to her lack of interactive initiative. Infant C's response to Maternal Nonvocal Sounds suggested a high degree of attentiveness, with a decrease in Toy Manipulation, Smiles, and Vocalizations in Phase A. By Phase C, a high rate of Reaching for Toy following Maternal Nonvocal Sounds indicated reliable ear-hand coordination. Whereas Maternal High-Involvement states initially increased the probability of Infant Low-Involvement, by Phase B these Maternal states were followed by rapid increase in the rate of Infant Vocalizations (see Table 22, p.113).

Mother C's interactions seemed to become more warm and involved over time. Maternal Caresses increased across Phases, and general Tactile activity increased across the Toy sequences. Infant Vocalizations were followed by high rates of Maternal Vocalizations and decreases in Maternal Nonvocal Sounds, with a Tactile response developing in Phase B. As with the other subject pairs, Infant C's smiles seemed to be powerful cues for

Maternal Touch and Vocalizations. Infant Gestures were followed by Maternal Vocalizations in Phases A and B, and a Tactile response had increased by Phase B. Mother C appropriately decreased Touch and Non-vocal Sounds following her infant's manipulative play, but the ramifications of the concomitant decrease in Maternal Vocalizations are difficult to evaluate. Mother C seemed to run through several strategies in the face of Low-Involvement states on the part of her infant. By Phase C this Infant state seemed to prompt an initial decrease in Maternal High-Involvement, followed by cyclical increases in this state 10 seconds later. The occurrence of Concurrent Vocalizations increased dramatically in Phase C.

Infant C seemed to be hovering between perlocutionary and illocutionary stages. Although her expressive activities (including some elicited manual gestures) were stable and intentional components of her behavioral repertoire, eliciting reliable responses from her mother, they were more reactive than spontaneous. Ritualized play and turn-taking schemes were developing, but had to be initiated and maintained by an adult. Infant C's gestural complex did not show a clear developmental pattern that would portend rapid acquisition of conventional gestures or vocalizations. However, her vocal imitative abilities and her apparent comprehension of a few words suggest that in time conventional language may appear.

Table 17. RAW DATA: PROPORTION OF INTERVALS CONTAINING EACH BEHAVIOR FOR INFANT C

	PHASE A			PHASE B			PHASE C		
	No Toys	Toys	Total	No Toys	Toys	Total	No Toys	Toys	Total
INFANT BEHAVIORS									
Nonvocal Sound	.03	.34	.28	.06	.38	.22	.03	.04	.03
Linguistic Vocalization	.00	.00	.00	.00	.00	.00	.00	.00	.00
Nonlinguistic Vocalization	.25	.16	.18	.11	.06	.08	.34	.31	.32
Vocal Imitation of Mother	.01	.00	.00	.00	.00	.00	.00	.00	.00
Head Gesture	.08	.00	.02	.00	.03	.01	.01	.03	.02
Inappropriate Visual Orientation	NA	NA	NA	NA	NA	NA	NA	NA	NA
Positive Facial Expression(Smile)	.33	.11	.15	.43	.04	.23	.64	.40	.52
Negative Facial Expression	.00	.01	.01	.00	.00	.00	.00	.00	.00
Spontaneous Manual Gesture	.07	.06	.06	.31	.05	.18	.01	.06	.03
Explore Space	.01	.00	.01	.00	.00	.00	.00	.00	.00
Elicited Manual Gesture	.04	.00	.01	.14	.00	.07	.04	.06	.05
Reach for Mother	.01	.00	.00	.08	.00	.04	.14	.08	.11
Reach for Toy	.00	.20	.16	.01	.16	.08	.00	.14	.07
Release Mother	.00	.00	.00	.01	.00	.00	.00	.00	.00
Release Toy	.00	.02	.01	.00	.01	.01	.01	.01	.01
Explore Mother	.00	.00	.00	.00	.00	.00	.27	.01	.14
Explore Toy	.00	.15	.12	.00	.10	.05	.00	.06	.03
Manipulate Mother	.00	.00	.00	.01	.00	.01	.00	.06	.03
Manipulate Toy	.00	.38	.31	.00	.40	.20	.00	.03	.01
Hold Mother	.00	.00	100	.04	.00	.02	.09	.17	.13
Hold Toy	.00	.02	.01	.00	.01	.00	.00	.06	.03
Withdraw Hand from Mother	.00	.00	.00	.00	.00	.00	.03	.00	.01
Withdraw Hand from Toy	.00	.01	.01	.00	.04	.02	.00	.04	.02
Push Away Mother	.00	.00	.00	.00	.01	.00	.00	.00	.00
Touch Self	.39	.03	.10	.06	.11	.08	.03	.04	.03
Hand: Other/Nothing	.50	.26	.31	.39	.26	.32	.46	.25	.35
Approach Mother	.00	.00	.00	.00	.00	.00	.00	.00	.00
Avoid Mother	.00	.00	.00	.00	.00	.00	.00	.00	.00
Toy Stereotypy	.00	.00	.00	.01	.00	.00	.00	.00	.00
Body Stereotypy	.03	.08	.07	.00	.01	.01	.01	.00	.01
Self-Abusive Stereotypy	.00	.00	.00	.00	.00	.00	.00	.00	.00

Table 18. RAW DATA: PROPORTION OF INTERVALS CONTAINING EACH BEHAVIOR FOR MOTHER C

MATERNAL BEHAVIORS	PHASE A			PHASE B			PHASE C		
	No Toys	Toys	Total	No Toys	Toys	Total	No Toys	Toys	Total
Caress	.01	.00	.00	.12	.01	.06	.49	.32	.40
Restrain	.03	.00	.01	.01	.00	.01	.00	.00	.00
Tactile Direction	.83	.28	.39	.86	.47	.65	.50	.46	.48
Visual Direction	NA	NA	NA	NA	NA	NA	NA	NA	NA
Positive Linguistic Vocalization	.00	.00	.00	.00	.00	.00	.00	.00	.00
Negative Linguistic Vocalization	.00	.00	.00	.00	.00	.00	.00	.00	.00
Other Linguistic Vocalization	.76	.22	.33	.46	.26	.35	.53	.64	.58
Nonlinguistic Vocalization	.12	.01	.04	.27	.05	.16	.26	.19	.22
Vocal Imitation of Infant	.03	.00	.01	.00	.00	.00	.00	.00	.00
Nonvocal Sound	.08	.45	.37	.06	.32	.19	.04	.14	.09

Table 19. BEHAVIOR CATEGORIES SELECTED FOR LAGS ANALYSES: PAIR C

(PROPORTION OF INTERVALS CONTAINING EACH BEHAVIOR CATEGORY)

	Phase A			Phase B			Phase C		
	No Toy	Toy	Total	No Toy	Toy	Total	No Toy	Toy	Total
INFANT BEHAVIORS:									
Nonvocal Sound	.03	.34	.28	.06	.38	.22	.03	.04	.03
Vocalization	.25	.16	.18	.11	.06	.08	.34	.31	.32
Positive Facial (Smile)	.33	.11	.15	.43	.04	.23	.64	.40	.52
Manual Gesture	.07	.06	.06	.31	.05	.18	.01	.06	.03
Manipulate Toy	.00	.38	.31	.00	.40	.20	.00	.03	.01
Reach for Toy	.00	.20	.16	.01	.16	.08	.00	.14	.07
Low-Involvement State	.32	.17	.20	.15	.25	.20			.11
MATERNAL BEHAVIORS:									
Tactile	.87	.28	.40	.99	.48	.72	.99	.78	.88
Vocalization	.89	.23	.37	.73	.31	.51	.79	.83	.80
Nonvocal Sound	.08	.45	.37	.06	.32	.19	.04	.14	.09
Low-Involvement State	.01	.41	.33	.00	.38	.19			.01
High Involvement State			.24			.47			.68

Table 20. PAIR C: THE MOTHER'S EFFECT ON THE INFANT

	MOTHER'S BEHAVIOR AT INTERVAL X-1	P_0: INFANT'S BEHAVIOR AT INTERVAL X: Auditory Nonvocal	Auditory Vocal	Positive Facial	Manual Gesture	Manipulate Toy	Reach for Toy
PHASE A	Tactile		.185	.210 +	.060	.165 -	.171
	Auditory/Vocal	.212 -	.179	.198 +	.058	.212 -	.212
	Auditory/Nonvocal	.206 -	.121	.060 -	.048	.153	.222
PHASE B	Tactile		.116	.304	.217	.074 -	.191
	Auditory/Vocal	.256	.097	.297	.255 +	.233	.116
	Auditory/Nonvocal	.130 -	.043	----	----	.087 -	.283 +
PHASE C	Tactile		.333	.553	----	----	----
	Auditory/Vocal	----	.310	.540	----	----	----
	Auditory/Nonvocal	----	----	----	----	----	----

P_0 = Observed Probability

+ = $P_0 > P_E$, $p \leq .001$

- = $P_0 < P_E$, $p \leq .001$

---- = Insufficient observations for analysis.

Table 21.

PAIR C: THE INFANT'S EFFECT ON THE MOTHER

		P_0: MOTHER'S BEHAVIOR AT INTERVAL X		
INFANT'S BEHAVIOR AT INTERVAL X-1		Tactile	Auditory Vocal	Auditory Nonvocal
PHASE A	Auditory/Nonvocal	.138 -		.228 -
	Auditory/Vocal	.409	.488 +	.370 -
	Positive Facial	.552 +	.514 +	.390
	Manual Gesture	.415	.512 +	
	Manipulate Toy	.140 -	.172 -	.167 -
	Reach for Toy		.150 -	
PHASE B	Auditory/Nonvocal	.096 -		.096 -
	Auditory/Vocal	$.958_{1-5}$ +	$.633_{1-5}$ +	$.022_{1-5}$ -
	Positive Facial	.970 +	.682 +	----
	Manual Gesture	.880 +	.740 +	
	Manipulate Toy	.130 -	.271	.087 -
	Reach for Toy		$.158_{1-5}$ -	
PHASE C	Auditory/Nonvocal	----		----
	Auditory/Vocal	.911	.778	----
	Positive Facial	.904	.836	----
	Manual Gesture	----	----	
	Manipulate Toy	----	----	----
	Reach for Toy		----	

P_0 = Observed Probability

+ = $P_0 > P_E$, $p \leq .001$

- = $P_0 < P_E$, $p \leq .001$

---- = Insufficient observations for analysis.

Table 22. PAIR C: STATES OF INVOLVEMENT

PHASE A	P_0: Infant's State at Interval X			P_0: Mother's State at Interval X:
	Low-Involvement	Vocalization		High-Involvement
Mother's State at Interval X-1:			Infant's State at Interval X-1:	
Low-Involvement		.184	Low-Involvement	.423 +
High-Involvement	.355 +	.154		
Vocalization	.288 +			
PHASE B				
Mother's State at Interval X-1:			Infant's State at Interval X-1:	
Low-Involvement		.000 -	Low-Involvement	.509
High-Involvement	.197	.106		
Vocalization	.186			
PHASE C				
Mother's State at Interval X-1:			Infant's State at Interval X-1:	
Low-Involvement		----	Low-Involvement	$.635_{1-5}$
High-Involvement	.104	.323		
Vocalization	.133			

P_0 = Observed Probability

+ = $P_0 > P_E$, $p \leq .001$

P - = $P_0 < P_E$, $p \leq .001$

---- = Insufficient observations

Fig. 19. EFFECT OF MATERNAL TOUCH ON SELECTED INFANT BEHAVIORS: PAIR C

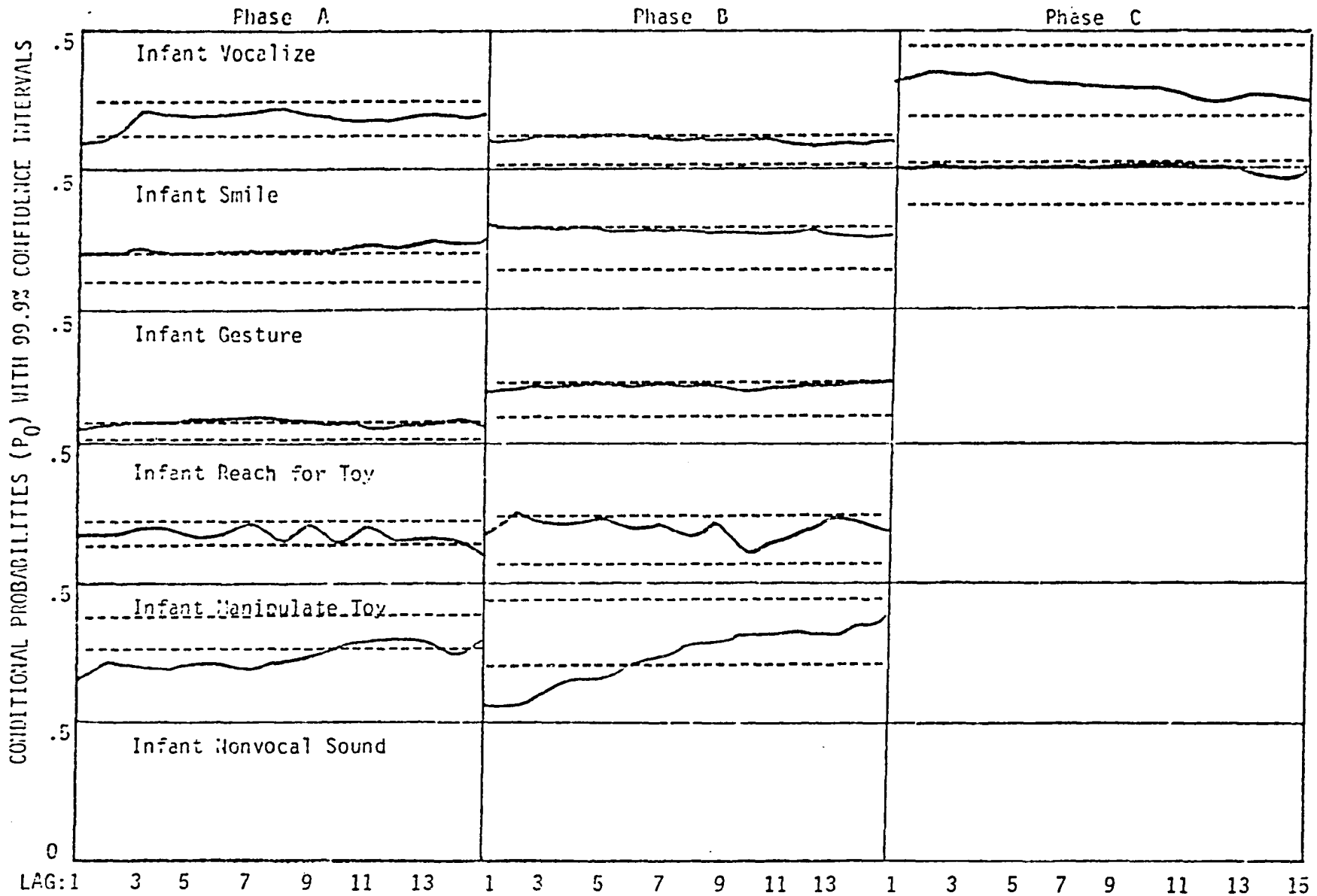


Fig. 20. EFFECT OF MATERNAL VOCALIZATIONS ON SELECTED INFANT BEHAVIORS: PAIR C

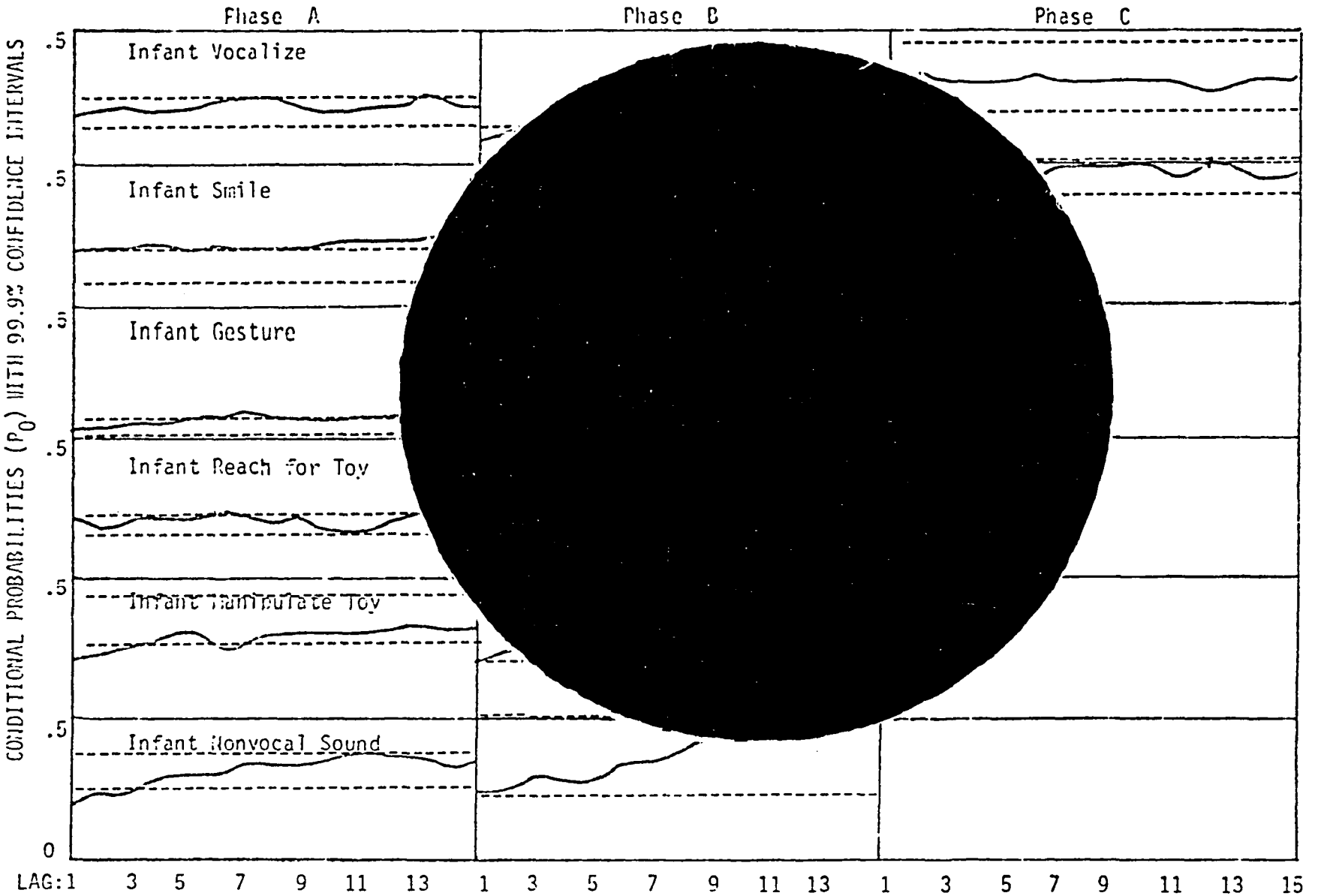


Fig. 20. EFFECT OF MATERNAL VOCALIZATIONS ON SELECTED INFANT BEHAVIORS: PAIR C

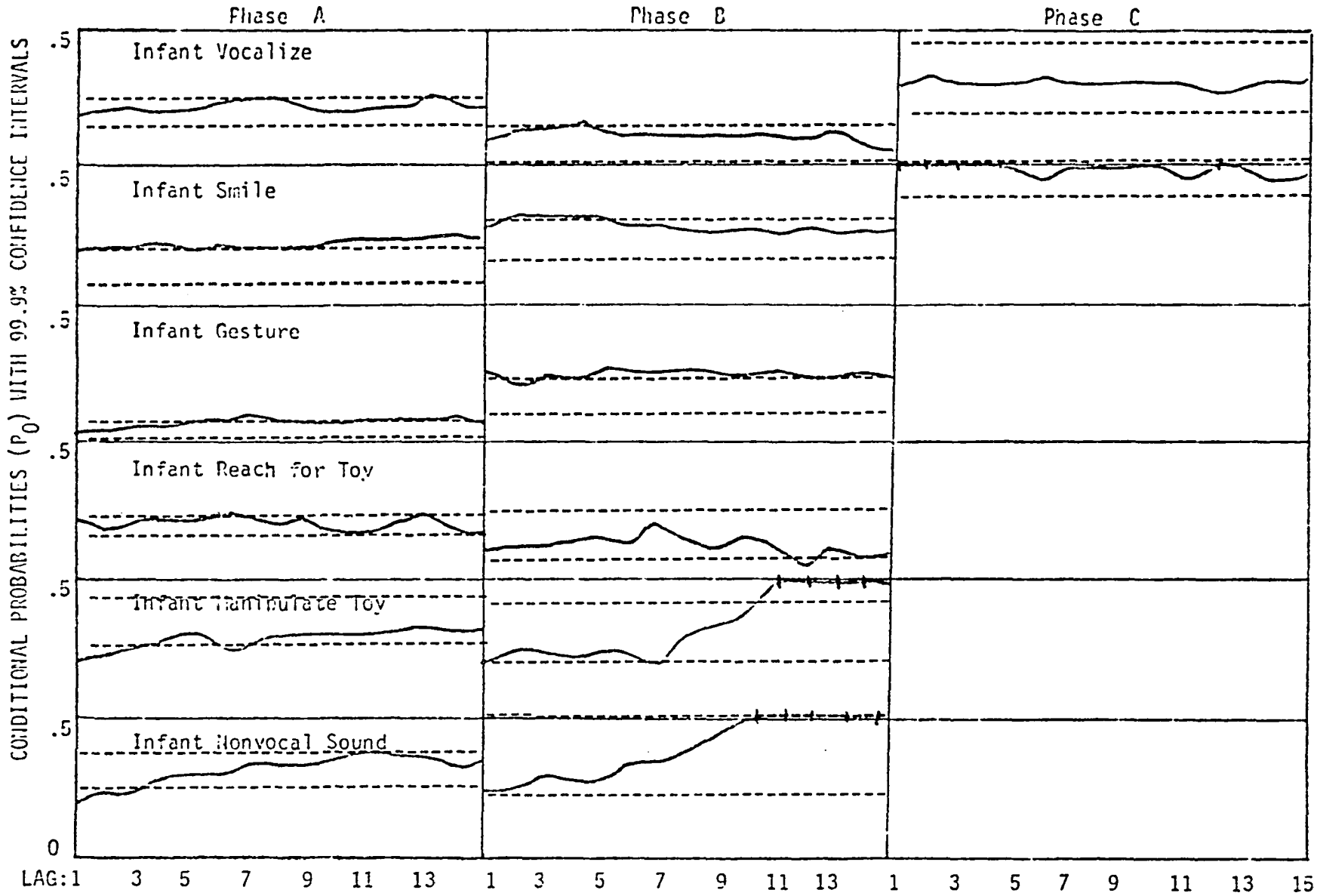


Fig. 21. EFFECT OF MATERNAL NONVOCAL SOUND ON SELECTED INFANT BEHAVIORS: PAIR C

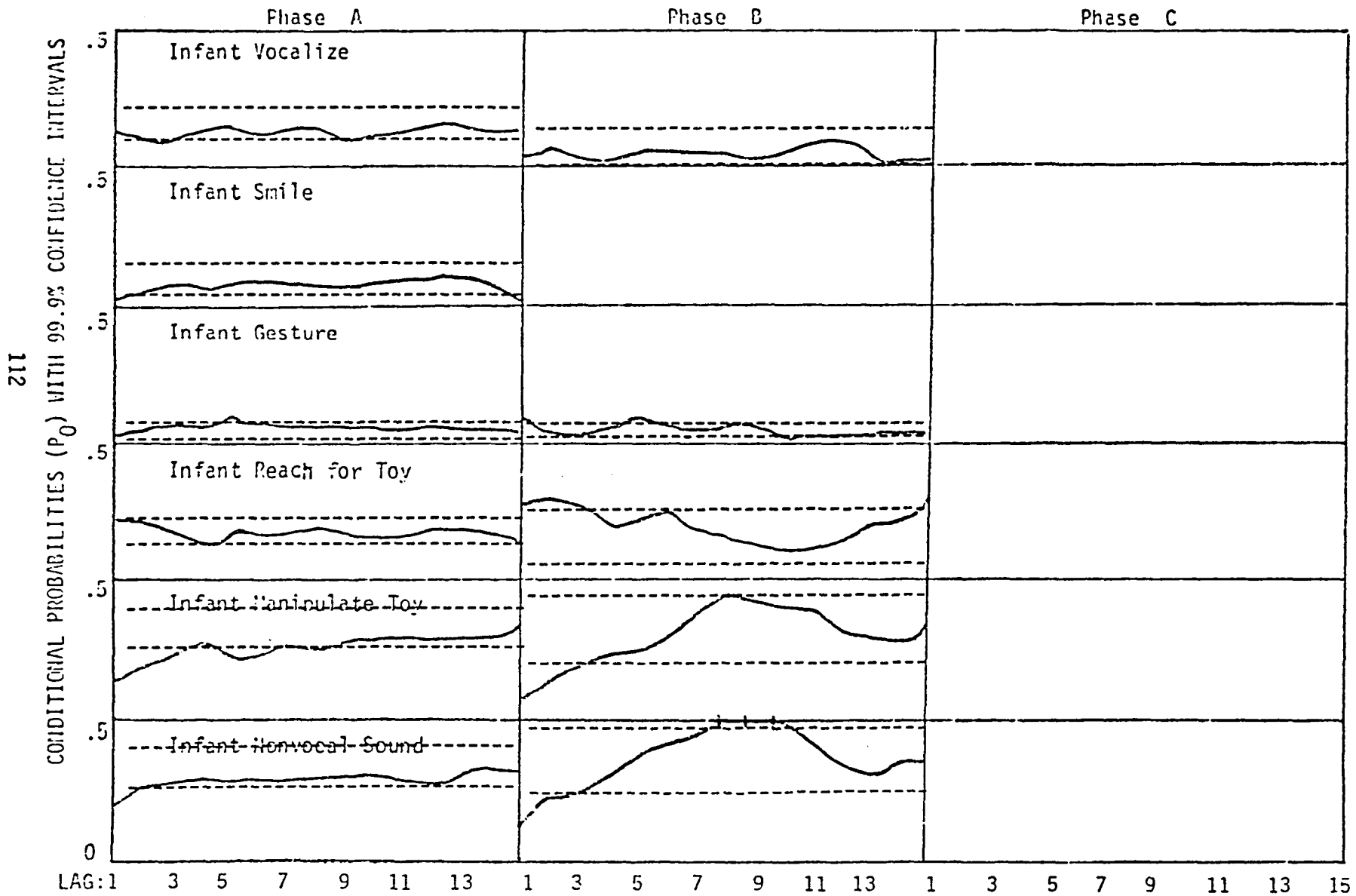


Fig. 22. STATES OF INVOLVEMENT: PAIR C

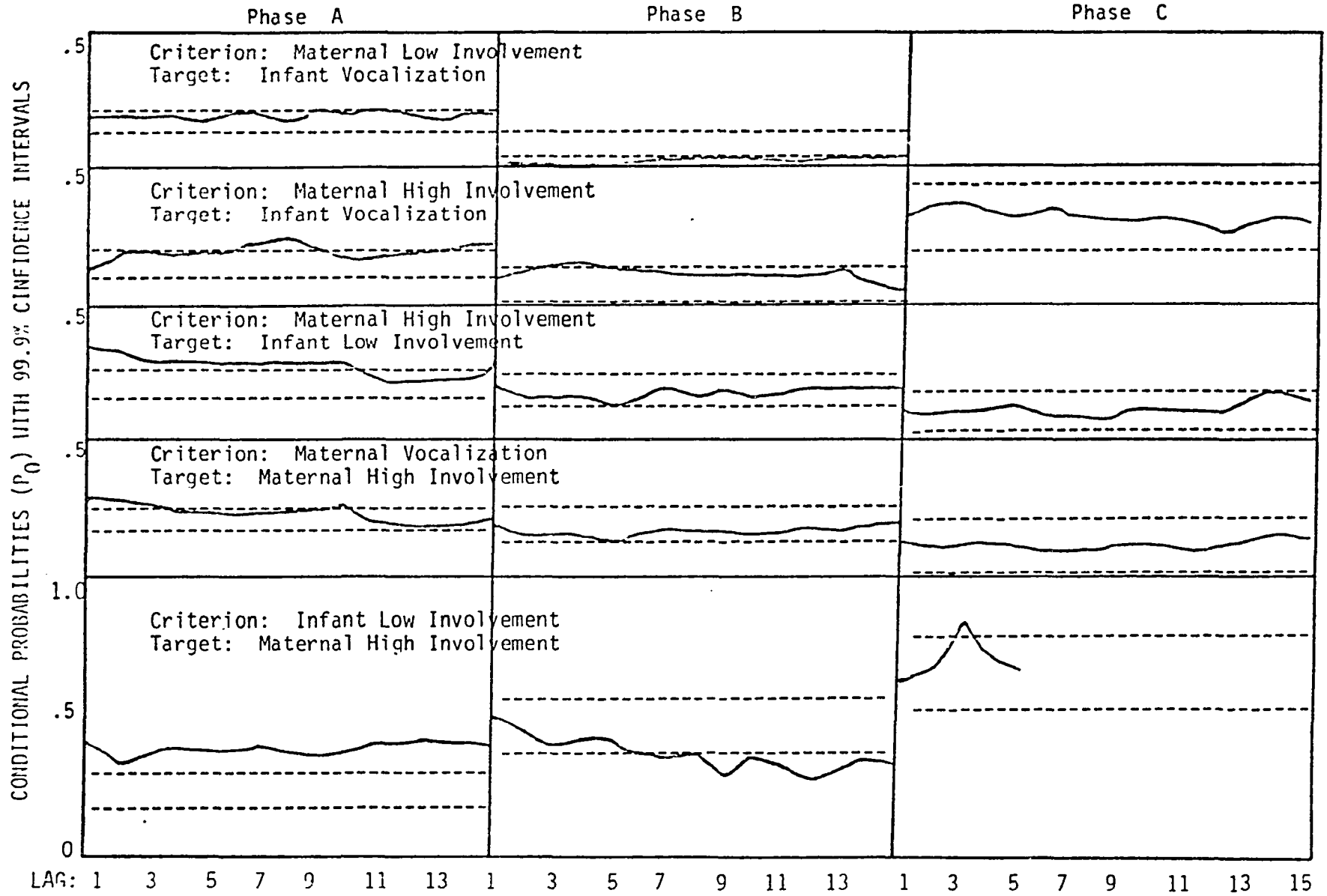
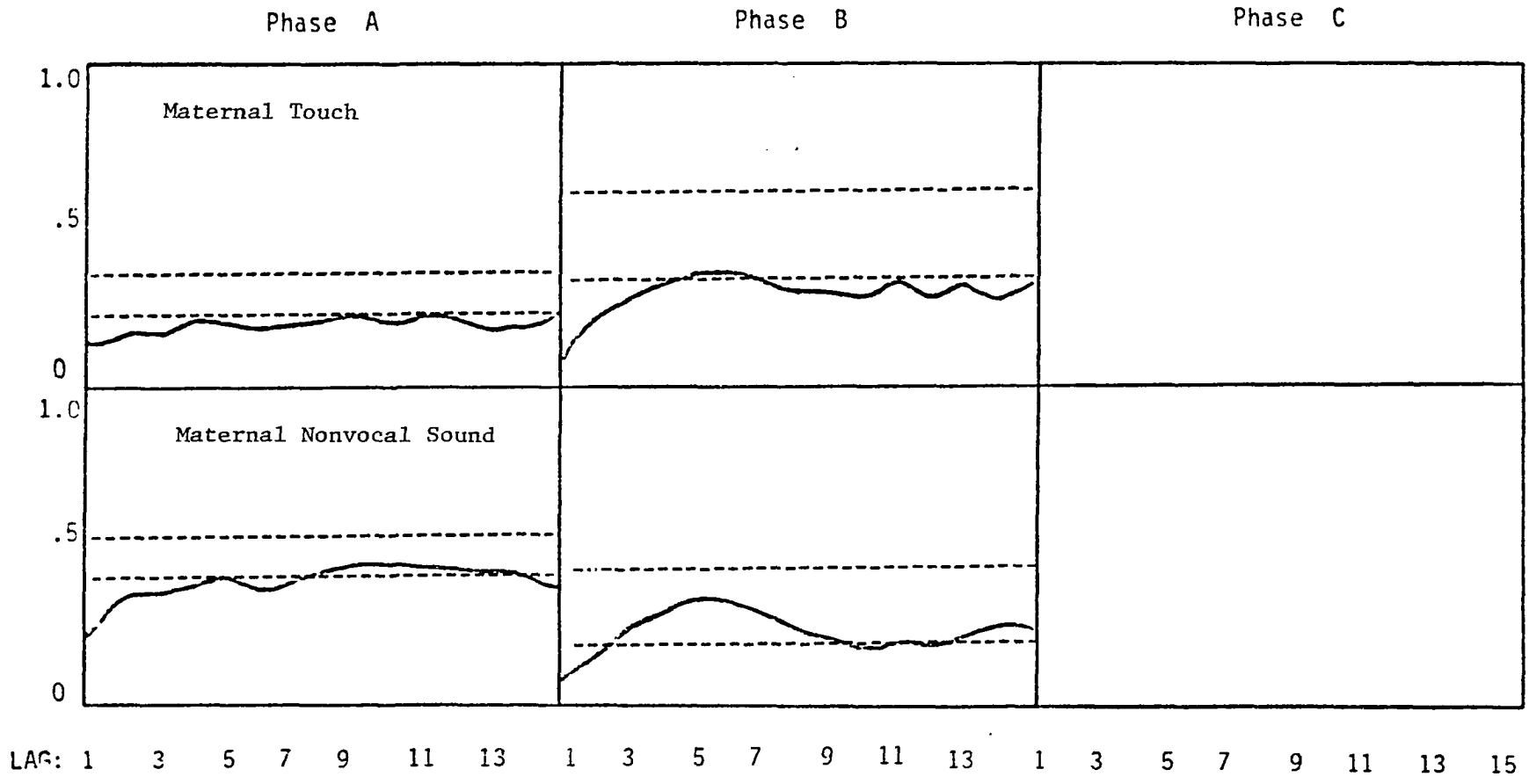


Fig. 23. EFFECT OF INFANT NONVOCAL SOUND ON SELECTED MATERNAL BEHAVIORS: PAIR C



CONDITIONAL PROBABILITIES (P_0) WITH 99.9% CONFIDENCE INTERVALS

Fig. 24. EFFECT OF INFANT VOCALIZATION ON SELECTED MATERNAL BEHAVIORS: PAIR C

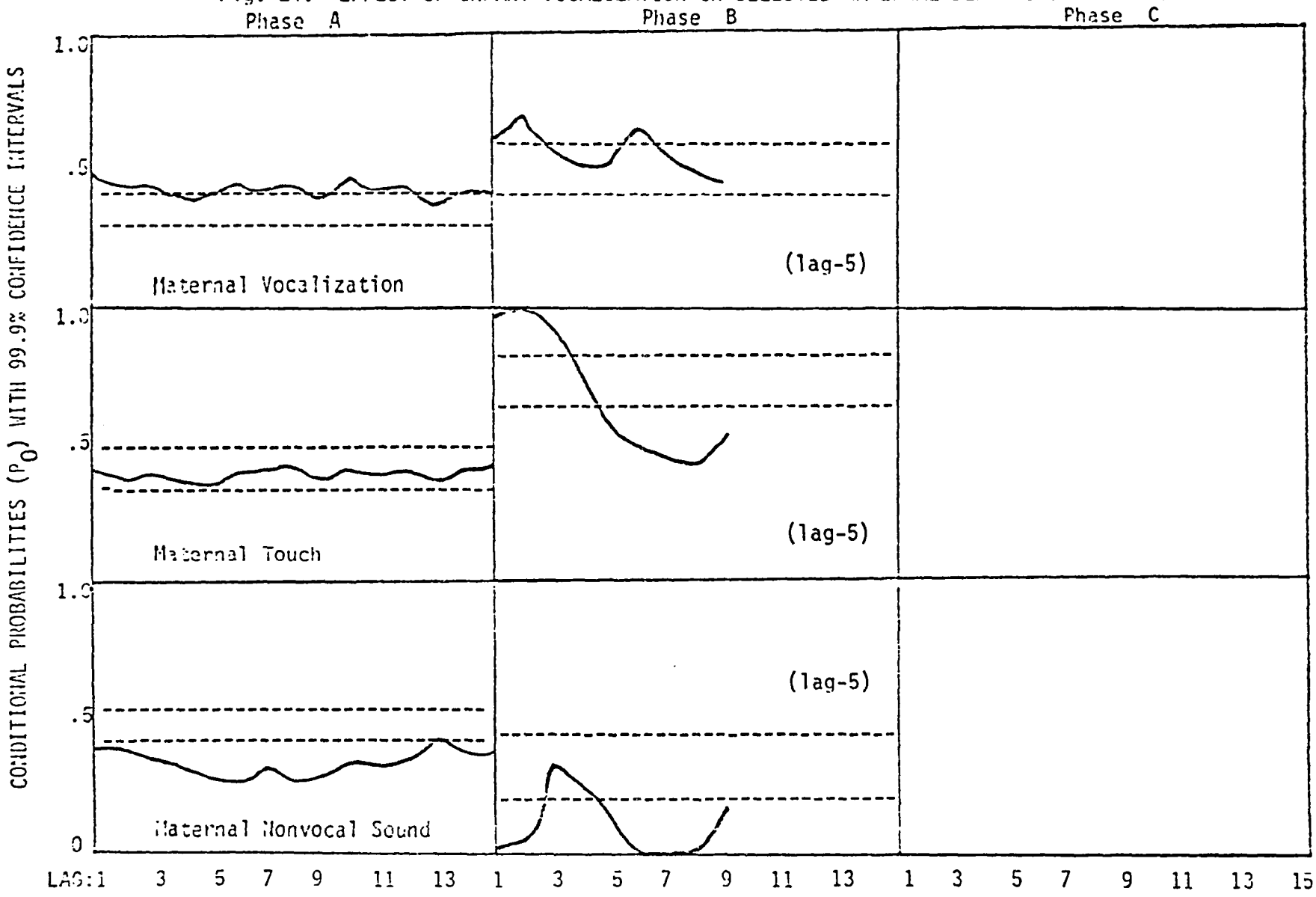


Fig. 25. EFFECT OF INFANT SMILE ON SELECTED MATERNAL BEHAVIORS: PAIR C

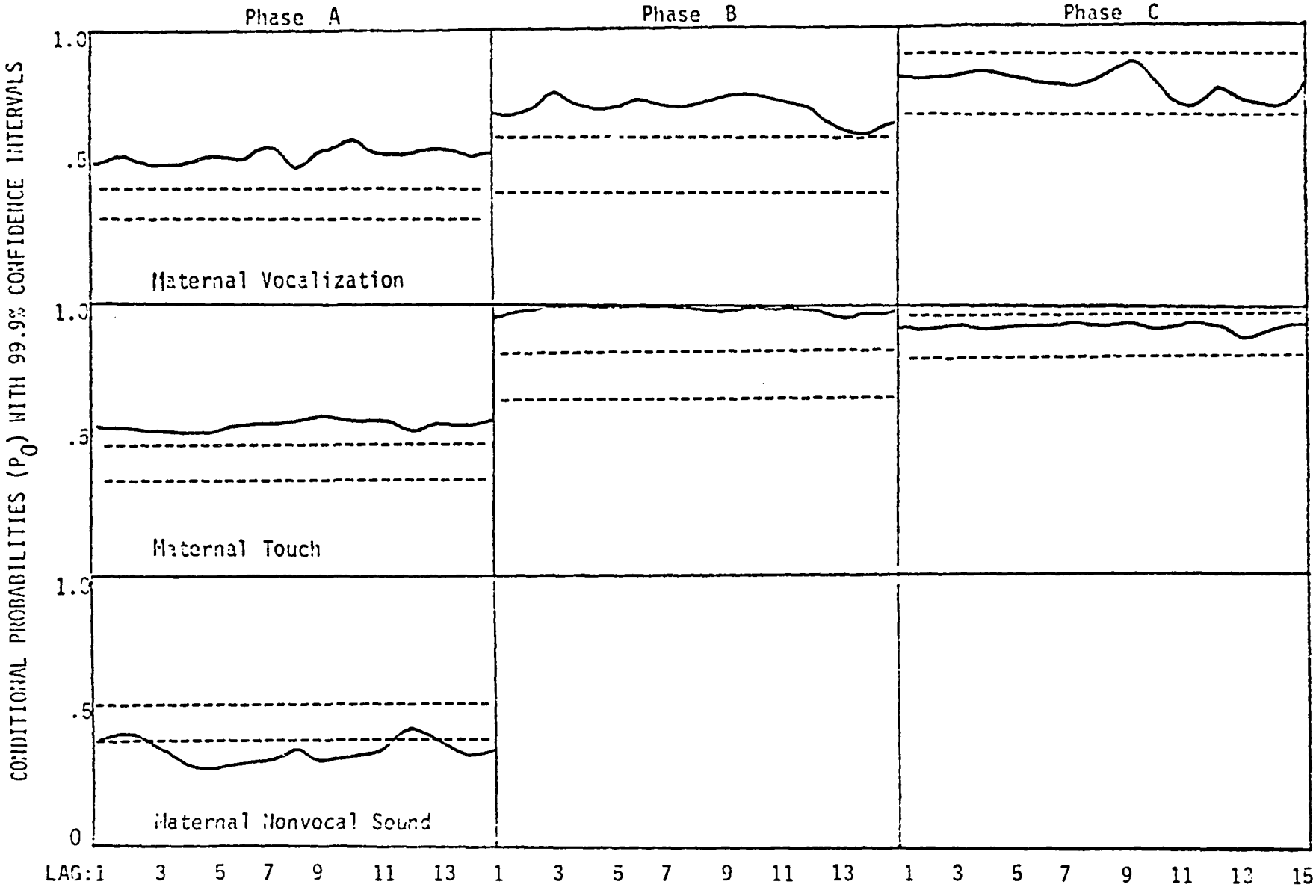
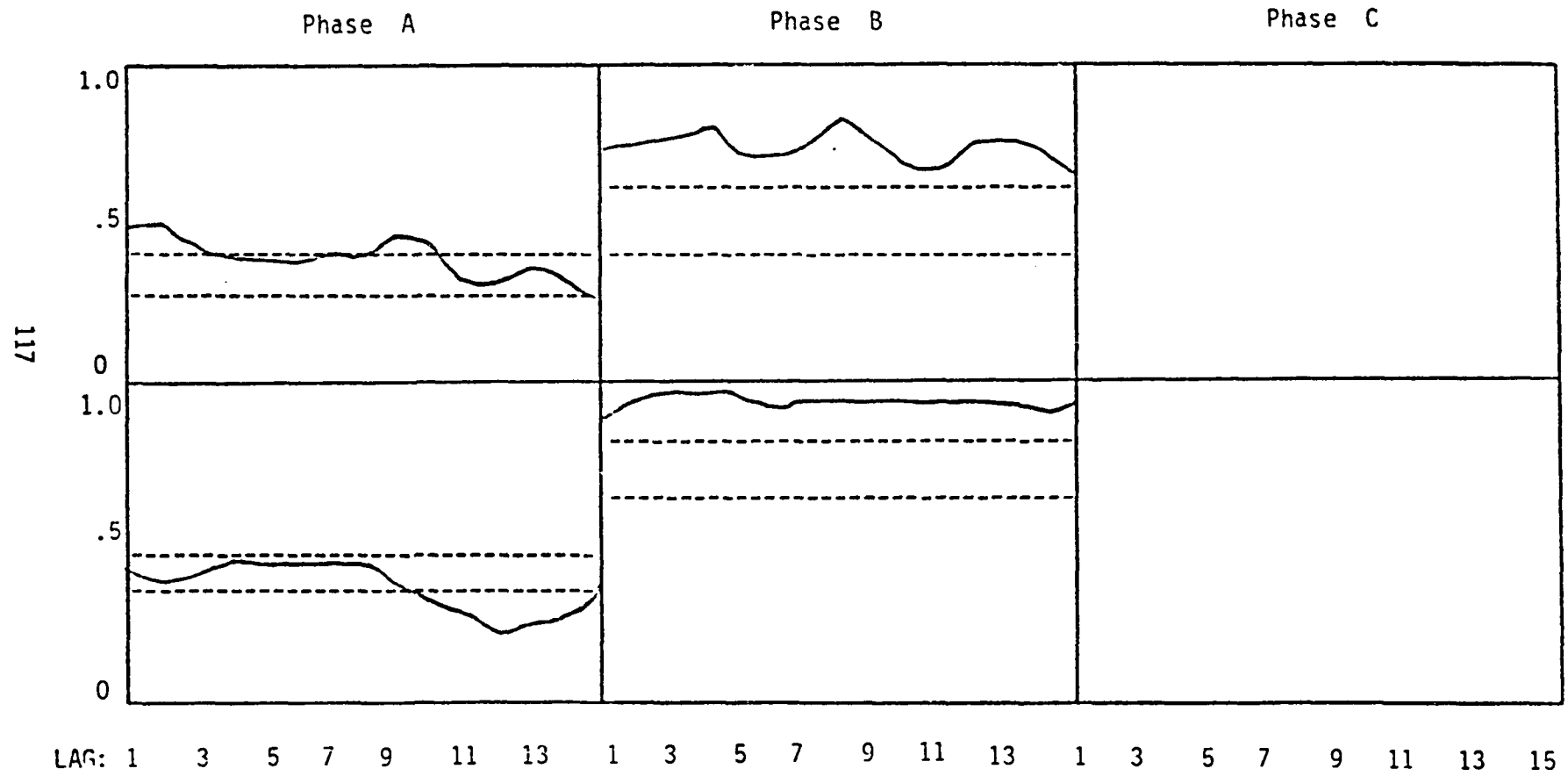


Fig. 26. EFFECT OF INFANT GESTURE ON SELECTED MATERNAL BEHAVIORS: PAIR C



CONDITIONAL PROBABILITIES (P_0) WITH 99.9% CONFIDENCE INTERVALS

Fig. 27. EFFECT OF INFANT MANIPULATE TOY ON SELECTED MATERNAL BEHAVIORS: PAIR C

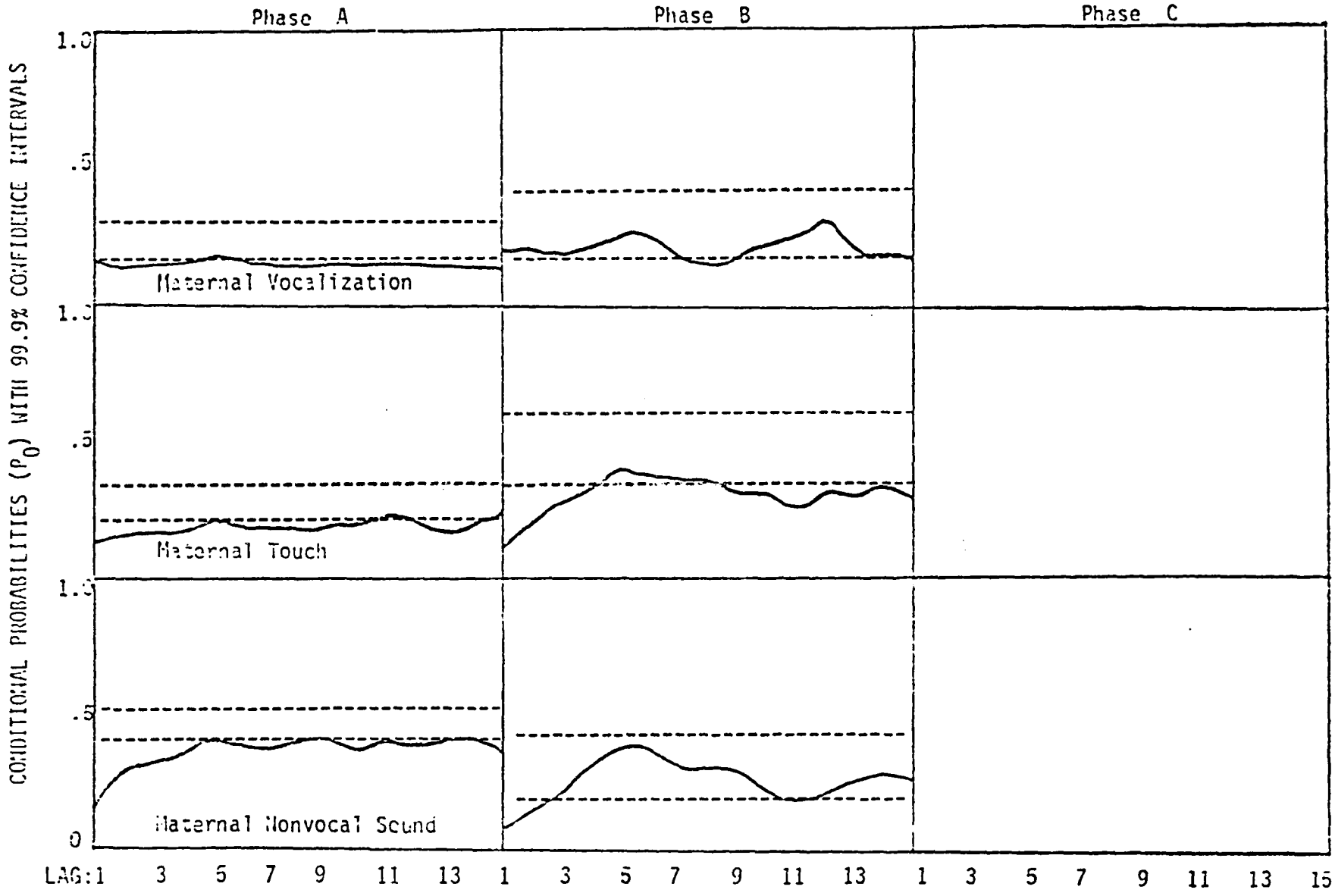
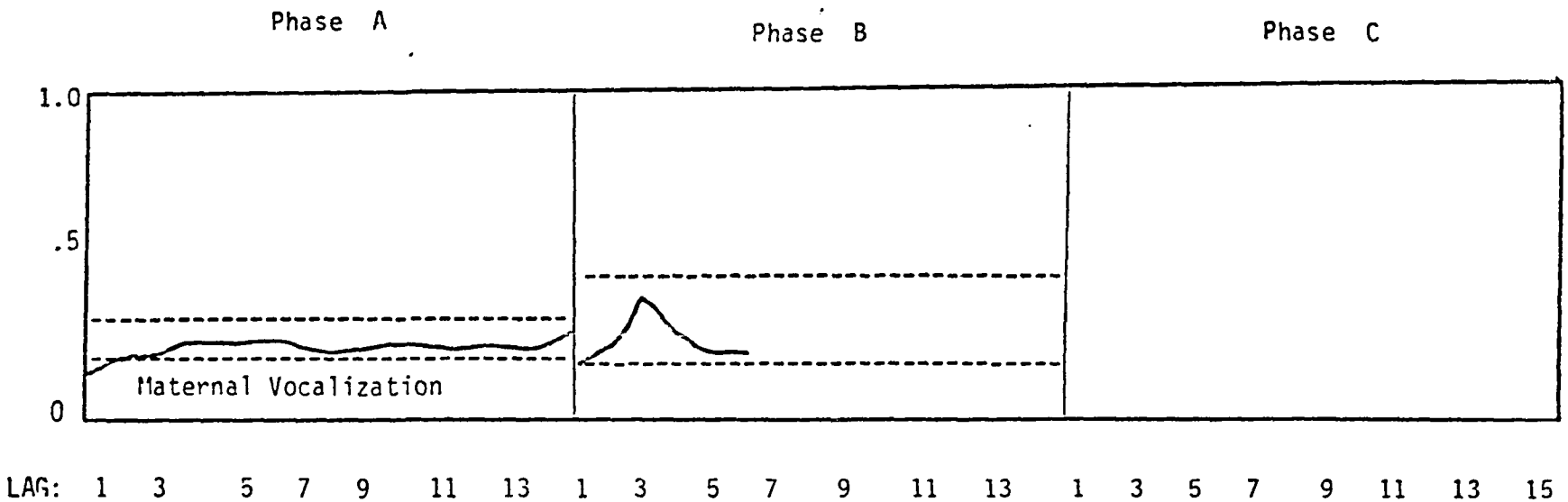


Fig. 28. EFFECT OF INFANT REACH FOR TOY ON SELECTED MATERNAL BEHAVIORS: PAIR C



CONDITIONAL PROBABILITIES (P_0) WITH 99.9% CONFIDENCE INTERVALS

Pair D

Infant D was 2 1/2 yrs old at the initiation of the project. Her vision had improved over the previous two months from light perception only to visual tracking of objects held within arm's length. Although she continually scanned her surroundings, she was not particularly attentive to ongoing interactions. She was the most severely involved of the subjects in terms of concomitant handicaps, suffering from hypertonicity of all limbs, hypotonicity of the trunk, and microcephaly. She could not sit unsupported and did not put herself into a crawling position. An extremely sociable infant in the home, she would roll all around the house, apparently following the voices of her parents and younger siblings. She seemed to understand several words, she imitated some one-syllable vocalizations, and occasionally said "mama" if very upset. She would indicate her desire for an activity to continue through whole-body movements. Since her vision had improved, she had started to pick up items, and she would transfer objects from hand to hand. Infant D visited the Child Study Center only once a month, and educational programs were implemented by her parents and the local school system.

Infant D's vision continued to improve over the course of this project, to the point that she would scan the whole room around her, and could visually locate a small dark bead on a dark background. She

had begun to push herself up into a crawling position and could sit unsupported in a highchair for several minutes. She had become more expressive, vocalizing loudly when frustrated. She enjoyed grabbing and pulling at her mother's hair and arms and she would turn towards her mother and bounce to indicate that she wanted to play a bouncing game. However, at 3 years of age, she remained severely delayed in all developmental areas.

Tables 23 and 24 (pp. 130 and 131) presents rates of occurrence for the originally scored behaviors. Note the incidence of Inappropriate Visual Orientation, Hold Toy, and Approach Mother for the Infant and the use of Visual Direction by the mother. Table 25 (p. 132) presents rates of occurrence for the 11 categories chosen for intensive analysis. Lag-1 transitional probabilities for infant behaviors, maternal behaviors and reciprocal Involvement States occur in Tables 26, 27 and 28, respectively (pp. 133 - 135). Figures 29 - 38 (pp. 136 - 145) display cross-contingencies among these behaviors.

The Mother's Effect on the Infant: Pair D

Maternal Tactile Behavior (see Fig. 29, p. 136). Maternal Touch occurred in 48% of total intervals, appearing in 88% and 26% of No-Toy and Toy intervals, respectively. This criterion was followed by a persistent increase in Infant Vocalizations in Phase C (P_{L1} = .182) only. Infant Smiles showed a delayed increase at 12 sec. post-criterion in Phase A (P_{L6} = .254) and an immediate persistent increase in Phase C (P_{L1} = .524). Infant Gestures increased persistently following Maternal

Touch in Phase A (P_{L1} = .114) and at 12 sec. post-criterion in Phase B (P_{L6} = .121), with no effect in Phase C. Infant Toy Manipulation decreased following this criterion in Phase A (P_{L1} = .175), but showed cyclical increase in Phase B, and a decrease across seconds 1 - 10 in the lag-5 profile for Phase C (P_{L1-5} = .122). Infant Reach for Toy showed cyclical decreases post-criterion in Phase A (P_{L1} = .143), a transitory increase at 30 sec. post-criterion in Phase B (P_{L15} = .162), but could not be assessed in Phase C.

Maternal Auditory/Vocal Behavior (see Fig. 30, p. 137). Maternal Vocalizations occurred in an average of 72% of No-Toy intervals and 27% of Toy intervals. In Phase A, Maternal Vocalizations were followed by immediate and transitory increases in Infant Vocalizations (P_{L1} = .089) and Infant Smile (P_{L1} = .276) and persistent increases in Infant Gesture (P_{L1} = .160) and Infant Manipulate Toy (P_{L1} = .460). Infant Reach for Toy showed decreases at 8 and 18 sec. post-criterion (P_{L4} = .121) and Infant Nonvocal Sounds increased at 24 sec. post-criterion in this Phase. In Phase B, the apparent effects of Maternal Vocalizations were attenuated, with a transitory increase in Infant Smile (P_{L1} = .303) being the only immediate consequence. Infant Vocalizations showed decreased frequencies at 8 and 22 sec. post-criterion, and Infant Gestures showed a transitory increase at 8 sec. and a persistent increase commencing at 14 sec. post-criterion in Phase B. Infant Low-Involvement states showed sustained increases in Phases A and B following Maternal Vocalizations (P_{L1} = .356 in Phase A; P_{L2} = .477 in Phase

B). In Phase C, no clear relationships between Maternal Vocalizations and infant behaviors appeared.

Maternal Auditory/Nonvocal Behavior (see Fig. 31, p. 138). Maternal Nonvocal Sounds occurred in 27%, 61% and 45% of Toy intervals in Phases A, B and C, respectively. In Phase A, this criterion was followed by a persistent decrease in Infant Nonvocal Sound (P_{L1} = .086), which appeared cyclical in the lag-5 profile and a concomitant decrease in Toy Manipulation (P_{L1} = .095). In Phase B, both of these infant behaviors showed immediate but transitory depressions following Maternal Nonvocal Sounds (P_{L1} = .133 for Infant Nonvocal Sound; P_{L1} = .148 for Infant Manipulate Toy). In Phase C, instances of Infant Toy Manipulation decreased briefly following this criterion (P_{L1} = .065). In Phase A, Infant Smiles showed a delayed increase at 14 sec. post-criterion (P_{L7} = .270), but not in Phases B or C. In Phase C, Infant Reach for Toy showed an immediate transitory enhancement (P_{L1} = .194) following Maternal Nonvocal Sounds. Given this infant's visual abilities, it is unclear whether this relationship demonstrates a true reach to sound cue, or improved ability to visually orient to an auditory stimulus followed by visually guided reaching.

Maternal Low-Involvement (see Fig. 32, p. 139). Maternal Low-Involvement states occurred in an average of 14% of Toy sequences and 2% of No-Toy sequences. In Phase A, Infant Vocalizations showed a cyclical pattern of depressions following this criterion, at 6 and 24 sec. post-criterion (P_{L3} = .023). In Phase C, the lag-5 profile showed sustained

decreases in Infant Vocalizations following this state (P_{L1-5} = .013).

Maternal High-Involvement (see Fig. 32, p.139). Maternal High-Involvement states occurred in 27% of intervals across all Phases. This criterion was followed by a decrease in Infant Vocalizations at 22 sec. in Phase B (P_{L11} = .023), but by persistent increases in Infant Vocalizations at 4 sec. in Phase C (P_{L2} = .194). In Phase A, this Maternal state preceeded a sustained increase in Infant Low-Involvement states (P_{L1} = .444); in Phase B a similar increase occurred commencing 12 sec. post-criterion (P_{L6} = .489), while no relationship between these behaviors appeared in Phase C.

The Effect of the Infant on the Mother: Pair D

Infant Auditory/Nonvocal Behavior (see Fig. 33, pp. 140). Infant D produced Nonvocal Sounds in an average 26% of Toy intervals. Following this criterion, Maternal Touch was depressed in Phases A (P_{L1} = .104) and C (P_{L1} = .024) with the lag-5 profile in Phase C showing a cyclical pattern of depressions. In Phase B, however, this criterion preceeded a cyclical increase in Maternal Touch, commencing at 10 sec. post-criterion (P_{L5} = .373). In Phases A and B, Maternal Nonvocal Sounds showed cyclical depressions following Infant Nonvocal Sounds (P_{L1} = .063 in Phase A; P_{L1} = .204 in Phase B), while in Phase C, an immediate but transitory depression occurred (P_{L1} = .286).

Infant Auditory/Vocal Behavior (see Fig. 34, p. 141). Infant Vocalizations occurred in 6%, 9% and 11% of intervals in Phases A, B and

C, respectively. In Phase B, the raw frequency of Vocalizations was too low to analyze. In both Phases A and C, Infant Vocalizations were followed by persistent increases in Maternal Touch (P_{L1} = .622 for Phase A; P_{L1} = .813 for Phase B), and immediate increases in Maternal Vocalizations (P_{L1} = .490 for Phase A; P_{L1} = .750 for Phase C).

Infant Positive Facial Expressions (see Fig. 35, p. 142). Infant Smiles occurred in an average 27% of intervals across all Phases. Infant Smiles were followed by delayed increases in Maternal Touch in Phases A and B (P_{L7} = .629 in Phase A; P_{L6} = .536 in Phase B), while in Phase C, there was an immediate increase in Maternal Touch (P_{L1} = .685) following this criterion. Phases A and B showed immediate increases in Maternal Vocalizations following this criterion (P_{L1} = .469 in Phase A; P_{L1} = .368 in Phase B). Maternal Nonvocal Sounds displayed completely different lag profiles for each of the three Phases. In Phase A, an immediate decrease in this maternal activity was followed by a sustained increase (P_{L5} = .408). Phase B showed cyclical depressions (P_{L1} = .351), while Phase C showed no clear relationship between Maternal Nonvocal Sound and this criterion.

Infant Spontaneous Manual Gesture (see Fig. 36, p. 143). Infant Gestures appeared in a mean of 10% of total intervals. This criterion was followed by increases in Maternal Touch in Phases A (P_{L1} = .731) and B (P_{L15} = .580), but not in Phase C. Maternal Vocalizations increased following this criterion in all Phases (P_{L1} = .673 in Phase A; $P_{L1\text{-}5}$ = .380 in Phase B; P_{L1} = .762 in Phase C).

Infant Manipulate Toy (see Fig. 37, p. 144). Toy Manipulation occurred in 43%, 32% and 25% of Toy sequences in Phases A, B and C, respectively. In Phase A, this criterion was followed by a sustained decrease in Maternal Touch (P_{L1} = .143) and cyclical decreases in Maternal Nonvocal Sounds (P_{L1} = .099). In Phase B, Infant Toy Manipulation was followed by cyclical increases in Maternal Touch, commencing 14 sec. post-criterion (P_{L7} = .358), and cyclical decreases in Maternal Nonvocal Sounds (P_{L1} = .322). In Phase C, Infant Toy Manipulation preceeded an immediate decrease in Maternal Touch (P_{L1-5} = .067) in the lag5 profile.

Infant Reach for Toy (see Fig. 38, p. 145). Infant D reached for toys in an average 13% of Toy sequences. In Phase A, this criterion was followed by cyclical decreases in Maternal Vocalizations commencing at 10 sec. post-criterion (P_{L5} = .089). No relationship between these behaviors appeared in the lag-5 profiles for Phases B or C.

Infant Low-Involvement (see Fig. 32, p. 139). Infant Low-Involvement states occurred in an average 30% of all intervals. In Phase A, this state preceeded a persistent increase in Maternal High-Involvement states (P_{L1} = .434). In Phase C, this criterion was followed by a transitory decrease in Maternal High-Involvement states (P_{L1} = .254), while no relationship appeared in Phase B.

Concurrent Vocalizations: Pair D

Concurrent Vocalization occurred in only 3%, 2% and 8% of Phase A, B and C intervals, respectively. This bheavior could only be analysed in Phase C, where it did not show cyclicity.

Data Summary: Pair D

Infant D, for all her handicaps, was a sociable, curious, active infant. She produced a relatively high rate of spontaneous gestures and smiles. Her mouth opened frequently as she gestured, but her rate of vocalization was rather low, and those vocalizations she did produce were very gross, apparently severely impeded by her spasticity. These expressive behaviors showed small overall increases in rate across the three Phases. While manipulative skills did not show significant improvement, visual tracking, scanning of the environment and visually guided locomotion did increase considerably. However, the visual regard skills normally found in interpersonal exchanges were not well developed. While Infant D's responsiveness to Maternal Touch increased by Phase C, with a higher rate of Vocalizations and Smiles, the gestural response to this Maternal behavior, which had been evident in Phase A, disappeared by Phase C. Similarly, a diverse repertoire of expressive responses to Maternal Vocalizations found in Phase A seemed to deteriorate completely by Phase C. Maternal Nonvocal Sounds were followed by immediate Reach for Toy in Phase C, but it is unclear whether this reflects ear-hand coordination, or visual attention to an auditory cue followed by visually guided reaching. Infant D's rate of Vocalization decreased following Maternal Low-Involvement states. Following Maternal High-Involvement states (which in early Phases had preceded increases in Infant Low-Involvement), Infant D's Vocalizations occurred at higher frequencies in Phase C.

Mother D seemed to become more and more actively involved with her infant as her sight improved, spending less time in noninvolved states. In the Toy sequences of Phases B and C, she spent approximately 50% of the time engaged in Visual Direction, either alone or in combination with other behaviors. Mother D's rate of Tactile Stimulation was quite high, no doubt affected by her infant's inability to support herself in an upright position. Although the rate of Maternal Vocalizations was relatively low, this mother was generally very responsive to her Infant. Infant Vocalizations were followed by Maternal Touch and Vocalization; Smiles were followed by Vocalizations and an increasingly rapid onset of Tactile responses. Infant Gestures were followed by Maternal Vocalizations. Mother D demonstrated progressive acceptance or perhaps acquiescence to her infant's Low-Involvement states. Whereas in Phase A (see Table 28, p.135), Infant Low-Involvement states were followed by increased High-Involvement by the mother, there was no relationship between these behaviors in Phase B, and in Phase C, Maternal High-Involvement actually decreased following Infant Low-Involvement. Concurrent Vocalizations did not occur frequently enough to permit analysis, the infant's vocalization rate being very low.

Infant D seemed to be operating on an illocutionary level, possessing the communicative substrate required for language according to pragmatic theory. She had a repertoire of expressive behaviors, social-interactive skills and rudimentary turn-taking skills. She could signal her desire for continuation of an activity, and would even extend her

arm in the direction of an interesting object. She also had a small receptive vocabulary. Her behavior was highly intentional, and she acted on both the animate and inanimate environment. As a pair, this infant and mother were mutually very responsive. Infant D should have been ripe for the transition from illocutionary to locutionary behavior. Her concomitant handicaps may prevent her from making this transition, however.

Table 23. RAW DATA: PROPORTION OF INTERVALS CONTAINING EACH BEHAVIOR FOR INFANT D

	PHASE A			PHASE B			PHASE C		
	No Toys	Toys	Total	No Toys	Toys	Total	No Toys	Toys	Total
INFANT BEHAVIORS									
Nonvocal Sound	.02	.22	.15	.00	.26	.20	.01	.31	.16
Linguistic Vocalization	.00	.00	.00	.00	.00	.00	.00	.00	.00
Nonlinguistic Vocalization	.05	.06	.05	.08	.10	.09	.19	.04	.11
Vocal Imitation of Mother	.00	.00	.00	.00	.00	.00	.00	.00	.00
Head Gesture	.00	.00	.00	.00	.00	.00	.00	.00	.00
Inappropriate Visual Orientation	.69	.58	.61	.74	.44	.52	.63	.29	.46
Positive Facial Expression(Smile)	.23	.19	.20	.28	.17	.20	.47	.32	.40
Negative Facial Expression	.01	.01	.01	.01	.00	.00	.00	.00	.00
Spontaneous Manual Gesture	.17	.03	.08	.13	.05	.07	.15	.15	.15
Explore Space	.00	.00	.00	.00	.00	.00	.00	.00	.00
Elicited Manual Gesture	.00	.00	.00	.00	.00	.00	.00	.00	.00
Reach for Mother	.02	.00	.01	.01	.00	.00	.09	.07	.08
Reach for Toy	.00	.20	.13	.00	.08	.06	.01	.12	.06
Release Mother	.00	.00	.00	.00	.00	.00	.01	.01	.01
Release Toy	.00	.03	.02	.00	.00	.00	.00	.01	.00
Explore Mother	.01	.00	.00	.00	.00	.00	.00	.00	.00
Explore Toy	.00	.02	.01	.00	.00	.00	.00	.00	.00
Manipulate Mother	.00	.00	.00	.00	.00	.00	.05	.04	.05
Manipulate Toy	.00	.43	.28	.00	.32	.24	.00	.25	.12
Hold Mother	.07	.00	.02	.03	.00	.01	.02	.03	.02
Hold Toy	.00	.13	.09	.00	.15	.12	.01	.05	.03
Withdraw Hand from Mother	.00	.00	.00	.00	.00	.00	.00	.00	.00
Withdraw Hand from Toy	.00	.00	.00	.00	.00	.00	.00	.00	.00
Push Away Mother	.00	.00	.00	.00	.00	.00	.00	.00	.00
Touch Self	.07	.09	.08	.11	.05	.06	.01	.06	.04
Hand: Other/Nothing	.68	.19	.35	.75	.39	.48	.69	.31	.50
Approach Mother	.00	.00	.00	.04	.00	.01	.15	.12	.14
Avoid Mother	.00	.00	.00	.00	.00	.00	.00	.00	.00
Toy Stereotypy	.00	.01	.01	.00	.00	.00	.00	.00	.00
Body Stereotypy	.00	.00	.00	.00	.00	.00	.00	.00	.00
Self-Abusive Stereotypy	.00	.00	.00	.00	.00	.00	.00	.00	.00

Table 24. RAW DATA: PROPORTION OF INTERVALS CONTAINING EACH BEHAVIOR FOR MOTHER D

	PHASE A			PHASE B			PHASE C		
MATERNAL BEHAVIORS	No Toys	Toys	Total	No Toys	Toys	Total	No Toys	Toys	Total
Caress	.17	.01	.06	.13	.02	.05	.32	.00	.16
Restrain	.00	.00	.00	.00	.00	.00	.00	.00	.00
Tactile Direction	.78	.35	.49	.73	.21	.34	.50	.20	.35
Visual Direction	.00	.24	.16	.00	.58	.44	.08	.50	.29
Positive Linguistic Vocalization	.00	.00	.00	.00	.00	.00	.03	.02	.02
Negative Linguistic Vocalization	.00	.00	.00	.00	.00	.00	.00	.01	.00
Other Linguistic Vocalization	.72	.13	.33	.70	.06	.22	.54	.53	.53
Nonlinguistic Vocalization	.02	.02	.02	.01	.01	.01	.15	.03	.09
Vocal Imitation of Infant	.00	.00	.00	.00	.00	.00	.00	.00	.00
Nonvocal Sound	.01	.27	.18	.04	.61	.46	.13	.45	.29

Table 25. BEHAVIOR CATEGORIES SELECTED FOR LAGS ANALYSES: PAIR D
(PROPORTION OF INTERVALS CONTAINING EACH BEHAVIOR CATEGORY)

	Phase A			Phase B			Phase C		
	No Toy	Toy	Total	No Toy	Toy	Total	No Toy	Toy	Total
INFANT BEHAVIORS:									
Nonvocal Sound	.02	.22	.15	.00	.26	.20	.01	.31	.16
Vocalization	.05	.06	.06	.08	.10	.09	.19	.04	.11
Positive Facial (Smile)	.23	.19	.20	.28	.17	.20	.47	.32	.40
Manual Gesture	.17	.03	.08	.13	.05	.07	.15	.15	.15
Manipulate Toy	.00	.43	.28	.00	.32	.24	.00	.25	.12
Reach for Toy	.00	.20	.13	.00	.08	.06	.01	.12	.06
Low-Involvement State	.53	.14	.27	.45	.36	.38	.23	.23	.23
MATERNAL BEHAVIORS:									
Tactile	.95	.36	.55	.86	.23	.39	.82	.20	.51
Vocalization	.74	.15	.35	.71	.07	.23	.72	.59	.64
Nonvocal Sound	.01	.27	.18	.04	.61	.46	.13	.45	.29
Low-Involvement State	.00	.30	.20	.03	.11	.09	.02	.12	.07
High Involvement State			.26			.17			.37

Table 26. PAIR D: THE MOTHER'S EFFECT ON THE INFANT

	MOTHER'S BEHAVIOR AT INTERVAL X-1 \ P_0: INFANT'S BEHAVIOR AT INTERVAL X	Auditory Nonvocal	Auditory Vocal	Positive Facial	Manual Gesture	Manipulate Toy	Reach for Toy
PHASE A	Tactile		.067	.214	.114 +	.175 -	.143 -
	Auditory/Vocal	.254	.089 +	.276 +	.160 +	.460 +	.159
	Auditory/Nonvocal	.086 -	.034	.164	----	.095 -	.216
PHASE B	Tactile		.065	.241	.111 +	.313	.042
	Auditory/Vocal	$.200_{1-5}$	.061	.303 +	.091	$.253_{1-5}$	$.040_{1-5}$
	Auditory/Nonvocal	.133 -	.086	.102 -	.047	.148 -	.063
PHASE C	Tactile		.182 +	.524 +	.182	$.122_{1-5}$ -	$.076_{1-5}$
	Auditory/Vocal	.284	.122	.431	.127	.185	.074
	Auditory/Nonvocal	.210	----	.306	.177	.065 -	.194 +

P_0 = Observed Probability

+ = $P_0 > P_E$, $p \leq .001$

- = $P_0 < P_E$, $p \leq .001$

---- = Insufficient observations for analysis.

Table 27.

PAIR D: THE INFANT'S EFFECT ON THE MOTHER

		P_0: MOTHER'S BEHAVIOR AT INTERVAL X		
INFANT'S BEHAVIOR AT INTERVAL X-1		Tactile	Auditory Vocal	Auditory Nonvocal
PHASE A	Auditory/Nonvocal	.104 -		.063 -
	Auditory/Vocal	.622 +	.490 +	----
	Positive Facial	.547	.469 +	.192 -
	Manual Gesture	.731 +	.673 +	
	Manipulate Toy	.143 -	.149	.099 -
	Reach for Toy		.181	
PHASE B	Auditory/Nonvocal	.204		.204
	Auditory/Vocal	----	----	----
	Positive Facial	.439	.368 +	.351 -
	Manual Gesture	$.580_{1-5}^{+}$	$.380_{1-5}^{+}$	
	Manipulate Toy	.271	.068	.322 -
	Reach for Toy		$.129_{1-5}^{+}$	
PHASE C	Auditory/Nonvocal	.024 -		.286 -
	Auditory/Vocal	.813 +	.750 +	----
	Positive Facial	.685 +	.739 +	.361
	Manual Gesture	.571	.762 +	
	Manipulate Toy	$.067_{1-5}^{-}$	----	$.378_{1-5}$
	Reach for Toy		----	

P_0 = Observed Probability

+ = $P_0 > P_E$, $p \leq .001$

- = $P_0 < P_E$, $p \leq .001$

---- = Insufficient observations for analysis.

Table 28. PAIR D: STATES OF INVOLVEMENT

PHASE A

Mother's State at Interval X-1:	P_0: Infant's State at Interval X: Low-Involvement	Vocalization
Low-Involvement		.053
High-Involvement	.444 +	.076
Vocalization	.356 +	

Infant's State at Interval X-1:	P_0: Mother's State at Interval X: High-Involvement
Low-Involvement	.434 +

PHASE B

Mother's State at Interval X-1:		
Low-Involvement		$.129_{1-5}$ +
High-Involvement	.396	.042 -
Vocalization	.439	

Infant's State at Interval X-1:	
Low-Involvement	.151

PHASE C

Mother's State at Interval X-1:		
Low-Involvement		$.013_{1-5}$ -
High-Involvement	.181	.171
Vocalization	.215	

Infant's State at Interval X-1:	
Low-Involvement	.254 -

P_0 = Observed Probability

+ = $P_0 > P_E$, $p \leq .001$

P - = $P_0 < P_E$, $p \leq .001$

---- = Insufficient observations

Fig. 29. EFFECT OF MATERNAL TOUCH ON SELECTED INFANT BEHAVIORS: PAIR D

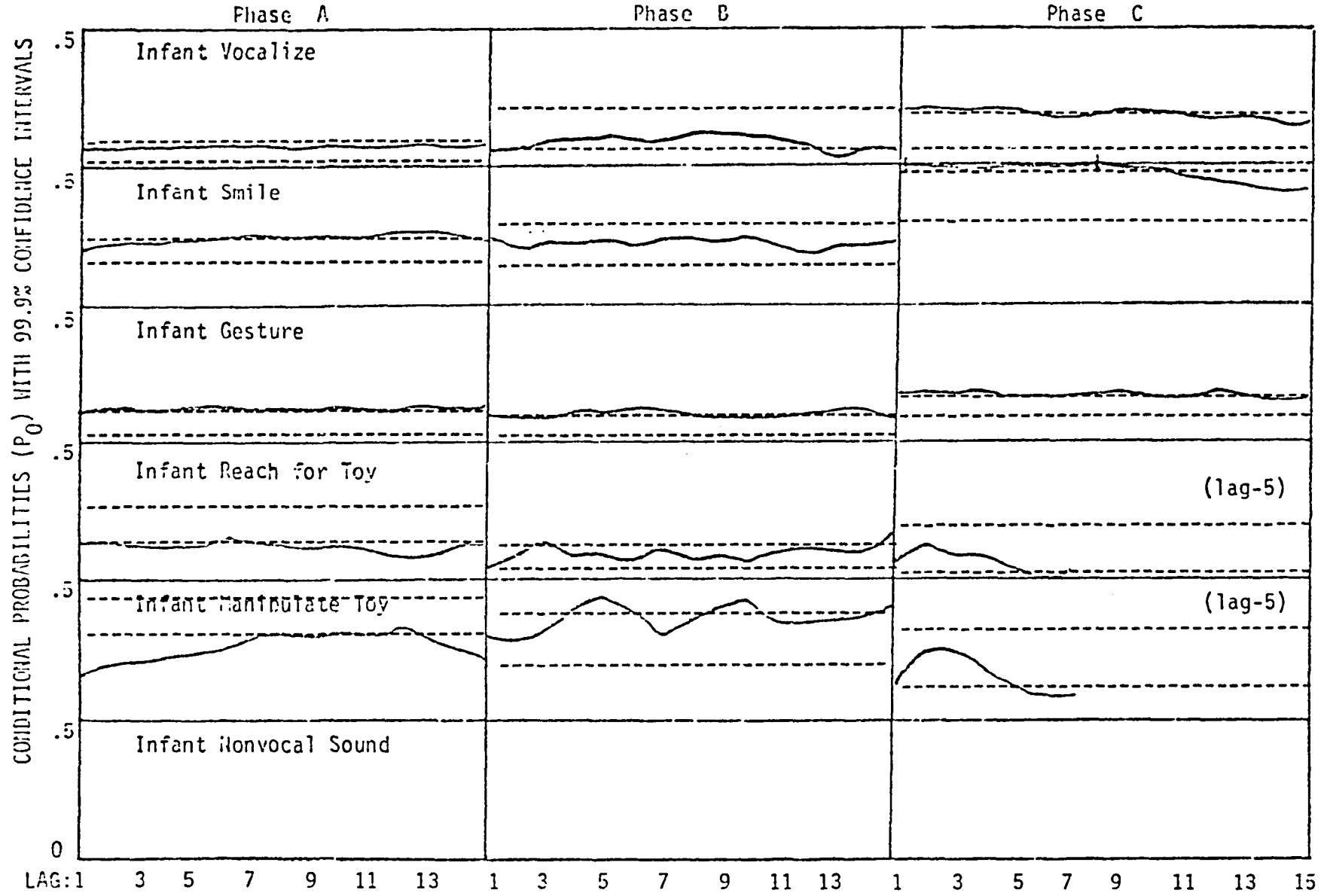


Fig. 30. EFFECT OF MATERNAL VOCALIZATION ON SELECTED INFANT BEHAVIORS: PAIR D

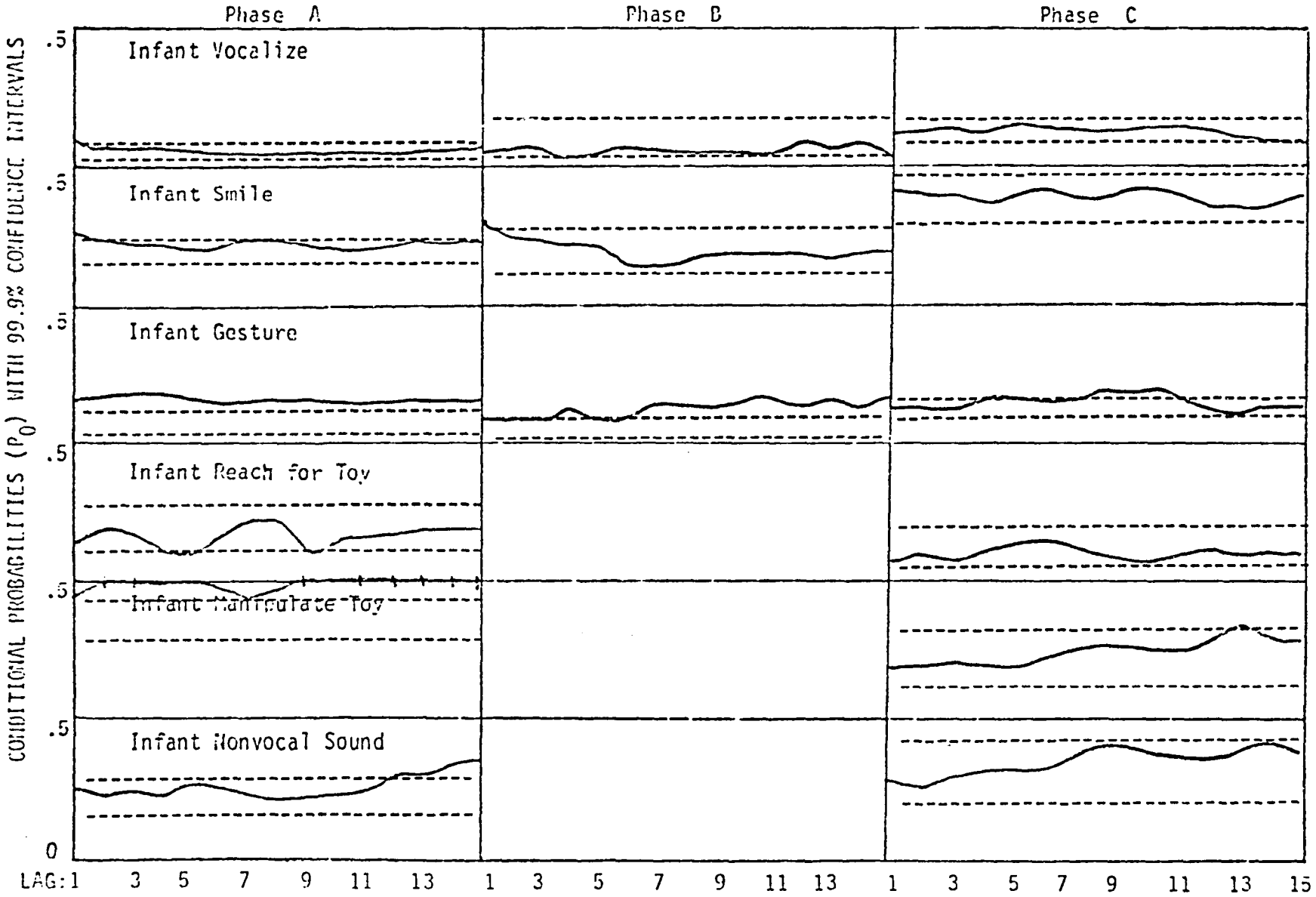


Fig. 31. EFFECT OF MATERNAL NONVOCAL SOUND ON SELECTED INFANT BEHAVIORS: PAIR D

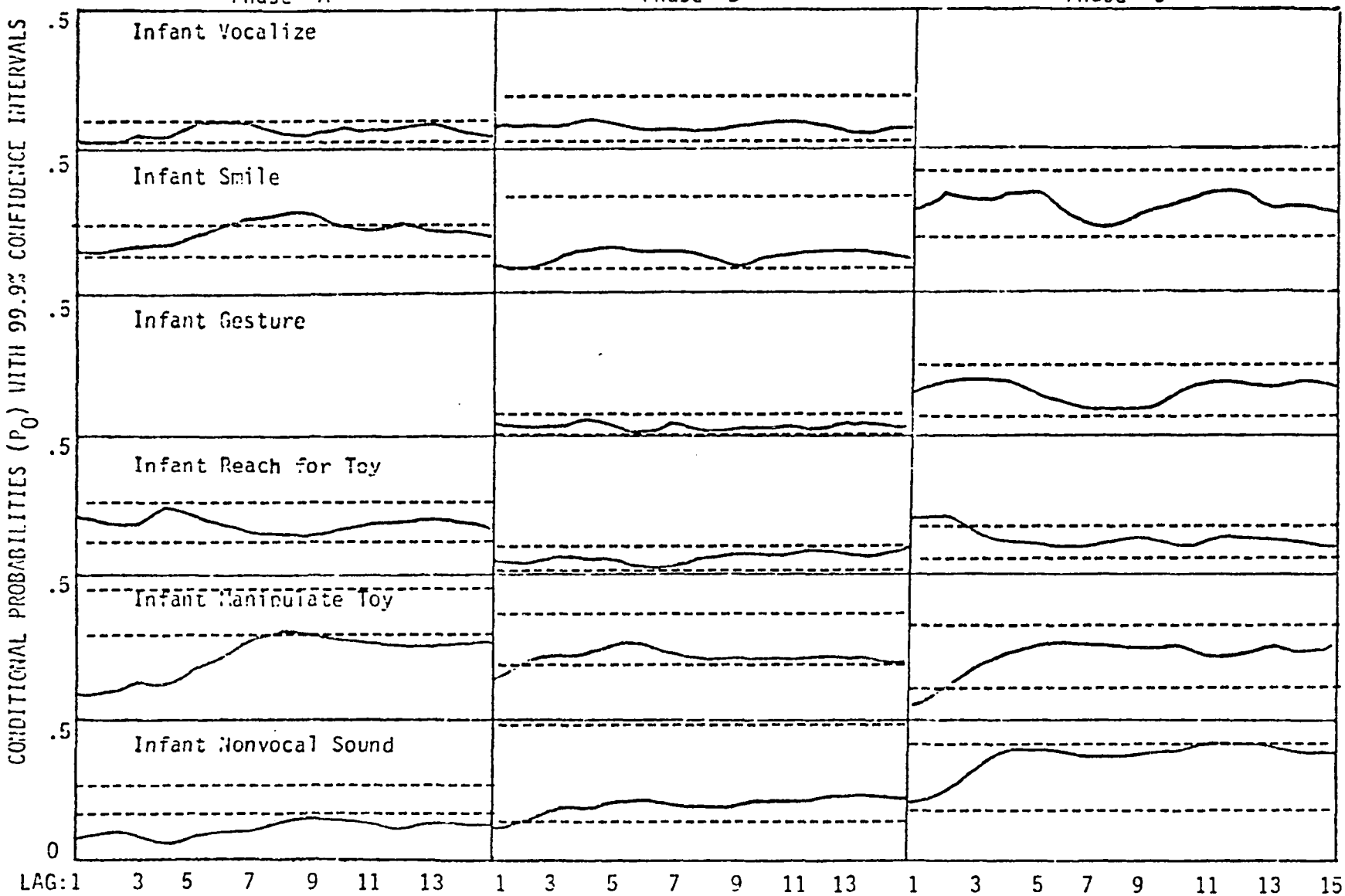


Fig. 32. STATES OF INVOLVEMENT: PAIR D

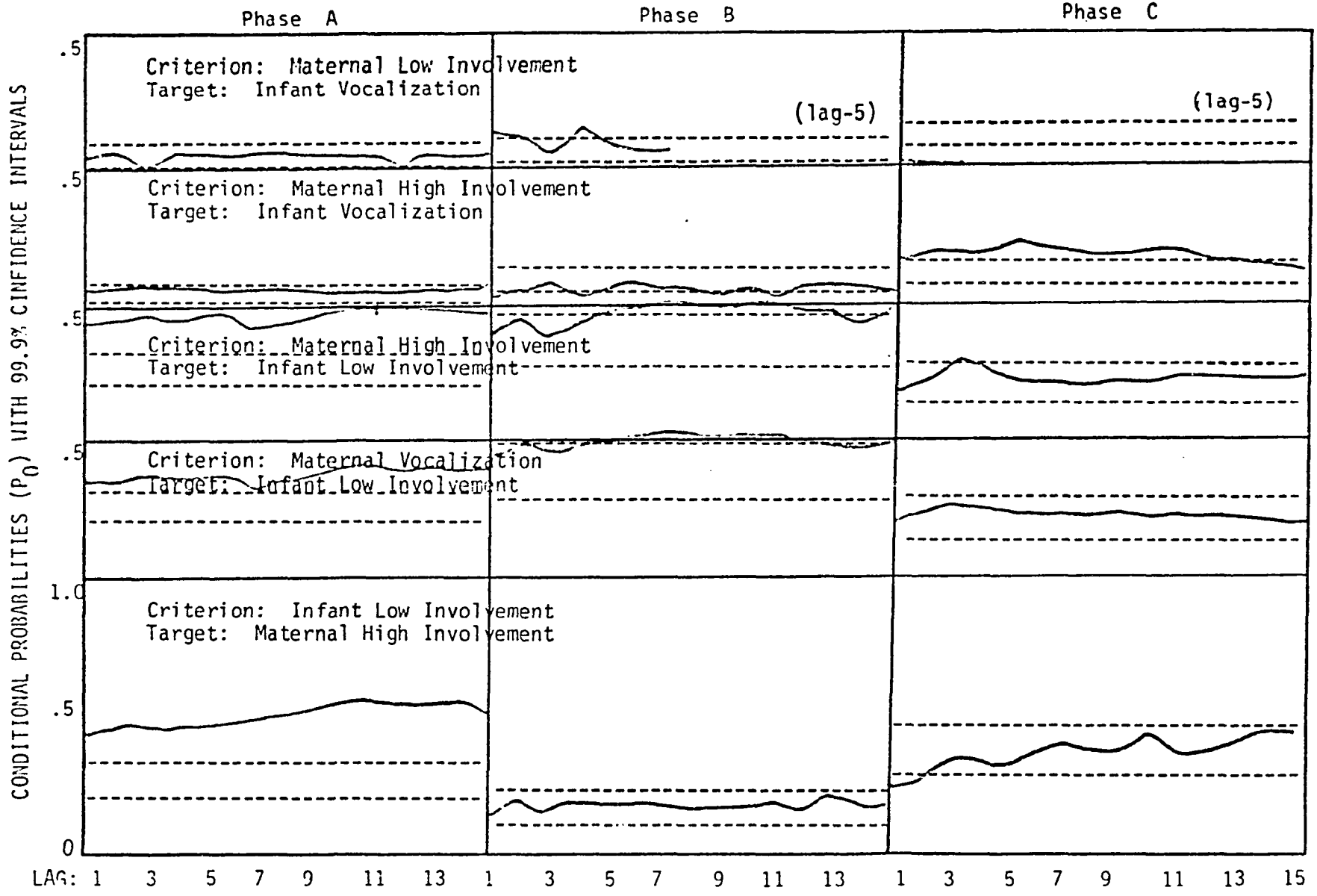
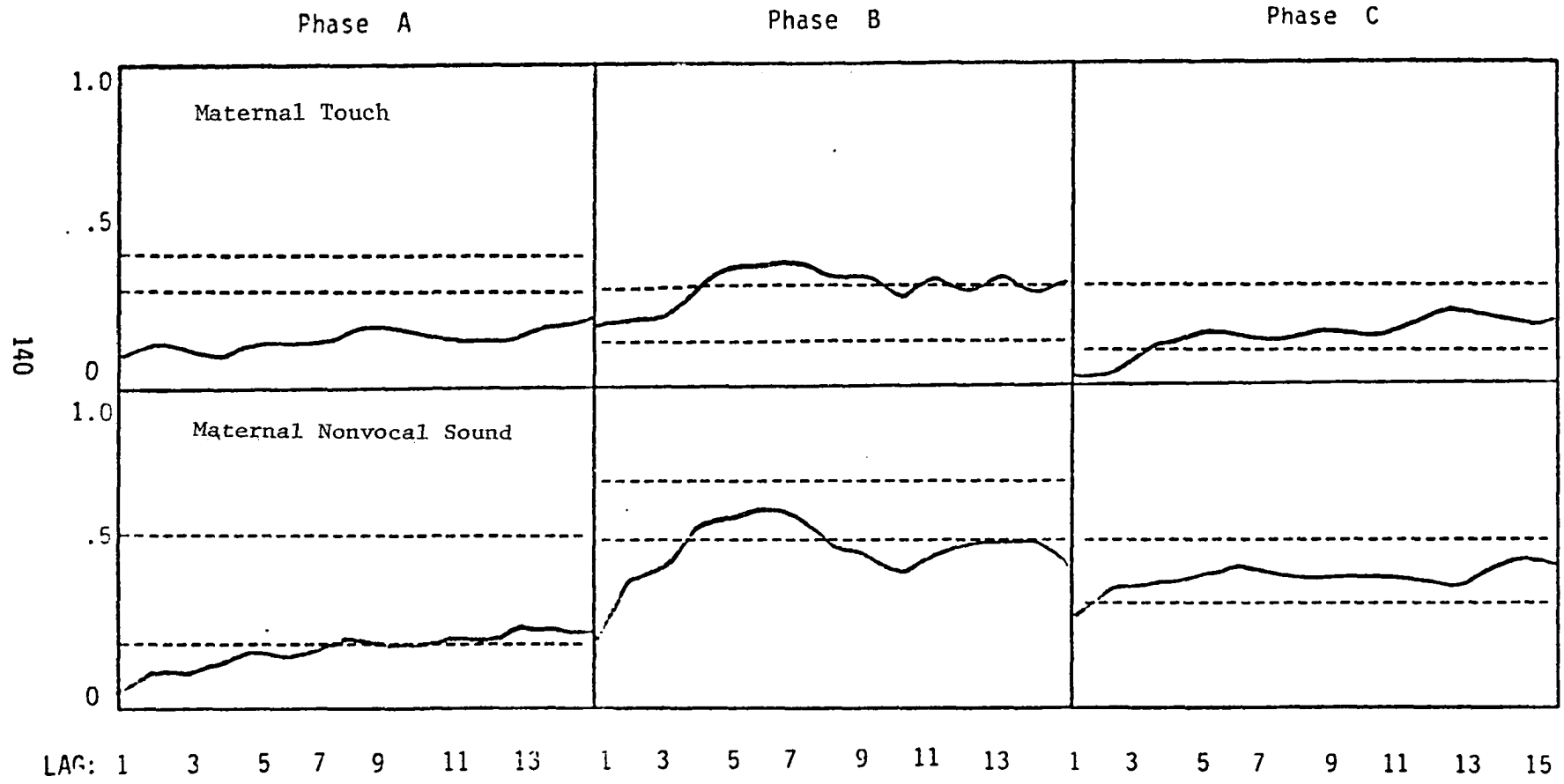


Fig. 33. EFFECT OF INFANT NONVOCAL SOUND ON SELECTED MATERNAL BEHAVIORS: PAIR D



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CONDITIONAL PROBABILITIES (P_0) WITH 99.9% CONFIDENCE INTERVALS

Fig. 34. EFFECT OF INFANT VOCALIZATION ON SELECTED MATERNAL BEHAVIORS: PAIR D

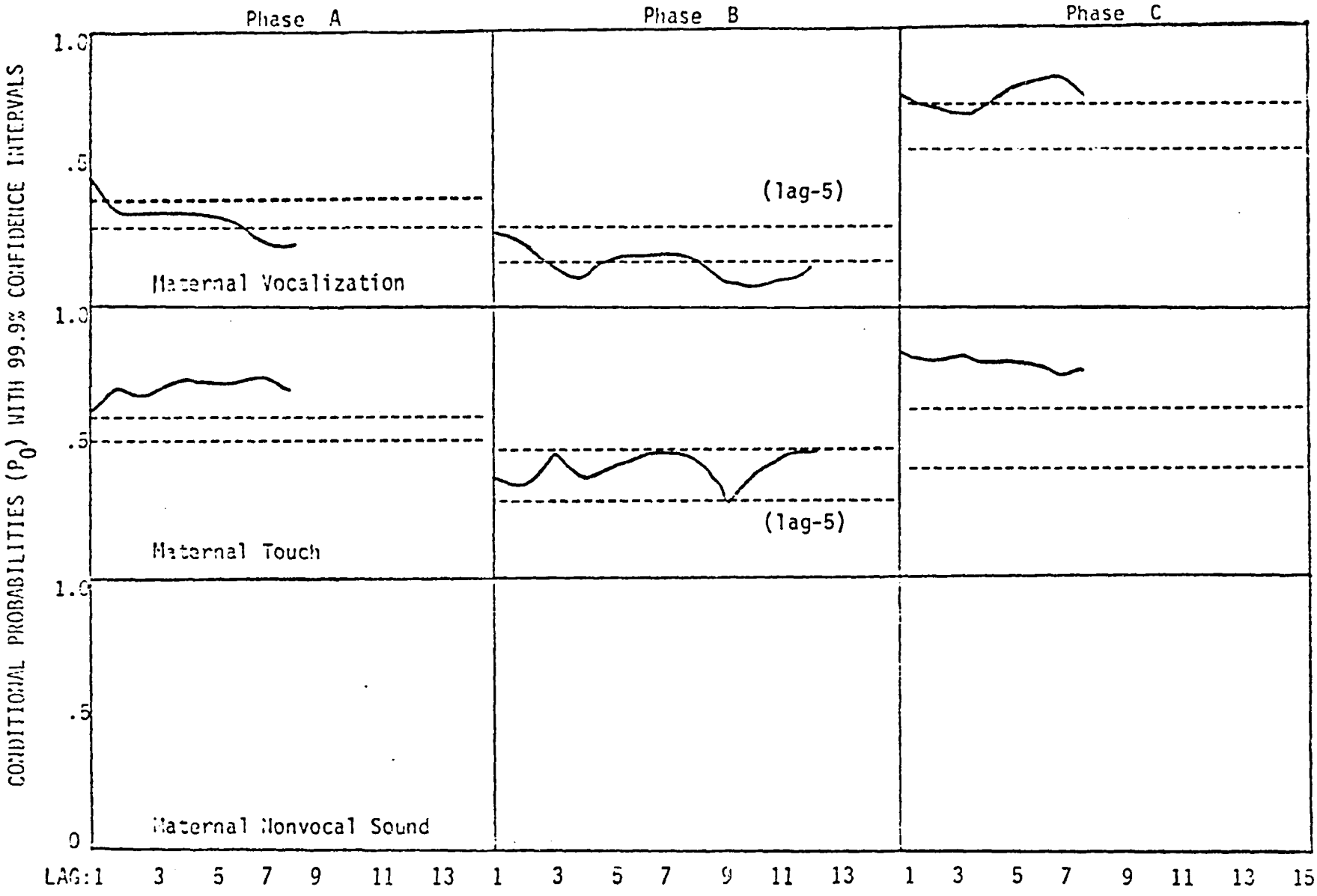


Fig. 35. EFFECT OF INFANT SMILE ON SELECTED MATERNAL BEHAVIORS: PAIR D

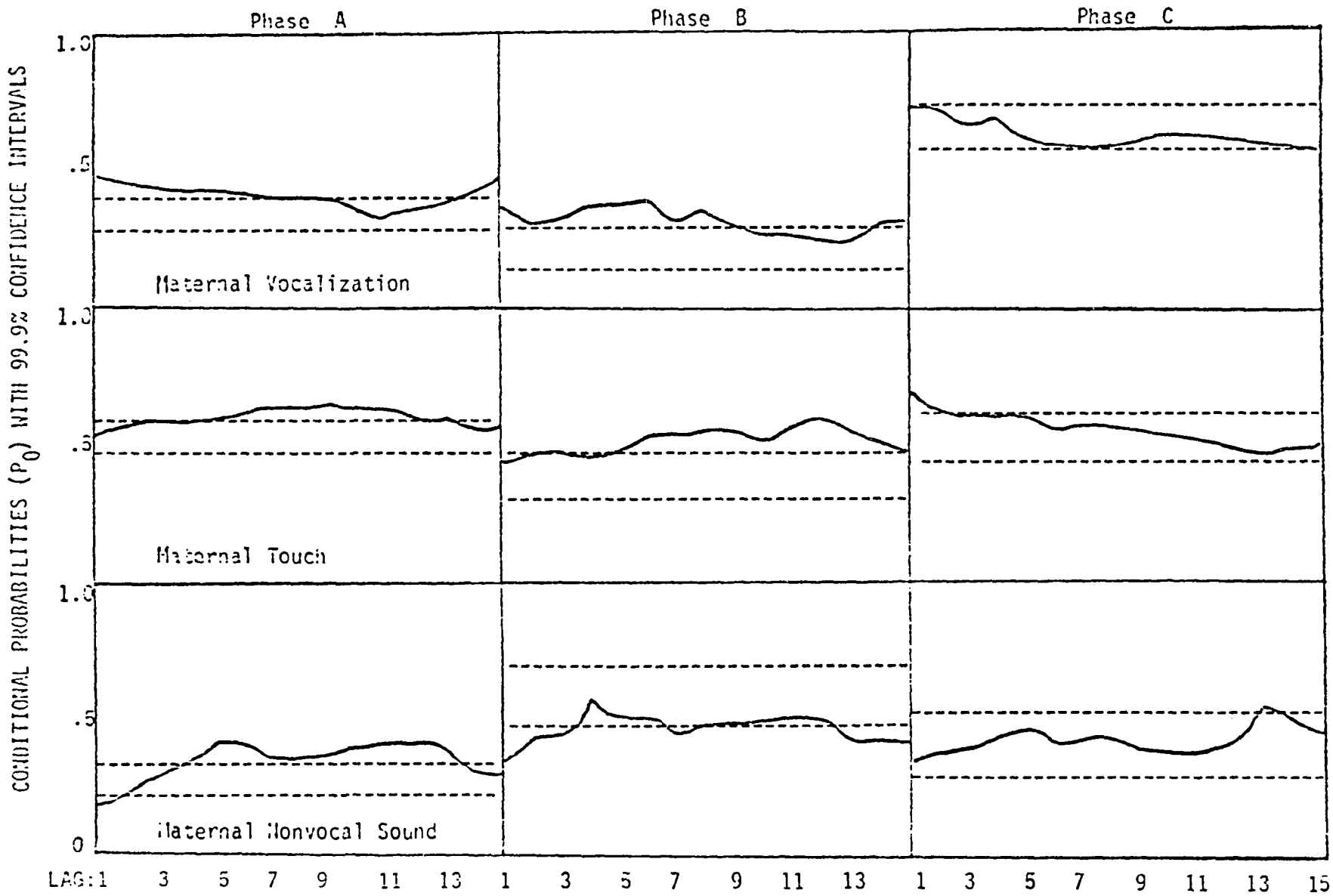
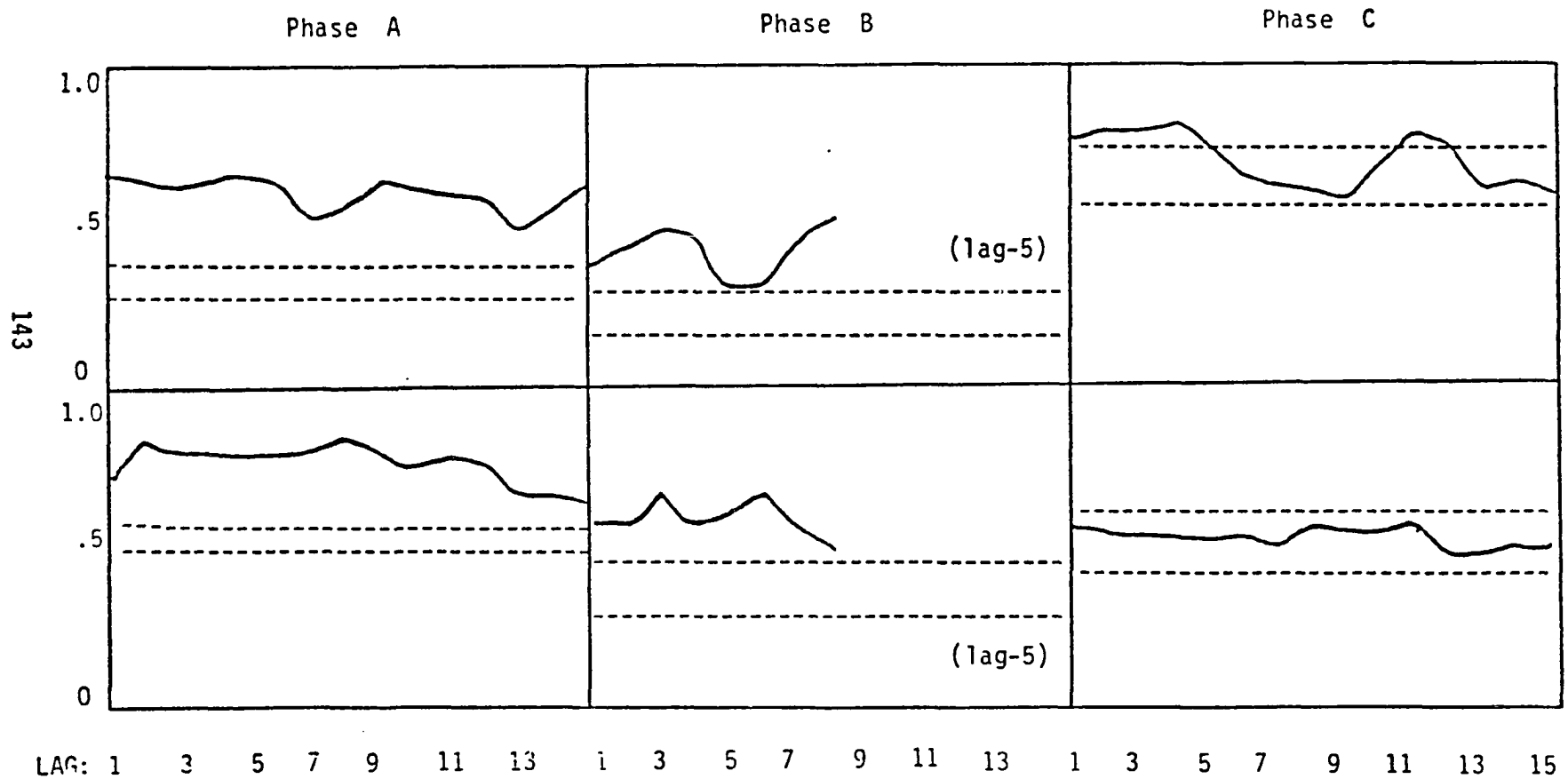


Fig. 36. EFFECT OF INFANT GESTURE ON SELECTED MATERNAL BEHAVIORS: PAIR D



CONDITIONAL PROBABILITIES (P_0) WITH 99.9% CONFIDENCE INTERVALS

Fig. 37. EFFECT IF INFANT MANIPULATE TOY ON SELECTED MATERNAL BEHAVIORS: PAIR D

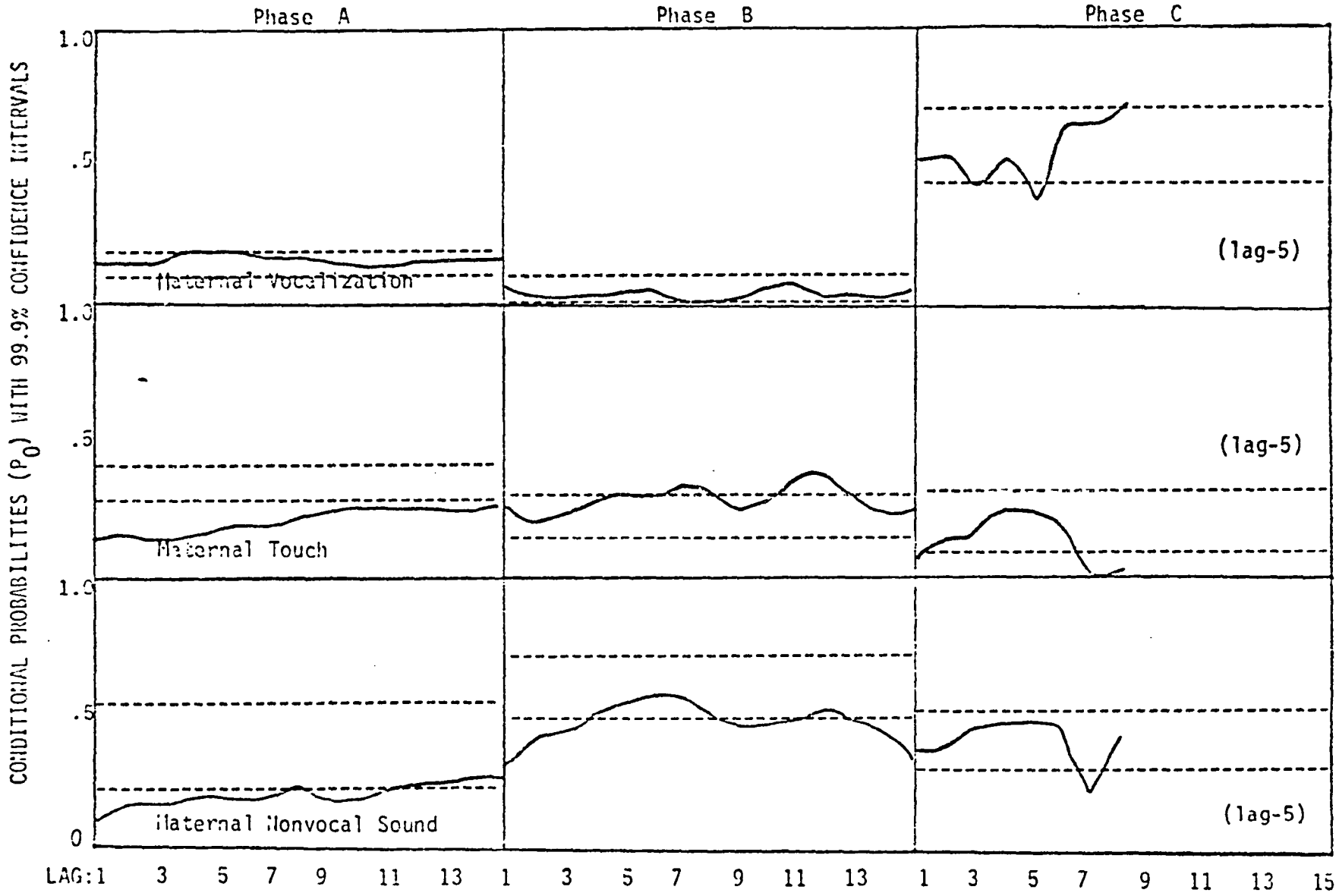
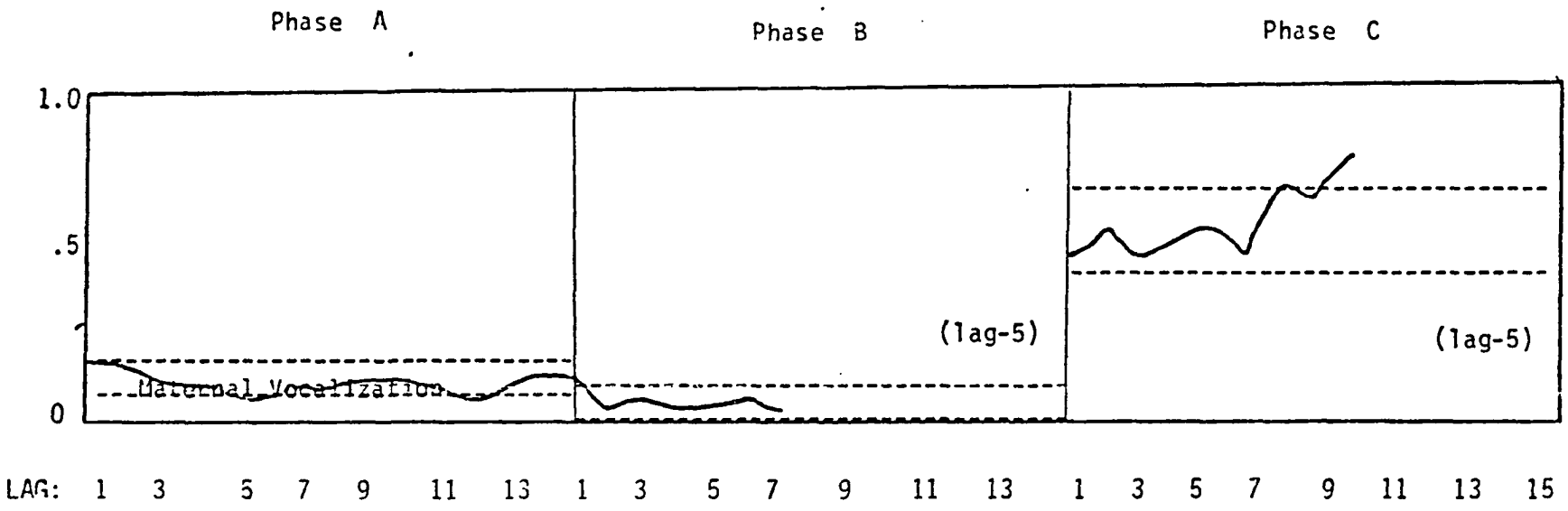


Fig. 38. EFFECT OF INFANT REACH FOR TOY ON SELECTED MATERNAL BEHAVIORS: PAIR D



CONDITIONAL PROBABILITIES (P_0) WITH 99.9% CONFIDENCE INTERVALS

Pair E

Infant E was 2 yrs, 8 mo. at the beginning of this project. Like Infant D, his sight had begun to improve. After a year of improvement, he could locate and track objects held as far as 4 1/2 feet away. Although he had no concomitant handicaps, he was severely delayed in all areas and demonstrated severe behavior problems. Motorically, he was capable of walking with hands held and could support himself standing in a playpen and would move around a little within the playpen. Left to his own devices, he would sit on the floor, moving around by rocking, rolling and abnormal whole-body movements, but never leaving the room he was in. He engaged in frequenc bouts of self-stimulatory stereotypic behavior, some of it self-abusive. Although Infant E used his vision very efficiently to locate objects, he would avert his eyes from objects as soon as he captured them and he did not visually explore objects. His toy play consisted almost entirely of banging objects on the floor, with no tactile exploration. His eyes were rarely fully open, and he would not return another person's gaze; indeed, he would avert his face from interactions with his parents. He produced no recognizable words spontaneously, although he would occasionally imitate sounds and words. Infant E had been seen monthly at the Child Study Center for 18 months. When first evaluated there, his developmental

delays were not severe, and his lack of progress over the ensuing two years was baffling. He occasionally demonstrated abilities with his therapists which he simply would not use at home, where he seemed to use disruptive or self-abusive behaviors very purposefully to control his parents. The only progress to be reported for this infant over the course of the project (at the end of which he was 37 mo. old) was increasing use of his vision.

Tables 29 and 30 (pp. 155 and 156) present presents rates of occurrence for the originally scored behaviors. Note the frequency of Push Away Mother, Avoid Mother, Touch Self, and all types of Stereotypy on the part of Infant E. Note also the incidence of Restraint by the Mother, which was usually prompted by the infant's stereotypic behaviors. Table 31 (p. 157) presents rates of occurrence for the 11 categories subjected to intensive analyses. Tables 32, 33 and 34 (pp. 158 - 160) present Lag-1 transitional probabilities for infant behaviors, maternal behaviors, and reciprocal States of Involvement, respectively. Figures 39 - 47 (pp. 161 - 169) display cross-contingencies for these behaviors.

The Mother's Effect on the Infant: Pair E

Maternal Tactile Behavior (see Fig. 39, p.161). Mother E touched her infant in an average 100% of No-Toy sequences, and 37% of Toy sequences. Infant Smiles showed a delayed decrease at 20 sec. post-criterion in Phase A (P_{L10} = .076); in Phase B, there was an immediate and sustained increase in Infant Smile (P_{L1} = .166); while in Phase C

there was an increase in Infant Smile 28 sec. post-criterion (P_{L14} = .178). In Phases A and B, Infant Toy Manipulation decreased post-criterion (P_{L1} = .227 in Phase A; P_{L1} = .120 in Phase B). Infant Reach for Toy decreased immediately following this criterion in Phase A (P_{L1} = .109), but increased at 8 sec. post-criterion in Phase B (P_{L4} = .290), and was unaffected in Phase C.

Maternal Auditory/Vocal Behavior (see Fig. 40, p. 162). Maternal Vocalizations occurred in a mean of 79% of No-Toy intervals and 52% of Toy intervals. Following this criterion, Infant Nonvocal Sounds decreased briefly in all three Phases (P_{L1} = 396 in Phase A; P_{L1} = .183 in Phase B; P_{L1} = .379 in Phase C). These effects were parallelled by similar decreases in Infant Toy Manipulation. Infant Reach for Toy decreased at 20 sec. post-criterion in Phase A (P_{L10} = .100), but increased at 24 sec. post-criterion in Phase B (P_{L12} = .291). In Phase A, Maternal Vocalizations preceeded an increase in the Infant Low-Involvement state (P_{L1} = .091).

Maternal Auditory/Nonvocal Behavior (see Fig. 41, p. 163). Maternal Nonvocal Sounds occurred in 17% of intervals in Toy sequences. This criterion preceeded cyclical increases and decreases in Infant Nonvocal Sounds in Phase A (P_{L2} = .632), and delayed increases in this behavior in Phase C (P_{L5} = .613). Infant Vocalizations showed a mixture of increases and decreases following this criterion in Phase A, and cyclical decreases in Phase B (P_{L1} = .118), with no effect in Phase C. Infant Smiles showed a decrease at 14 sec. post-criterion in Phase C

(P_{L7} = .041), the only Phase where they occurred frequently enough to be analyzed. The only consistent aftermath of Maternal Nonvocal Sound was an immediate increase in Infant Reaching for Toy, showing that this infant localized sound well (P_{L1} = .263 in Phase A; P_{L1} = .324 in Phase B; P_{L1} = .333 in Phase C). It is not clear, however, whether subsequent reaching was guided by auditory or visual cues. In Phase A this response was cyclical, reflecting the cyclic autocontingency of this infant behavior in that Phase. In Phase B, Infant Toy Manipulation was temporarily depressed following Maternal Nonvocal Sound (P_{L1} = .118), which would be expected, given the increase in Reach for Toy at this point.

Maternal Low-Involvement State (see Fig. 42, p. 164). Maternal Low-Involvement states occurred in 34% of Toy intervals but in none of the No-Toy intervals. The effects of this state on Infant Vocalizations were inconsistent across Phases, with cyclical increases in Phase A (P_{L1} = .552), cyclical decreases in Phase B (P_{L2} = .270) and an increase in Phase C at 24 sec. post-criterion (P_{L12} = .365), which showed a cyclical pattern in the lag-5 profile.

Maternal High-Involvement State (see Fig. 42, p.164). Maternal High-Involvement States occurred in 36% of all intervals across Phases. This state was followed by a persistent increase in Infant Low-Involvement states in Phase A (P_{L1} = .161), but showed no effects in Phase B or Phase C. In Phase A, Infant Vocalizations decreased briefly at 12 sec. post-criterion (P_{L6} = .395).

The Effect of the Infant on the Mother: Pair E

Infant Auditory/Nonvocal Behavior (see Fig. 43, p. 165). Infant E produced Nonvocal Sounds in 45% of total intervals in the Toy sequences. This behavior was followed by decreases in Maternal Touch for all Phases (P_{L1} = .104 in Phase A; P_{L1} = .141 in Phase B; P_{L1} = .360 in Phase C). In Phase B alone, this criterion was also followed by a decrease in Maternal Nonvocal Sounds at 18 sec. post-criterion (P_{L9} = .047).

Infant Auditory/Vocal Behavior (see Fig. 44, p. 166). Infant Vocalizations occurred in a mean of 39% of total intervals across Phases. Mother E's Tactile Behavior increased following this criterion in Phase B (P_{L1} = .678) and and at 16 sec. post-criterion in Phase C (P_{L8} = .586). Maternal Vocalizations following Infant Vocalizations decreased temporarily in Phase A (P_{L1} = .424), but showed no effects in Phase B or C. Maternal Nonvocal sounds following this criterion showed delayed decreases in Phase B (P_{L2} = .043).

Infant Positive Facial Expression (see Fig. 45, p. 167). Infant Smiles appeared in an average 12% of all intervals. Patterns of Maternal Touch following Infant Smile were completely different for each Phase, showing initial decreases in Phase A (P_{L1} = .231), sustained increases in Phase B (P_{L1} = .870), and increases in Phase C commencing at 22 sec. post-criterion (P_{L11} = .594). Maternal Vocalizations following this criterion decreased cyclically in Phase A (P_{L1} = .397), increased persistently in Phase B (P_{L1} = .761), and increased cyclically in Phase C (P_{L1} = .750). Maternal Nonvocal Sounds showed cyclical decreases

starting 8 sec. post-criterion in Phase A (P_{L4} = .070), sustained decreases followed by increases in the lag-5 profile for Phase B ($P_{L1\text{-}5}$ = .048) and a delayed decrease in Phase C (P_{L6} = .094).

Infant Spontaneous Manual Gesture. Infant E produced virtually no gestures.

Infant Manipulate Toy (see Fig. 46, p. 168). Infant E engaged in Toy Manipulation in an average 46% of intervals in the Toy sequences. Maternal Touch decreased persistently following this criterion in Phases A (P_{L1} = .126) and B (P_{L1} = .153), but showed a delayed increase at 26 sec. post-criterion in Phase C (P_{L13} = .587). Maternal Vocalizations decreased cyclically post-criterion in Phases A (P_{L2} = .373) and B (P_{L1} = .33), but showed a brief increase at 12 sec. in Phase C (P_{L6} = .728). Maternal Nonvocal Sounds following this criterion showed no consistent pattern. In Phase A, cyclical increases in this behavior commenced 4 sec. post-criterion (P_{L2} = .195); in Phase B, there was a decrease in Maternal Nonvocal Sound commencing 18 sec. post-criterion (P_{L9} = .044); while Phase C showed no effect.

Infant Reach for Toy (see Fig. 47, p. 169). Infant E Reached for Toys in 19% of all Toy intervals. In Phase A, this criterion preceded a decrease in Maternal Vocalizations (P_{L1} = .282); in Phase B, Maternal Vocalizations increased cyclically commencing 10 sec. post-criterion (P_{L5} = .607); while in Phase C, this maternal behavior showed a brief depression following 14 seconds after Infant Reach for Toy (P_{L7} = .552).

Infant Low-Involvement States (see Fig. 42, p.164). Infant Low-Involvement states occurred in a mean of 12% of total intervals across all Phases. Maternal High-Involvement States increased persistently following this criterion in Phase A, showed no relationship in Phase B, and showed an increase across seconds 20 - 30 in the lag-5 profile for Phase C (P_{L15} = .857).

Concurrent Vocalizations: Pair E

Concurrent Vocalization occurred in 19%, 19% and 21% of total intervals in Phases A, B, and C, respectively. In Phase C, this behavior showed a cyclical pattern of autocontingency (see Appendix F, p. 265).

Data Summary: Pair E

Pair E's interactive patterns were remarkable for their lack of consistency. Infant E seemed to operate on his environment deliberately and expressively, but most of his intentional expressive behavior was used to terminate interactions (pushing away his mother, biting his hand) or to stimulate himself (stereotypies). Infant E vocalized comparatively frequently, but often as an accompaniment to stereotypic behavior, making it inappropriate to reinforce his vocalizations. He produced virtually no manual gestures, and his smile was rare. Although no clear patterns to his behavior appeared through the LAGS analyses, there was a general decrease in toy-related activities following Maternal Touch and Vocalization. Maternal Involvement states, however, did not show any reliable relationship to this infant's activity level (see Table 34, p.160).

Mother E's rate of Tactile stimulation was extremely high (averaging 100% of No-Toy intervals), considering that Infant E had no trouble sitting independently. Surprisingly, though, in Toy sequences she did not use much tactile direction at all, and her use of Nonvocal Sound was extremely low. Furthermore, in spite of her infant's increasingly accurate vision, she rarely used Visual Direction. Mother E did seem to appropriately reduce Tactile stimulation following toy-related activities across all Phases. She seemed to respond vocally to infant Smiles beginning in Phase B, and in that same Phase began to respond Tactilely, but not Vocally, to her infant's Vocalizations.

Infant E seemed to be operating at a primitive illocutionary level, showing intentional expressive behavior (mostly negative in affect), a high rate of vocalization, some vocal-imitative skills, and an indeterminate receptive vocabulary. However, the social-interactive skills of the pair were so inefficient that communicative efforts seemed to have achieved a punishing quality for both mother and infant. Given the lack of confounding organic deficits in the infant, it seems likely that his severe communicative delay is attributable to these ineffective interaction patterns. This explanation is unfortunately strengthened by the knowledge that Infant E's older sibling also presents severe behavior problems.

Infant E's blindness was not suspected until he was at least three months of age and was not confirmed until he was six months old. Thus, he was treated as a sighted infant for at least three months, then

treated as a blind infant for about a year, and then as his sight began to improve he no doubt was handled in yet another way. Perhaps the demonstrably poor parenting skills combined with these switches in strategies based on the perceived sensory abilities of the child combined to the detriment of effective communication for this mother-infant pair.

Table 29. RAW DATA: PROPORTION OF INTERVALS CONTAINING EACH BEHAVIOR FOR INFANT E

	PHASE A			PHASE B			PHASE C	
	No Toys	Toys	Total	No Toys	Toys	Total	No Toys	Toys Total
INFANT BEHAVIORS								
Nonvocal Sound	.00	.54	.47	.00	.32	.21	.48	
Linguistic Vocalization	.00	.01	.01	.03	.00	.01	.00	
Nonlinguistic Vocalization	.33	.48	.46	.52	.25	.34	.36	
Vocal Imitation of Mother	.00	.01	.01	.00	.00	.00	.00	
Head Gesture	.04	.00	.01	.00	.01	.01	.02	
Inappropriate Visual Orientation	.91	.36	.43	.83	.47	.59	.10	
Positive Facial Expression(Smile)	.05	.15	.14	.22	.04	.10	.11	
Negative Facial Expression	.03	.03	.03	.03	.01	.02	.07	
Spontaneous Manual Gesture	.00	.00	.00	.00	.00	.00	.01	
Explore Space	.00	.01	.01	.01	.00	.00	.01	
Elicited Manual Gesture	.00	.00	.00	.00	.00	.00	.00	
Reach for Mother	.04	.01	.01	.01	.01	.01	.02	
Reach for Toy	.04	.17	.16	.00	.21	.14	.20	
Release Mother	.00	.00	.00	.00	.00	.00	.00	
Release Toy	.00	.02	.02	.00	.03	.02	.06	
Explore Mother	.00	.00	.00	.00	.00	.00	.00	
Explore Toy	.00	.01	.01	.00	.02	.01	.01	
Manipulate Mother	.00	.00	.00	.00	.00	.00	.00	
Manipulate Toy	.00	.53	.46	.00	.33	.22	.51	
Hold Mother	.03	.01	.01	.05	.02	.03	.01	
Hold Toy	.01	.04	.03	.00	.01	.01	.03	
Withdraw Hand from Mother	.00	.00	.00	.00	.00	.00	.00	
Withdraw Hand from Toy	.00	.00	.00	.00	.00	.00	.00	
Push Away Mother	.00	.01	.01	.08	.01	.04	.01	
Touch Self	.37	.16	.18	.23	.17	.19	.09	
Hand: Other/Nothing	.57	.16	.21	.65	.32	.43	.17	
Approach Mother	.00	.00	.00	.01	.00	.00	.01	
Avoid Mother	.15	.03	.05	.16	.03	.07	.00	
Toy Stereotypy	.00	.34	.29	.00	.09	.06	.16	
Body Stereotypy	.04	.16	.14	.18	.26	.23	.08	
Self-Abusive Stereotypy	.00	.05	.04	.13	.06	.08	.06	

Table 30. RAW DATA: PROPORTION OF INTERVALS CONTAINING EACH BEHAVIOR FOR MOTHER E

MATERNAL BEHAVIORS	PHASE A			PHASE B			PHASE C	
	No Toys	Toys	Total	No Toys	Toys	Total	No Toys	Toys Total
Caress	.00	.01	.01	.00	.00	.00		.02
Restrain	.03	.03	.03	.45	.06	.19		.03
Tactile Direction	.97	.20	.20	.55	.32	.39		.44
Visual Direction	.00	.09	.08	.00	.09	.06		.15
Positive Linguistic Vocalization	.00	.00	.00	.01	.00	.01		.01
Negative Linguistic Vocalization	.00	.02	.02	.01	.02	.02		.02
Other Linguistic Vocalization	.81	.40	.45	.73	.46	.55		.60
Nonlinguistic Vocalization	.01	.03	.03	.00	.00	.00		.00
Vocal Imitation of Infant	.01	.02	.02	.02	.00	.01		.00
Nonvocal Sound	.00	.12	.11	.00	.12	.08		.26

Table 31. BEHAVIOR CATEGORIES SELECTED FOR LAGS ANALYSES: PAIR E
(PROPORTION OF INTERVALS CONTAINING EACH BEHAVIOR CATEGORY)

	Phase A			Phase B			Phase C		
	No Toy	Toy	Total	No Toy	Toy	Total	No Toy	Toy	Total
INFANT BEHAVIORS:									
Nonvocal Sound	.00	.54	.47	.00	.32	.21		.48	
Vocalization	.33	.49	.47	.54	.25	.35		.36	
Positive Facial (Smile)	.05	.15	.14	.22	.04	.10		.11	
Manual Gesture	.00	.00	.00	.00	.00	.00		.01	
Manipulate Toy	.00	.53	.46	.00	.33	.22		.51	
Reach for Toy	.04	.17	.16	.00	.21	.14		.20	
Low-Involvement State	.19	.03	.05	.24	.24	.24		.07	
MATERNAL BEHAVIORS:									
Tactile	1.00	.24	.34	1.00	.38	.58		.49	
Vocalization	.82	.45	.50	.75	.48	.58		.63	
Nonvocal Sound	.00	.12	.11	.00	.12	.08		.26	
Low-Involvement State	.00	.44	.38	.00	.39	.26		.20	
High Involvement State			.27			.44		.36	

Table 32. PAIR E: THE MOTHER'S EFFECT ON THE INFANT

	MOTHER'S BEHAVIOR AT INTERVAL X-1	P_0: INFANT'S BEHAVIOR AT INTERVAL X: Auditory Nonvocal	Auditory Vocal	Positive Facial	Manual Gesture	Manipulate Toy	Reach for Toy
PHASE A	Tactile		.440	.104	----	.227 -	.109 -
	Auditory/Vocal	.396 -	.415 -	.150	----	.347 -	.178
	Auditory/Nonvocal	.600 +	.450	.300 +	----	.483	.263 +
PHASE B	Tactile		.411 +	.166 +	----	.120 -	.250
	Auditory/Vocal	.183 -	.359	.135	----	.176 -	.261
	Auditory/Nonvocal	.235 -	.118 -	----	----	.118 -	.324 +
PHASE C	Tactile		.390	.132	----	.360	.191
	Auditory/Vocal	.379 -	.345	.130	----	.333 -	.226
	Auditory/Nonvocal	.467	.347	.120	----	.387	.333 +

P_0 = Observed Probability

+ = $P_0 > P_E$, $p \leq .001$

- = $P_0 < P_E$, $p \leq .001$

---- = Insufficient observations for analysis.

Table 33.

PAIR E: THE INFANT'S EFFECT ON THE MOTHER

INFANT'S BEHAVIOR AT INTERVAL X-1		P_0: MOTHER'S BEHAVIOR AT INTERVAL X		
		Tactile	Auditory Vocal	Auditory Nonvocal
PHASE A	Auditory/Nonvocal	.104 -		.119
	Auditory/Vocal	.323	.424 -	.082 -
	Positive Facial	.231 -	.397 -	.162 +
	Manual Gesture	----	----	
	Manipulate Toy	.126 -	.381 -	.148 -
	Reach for Toy		.282 -	
PHASE B	Auditory/Nonvocal	.141 -		.098
	Auditory/Vocal	.678 +	.592	.069
	Positive Facial	.870 +	.761 +	$.048_{1-5}$
	Manual Gesture	----	----	
	Manipulate Toy	.153 -	.333 -	.097
	Reach for Toy		.557	
PHASE C	Auditory/Nonvocal	.360 -		.228
	Auditory/Vocal	.545	.594	.188 -
	Positive Facial	.531	.750 +	.281
	Manual Gesture	----	----	
	Manipulate Toy	.410	.581	.222
	Reach for Toy		.552 -	

P_0 = Observed Probability

+ = $P_0 > P_L$, $p \leq .001$

- = $P_0 < P_L$, $p \leq .001$

---- = Insufficient observations for analysis.

Table 34. PAIR E: STATES OF INVOLVEMENT

PHASE A	P_0: Infant's State at Interval X		P_0: Mother's State at Interval X:
	Low-Involvement	Vocalization	High-Involvement
Mother's State at Interval X-1:			Infant's State at Interval X-1:
Low-Involvement		.552 +	Low-Involvement .645 +
High-Involvement	.161 +	.419	
Vocalization	.091 +		

PHASE B			
Mother's State at Interval X-1:			Infant's State at Interval X-1:
Low-Involvement		.277 -	Low-Involvement .458
High-Involvement	.280	.394	
Vocalization	.279		

PHASE C			
Mother's State at Interval X-1:			Infant's State at Interval X-1:
Low-Involvement		.382	Low-Involvement ----
High-Involvement	----	----	
Vocalization	.090		

P_0 = Observed Probability

+ = $P_0 > P_E$, $p \leq .001$

P - = $P_C < P_E$, $p \leq .001$

---- = Insufficient observations

Fig. 39. EFFECT OF MATERNAL TOUCH ON SELECTED INFANT BEHAVIORS: PAIR E

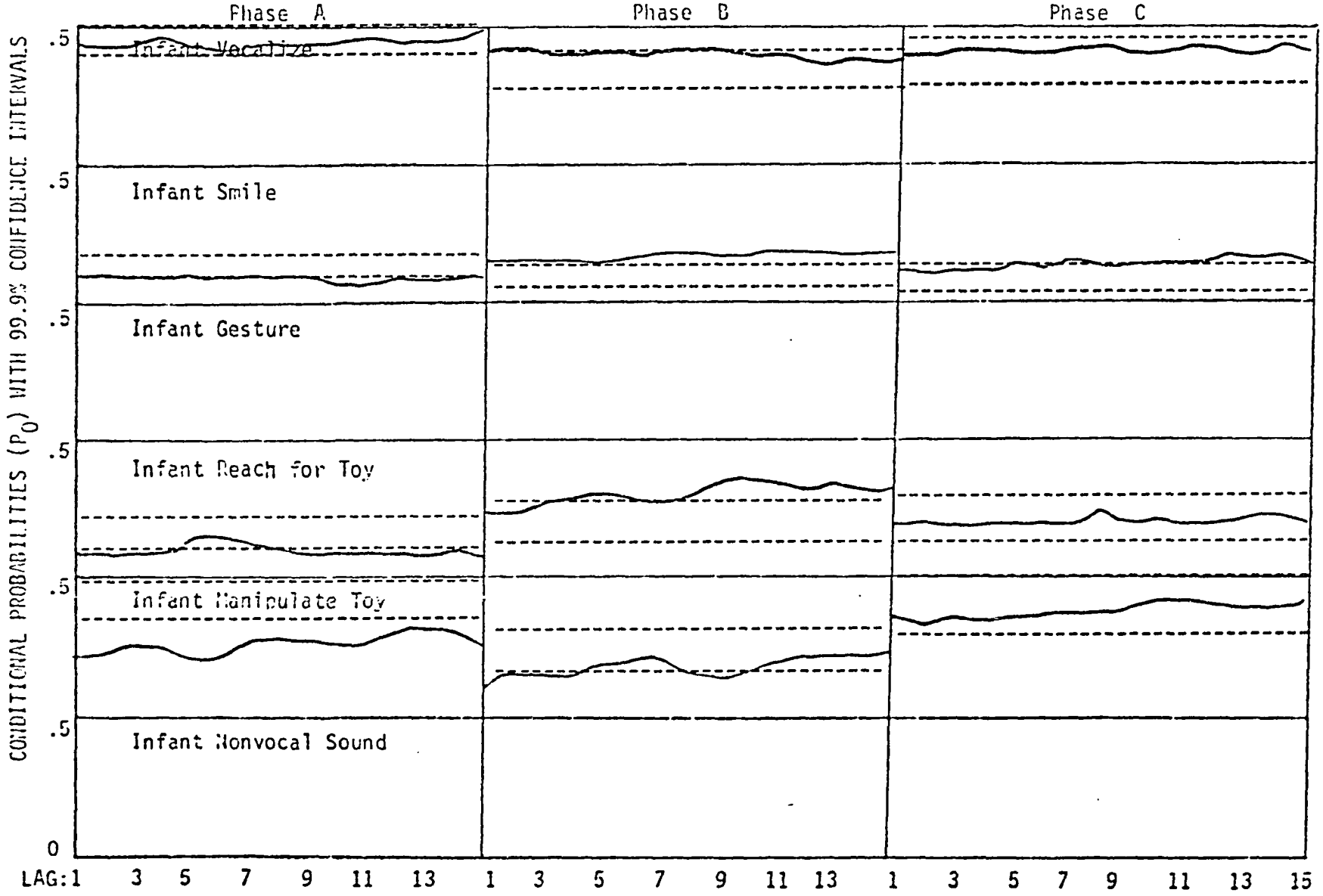


Fig. 40. EFFECT OF MATERNAL VOCALIZATION ON SELECTED INFANT BEHAVIORS: PAIR E

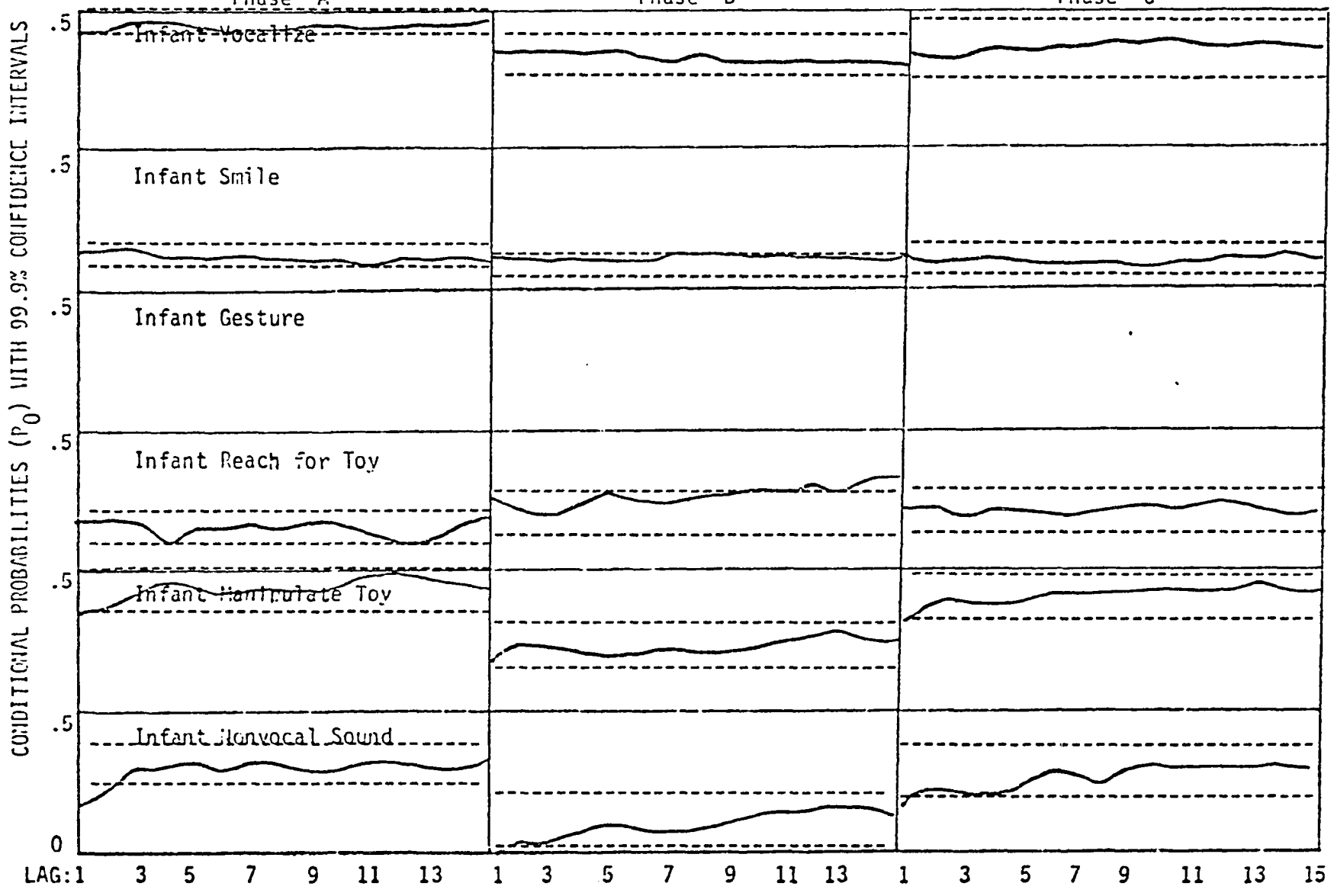


Fig. 41. EFFECT OF MATERNAL NONVOCAL SOUND ON SELECTED INFANT BEHAVIORS: PAIR E

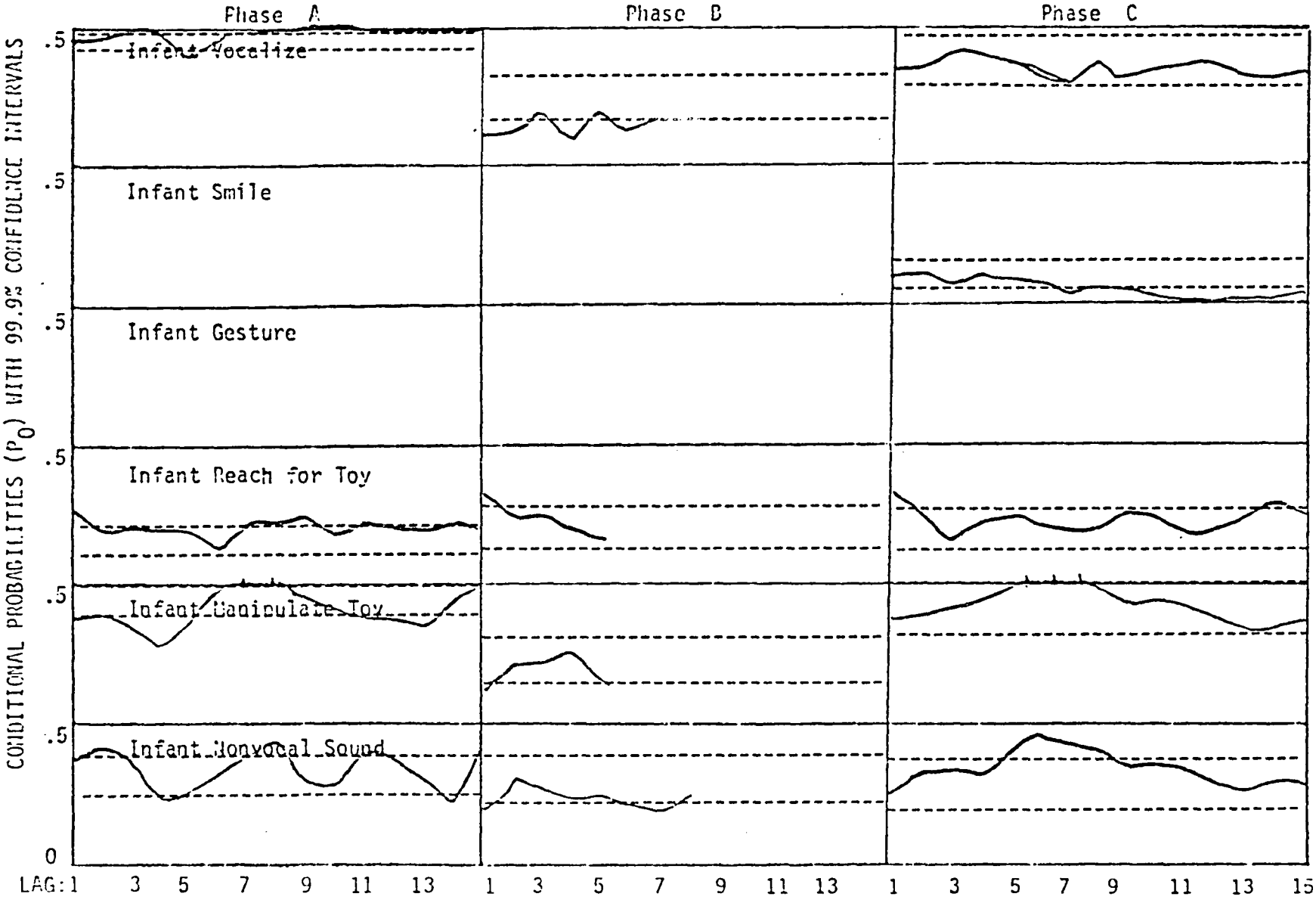


Fig. 42. STATES OF INVOLVEMENT: PAIR E

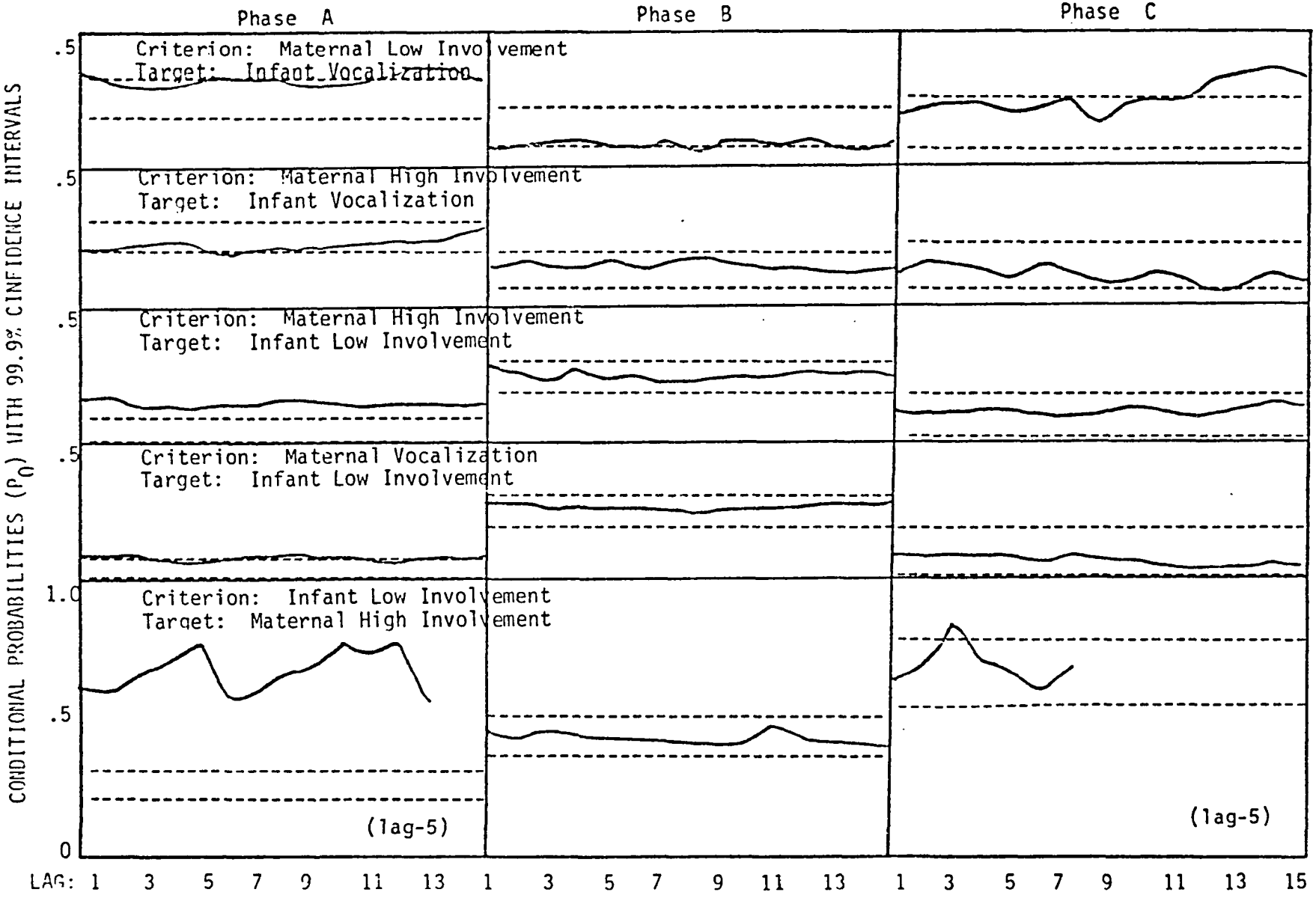
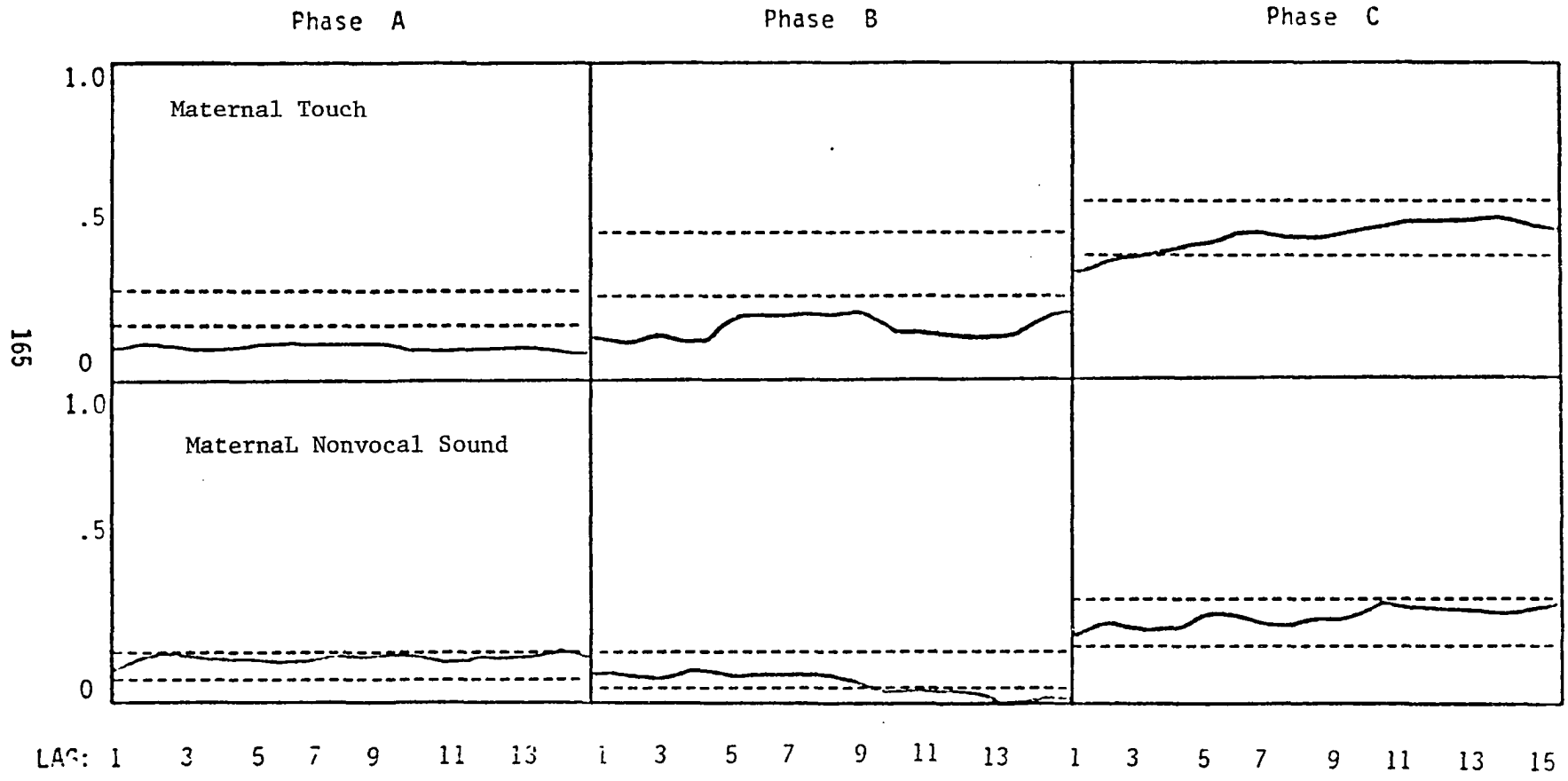


Fig. 43. EFFECT OF INFANT NONVOCAL SOUND ON SELECTED MATERNAL BEHAVIORS: PAIR E



CONDITIONAL PROBABILITIES (P_0) WITH 99.9% CONFIDENCE INTERVALS

Fig. 44. EFFECT OF INFANT VOCALIZATION ON SELECTED MATERNAL BEHAVIORS: PAIR E

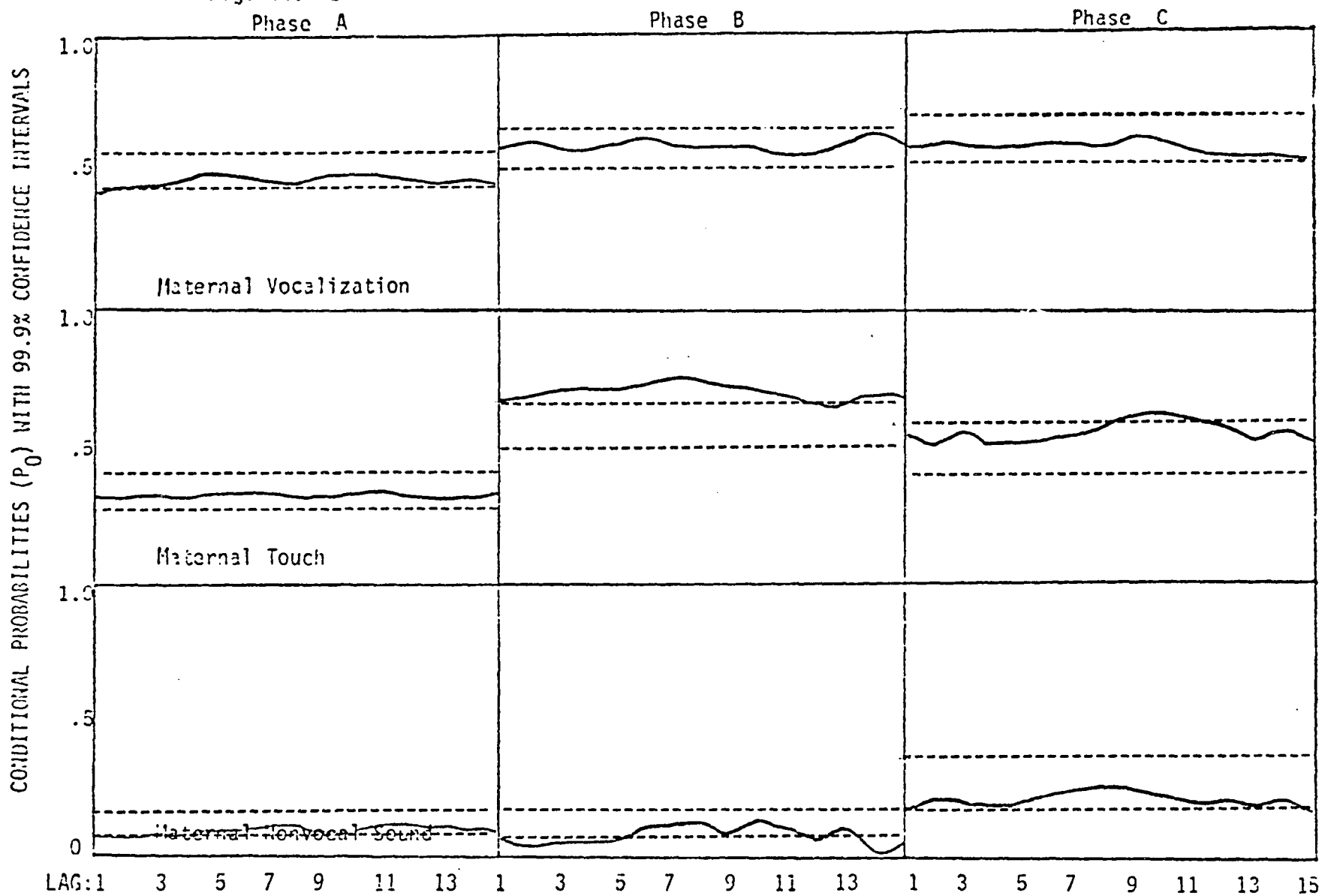


Fig. 45. EFFECT OF INFANT SMILE ON SELECTED MATERNAL BEHAVIORS: PAIR E

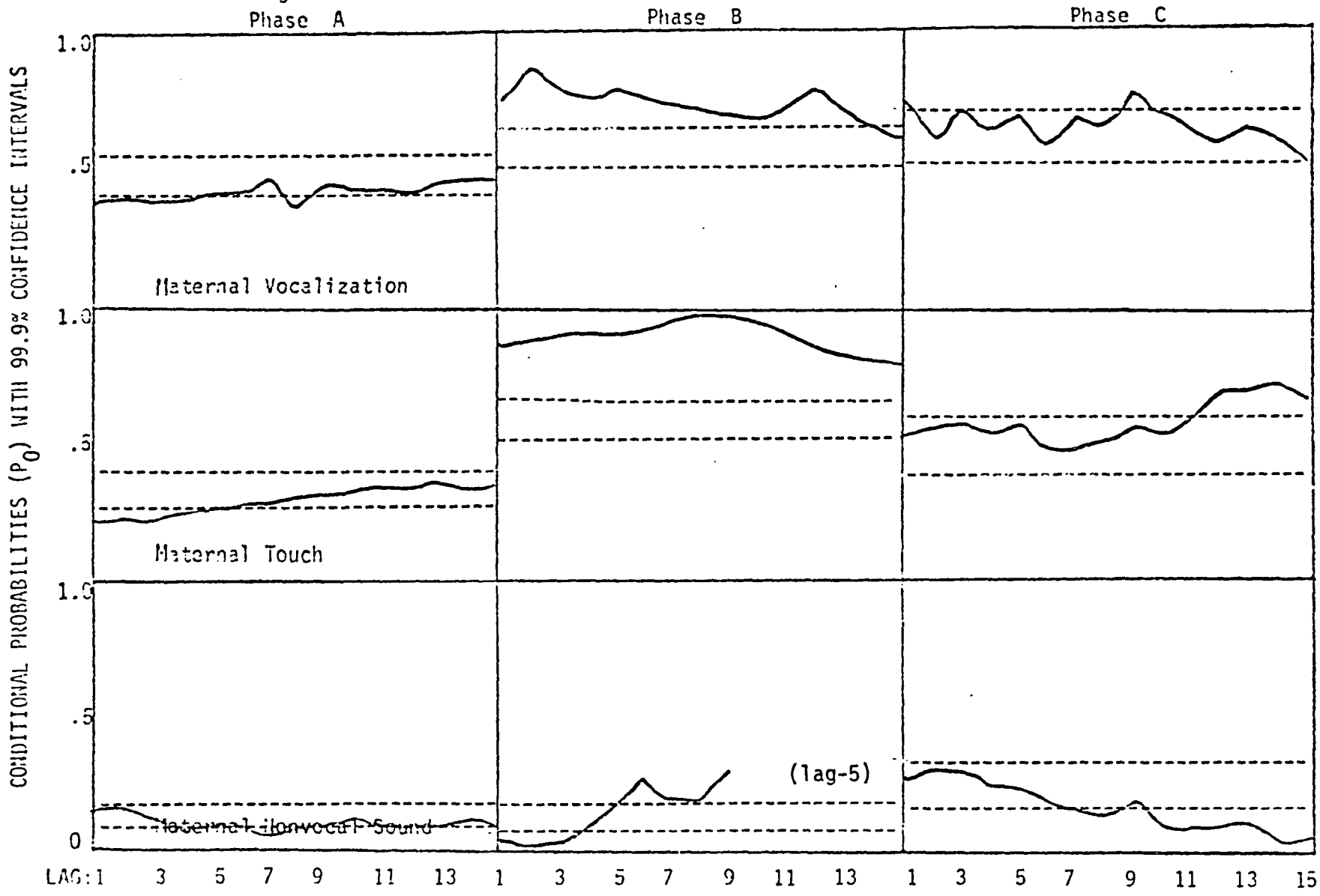


Fig. 46. EFFECT OF INFANT MANIPULATE TOY ON SELECTED MATERNAL BEHAVIORS: PAIR E

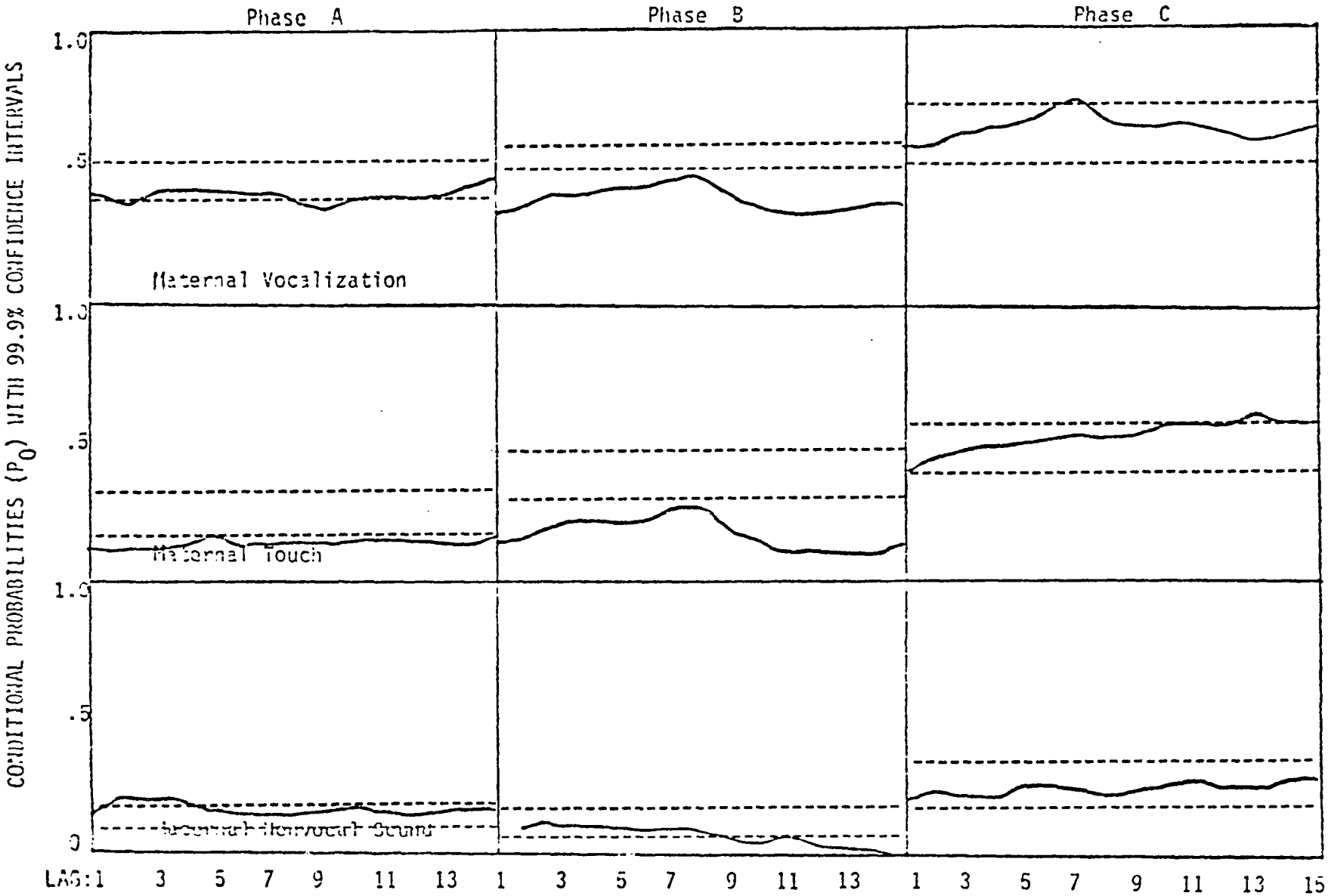
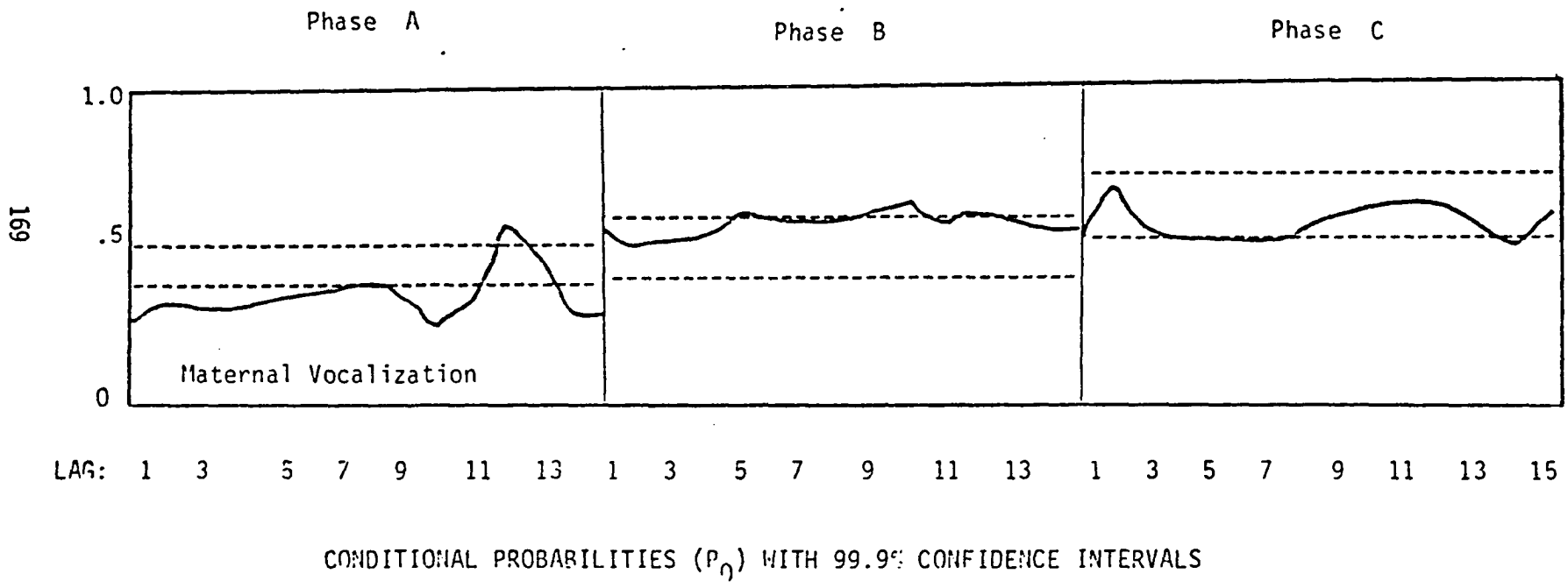


Fig. 47. EFFECT OF INFANT REACH FOR TOY ON SELECTED MATERNAL BEHAVIORS: PAIR F



CONDITIONAL PROBABILITIES (P_0) WITH 99.9% CONFIDENCE INTERVALS

DISCUSSION AND CONCLUSIONS

Description

The Communicative Repertoire of Visually Impaired Infants

It is difficult to compare the behavioral repertoires of this assortment of subjects with those of sighted subjects, since there is no sensible control group of sighted infants to match this group. What data do exist regarding the frequencies of similar behaviors in sighted infants have been gathered and analyzed in completely disparate manners, making even gross comparisons difficult. Ling and Ling (1976) provide some frequency data on the communicative behaviors of mothers and their normal infants aged one through 36 months. Their data will be cited below in the interest of making tentative comparisons, but it must be emphasized that these data derive from point-sampling of hour-long sessions.

Let us begin with what was expected. Based on Fraiberg's work, we would expect to find low rates of vocalization and facial expression, but high rates of manual activity (expressive, exploratory and manipulative). These expectations were not met. The trends across subjects for vocal, facial, and manual behavior categories are discussed below. Table 35 (p. 171) contains frequency data for all five subjects for the

Table 35. COMPARISON OF PAIRS ON OCCURRENCE OF SELECTED BEHAVIORS: PROPORTION OF INTERVALS CONTAINING BEHAVIORS

	PAIR A			PAIR B			PAIR C			PAIR D			PAIR E		
INFANT BEHAVIORS PHASE:	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C
*Nonvocal Sound	.09	.14	.29	.20	.40	.17	.34	.38	.04	.22	.26	.31	.54	.32	.48
Vocalization	.26	.22	.41	.21	.27	.21	.18	.08	.32	.06	.09	.11	.47	.35	.36
Positive Facial Expression	.05	.10	.10	.23	.19	.26	.15	.23	.52	.20	.20	.40	.14	.10	.11
Negative Facial Expression	.08	.06	.07	.02	.06	.00	.01	.00	.00	.01	.00	.00	.03	.02	.07
Spontaneous Manual Gesture	.02	.00	.01	.07	.09	.03	.06	.18	.03	.08	.07	.15	.00	.00	.00
Explore Space	.01	.04	.04	.00	.00	.35	.01	.00	.00	.00	.00	.00	.01	.00	.01
*Manipulate Toy	.09	.13	.29	.22	.57	.14	.38	.40	.03	.43	.32	.25	.53	.33	.51
*Explore Toy	.01	.13	.05	.03	.01	.07	.15	.10	.06	.02	.00	.00	.01	.02	.01
Explore Mother	.00	.00	.01	.04	.03	.00	.00	.00	.14	.00	.00	.00	.00	.00	.00
*Reach for Toy	.00	.02	.01	.17	.35	.08	.20	.16	.14	.20	.08	.12	.17	.21	.20
Touch Self	.37	.25	.42	.03	.04	.03	.10	.18	.03	.08	,06	.04	.18	.19	.09
No Manual Activity	.50	.56	.31	.21	.29	.21	.31	.32	.35	.35	.39	.50	.21	.43	.17
MATERNAL BEHAVIORS															
Touch	.93	.92	.76	.64	.61	.35	.40	.72	.88	.55	.39	.51	.34	.58	.49
Vocalization	.39	.61	.32	.72	.64	.61	.37	.51	.80	.35	.23	.64	.50	.58	.63
*Nonvocal Sound	.74	.55	.39	.33	.22	.18	.45	.32	.14	.27	.61	.45	.12	.12	.26
Vocal Imitation of Infant	.01	.01	.00	.04	.01	.04	.01	.00	.00	.00	.00	.00	.02	.01	.00

* Proportions generated from Toy sequences only.

behavior categories specifically discussed in this secion. Table 36 (p. 173) compares maternal behavior patterns across all five mothers, displaying frequencies of concurrent behaviors.

Vocal Behavior. Ling and Ling reported that normal infants between one and 24 months of age produced nonverbal vocalizations in a range of 19% to 27% of observation intervals. In infants older than 24 months, verbal activity largely replaced these nonverbal vocalizations. The rate of vocalization for the blind subjects of this study ranged from 6% to 48% of intervals within a Phase. When vocalization rates for each subject were averaged across Phases, however, only Infant D's rate was less than 19%. (This infant suffered from spastic involvement of the orofacial musculature.) Significantly, none of the mothers considered their infants to be particularly quiet, and the mothers of infants A, B, and C reported high rates of vocalization by their infants when they were left alone. Infant C vocalized in an average 33% of intervals made of her alone, while Infant E vocalized in 35% of intervals filmed under similar circumstances.

Fraiberg speculated that the mothers of sightless infants might themselves vocalize less frequently, in response to their infants' reduced vocalizations. Referring again to Ling and Ling, who found that a maximum 43% of intervals contained verbal or nonverbal vocalization for mothers of infants aged one to 36 months, this speculation is not supported. The rate of vocalization for the mothers in this study ranged from 23% to 80%, with all mothers averaging rates of at least 40% across the three Phases.

Table 36. MATERNAL BEHAVIOR PATTERNS: OCCURRENCE OF CONCURRENT BEHAVIORS

Subject:	A			B			C			D			E		
Phase:	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C
PROPORTION OUT OF TOTAL INTERVALS															
No Activity	.01	.04	.13	.10	.15	.25	.33	.19	.01	.20	.10	.06	.38	.25	.20
Vocalize Alone	.01	.01	.01	.15	.18	.32	.08	.04	.09	.05	.02	.10	.16	.08	.10
Touch Alone	.18	.14	.37	.09	.16	.06	.05	.17	.16	.17	.09	.12	.06	.12	.08
Vocalize + Touch	.24	.47	.22	.45	.40	.23	.16	.39	.64	.25	.16	.25	.25	.42	.31
PROPORTION OUT OF TOY INTERVALS ONLY															
Nonvocal Sound Alone	.08	.06	.17	.06	.10	.06	.18	.06		.03	.07	.02	.02	.02	.02
Show (Visual Direction) Alone	NA	NA	NA	NA	NA	NA	NA	NA		.15	.19	.03	.02	.01	.01
Nonvocal Sound + Touch	.49	.34	.17	.06	.02	.04	.13	.18		.17	.15	.02	.01	.02	.02
Nonvocal Sound + Show	NA	NA	NA	NA	NA	NA	NA	NA		.05	.33	.18	.02	.01	.02
Nonvocal Sound + Vocalize	.00	.00	.02	.12	.04	.05	.06	.01		.01	.01	.01	.02	.01	.04
Vocalize + Show	NA	NA	NA	NA	NA	NA	NA	NA		.04	.03	.08	.02	.05	.02
Nonvocal Sound + Vocalize + Touch	.15	.14	.07	.09	.05	.02	.07	.08		.01	.01	.01	.02	.03	.05
Nonvocal Sound + Vocalize + Show	NA	NA	NA	NA	NA	NA	NA	NA		.00	.02	.20	.03	.02	.09

Manual Activity. The amount and quality of infant manual activity did not seem extraordinary, either in terms of quantity or quality. These subjects spent a large percent of intervals with hands in repose (including within the mother's grasp) or touching themselves. Even in Toy conditions, where a high level of manual manipulation would be expected, a minimum of 13% of intervals for all children contained no independent manual activity (see Table 35, p. 171). The Touch Self category varied widely in frequency across infants, but in all cases seemed more self-stimulatory than self-exploratory.

Manual toy exploration appeared in 0% to 15% of Toy intervals. Infants D and E rarely tactiley explored either mother or toys; but, of course, they were able to visually explore their environments. Infant A began to manually explore toys in Phase B, but rarely explored her mother's features. Infant B (who was not very object-oriented by nature), increased her toy exploration to 7% by Phase C. Her manual exploration of her mother, which averaged 4% and 3% in Phases A and B, respectively, dropped to 0% in Phase C, by which point she was able to move around the larger environment independently. Infant C explored toys at rates of 15% and 10% in Phase A and B, but did not explore her mother's features in these Phases. In Phase C, however, concomitant with her teacher's efforts to increase her social behavior, her toy exploration decreased and maternal exploration increased dramatically, to 14%. Only Infants A and B showed clear nonspecific searching behavior (Explore Space category). Infant B was able to explore her environment

by locomoting around it, while Infant A would feel around herself on the floor, the couch or around her high chair tray. Infant C seemed to search only for clearly present items, while Infants D and E could visually monitor their surrounds.

The spontaneous manual gestures produced by these subjects were almost exclusively idiosyncratic and were usually expressive of excitement states (see the behavioral descriptions of subjects' gestures in Appendix E). These gestures, though probably associated with specific affective states recognizable to the mother, were not referential, nor could they be objectively described as intentionally communicative. The only conventional indicating gesture (except for Infant B's elicited gestures) was the reach, which all infants accomplished. However, this reaching behavior could not be interpreted as a request for help or a referential gesture, since it was executed only when the infant was cognizant of the close presence of an object and could succeed in capturing it.

Facial Expressions. Infant Smiles appeared with gratifying frequency, with average rates of 8% for Infant A, 23% for Infant B, 30% for Infant C, 26% for Infant D, and 12% for Infant E. Negative Facial Expressions occurred in an average 7%, 3%, 0%, 0%, and 4% of intervals for Infants A through E, respectively. Combining Positive and Negative Facial Expression categories, the subjects produced facial expressions in a range of 13% to 37% of intervals, comparing favorably to the range of 6% to 31% found by Ling and Ling in infants ranging from one to 36

months. Thus, the blind subjects did not seem particularly inexpressive facially, although no attempt was made to assess the contrastiveness of their facial expressions.

The Responsiveness of Communicative Behaviors in Visually Impaired Infants

Responsiveness of Infant Smile, Vocalization and Gesture was inferred from the likelihood that the expected probability of these behaviors would be altered by antecedent maternal behaviors. Tables 37 through 42 (pp. 178 - 183) compare the Lag-1 transitional probabilities of individual infant behaviors following selected maternal behaviors across all subjects. Infant Vocalizations did not show clear patterns of responsiveness across subjects. The lag-1 contingent probabilities (Table 37, p. 178) showed only spotty increases and decreases in this behavior across subjects. Infants B and C demonstrated delayed increases in vocalization following Maternal Touch, while Infant C's vocalizations showed delayed increases following Maternal Vocalization.

Infant Smiles increased following Maternal Vocalizations and Touch for four out of the five infants. As can be seen in Table 38 (p. 179), 15 out of 38 of the Lag-1 transitional probabilities for Infant Smile were significantly altered following maternal behaviors. No doubt the apparent responsiveness of this behavior was influenced by the extreme responsiveness of the mothers to smiles. The infants' gestural behavior (measurable only in Infants B, C and D) seemed less responsive than their facial expressions. Manual gestures increased following Maternal Touch

and Vocalization for only two of these three infants (C and D, see Table 39, p. 180).

Obviously, the behavior most susceptible to maternal influence was the smile. Gestures and Vocalizations may be affected by maternal behaviors, but the responsivity of these behaviors is not well established across subjects. The lack of responsivity of Infant Vocalizations is surprising, given the fact that strong emphasis was placed on the reinforcement of vocalization in home programs recommended to the mothers by the CSC. Perhaps the deviation in vocal behavior suspected by Fraiberg reflects differences in temporal organization rather than in rate of production. The blind infant does not seem to vocalize when he or she is expected to--in response to maternal behavior or stimulation. Mothers' attempts to encourage vocalization are often met with silence. The normal infant will cease vocalization during maternal vocalization, a phenomenon interpreted as evidence that the infant is listening selectively to maternal vocalizations (Barrett-Goldfarb & Whitehurst, 1973). Listening should be an especially important behavior for the blind child. Consider that auditory stimuli cannot be processed simultaneously, but must be processed sequentially. Consider further that auditory information is the only information available about the environment that exists beyond arm's reach of the nonambulatory sightless infant. Listening, or silence, may be so critical to interpretation of the distal environment that it would be maladaptive for the blind infant to clutter the auditory milieu with his or her own vocalizations. Thus,

Table 37.

EFFECT OF SELECTED MATERNAL BEHAVIORS ON INFANT AUDITORY-VOCAL BEHAVIOR AT LAG-1

	MOTHER'S BEHAVIOR AT INTERVAL X-1: \ P_0: INFANT VOCALIZATION AT INTERVAL X — INFANT:	A	B	C	D	E
PHASE A	Touch	.273	.227	.185	.067	.440
	Vocalization	.230	.242	.179	.089+	.415-
	Nonvocal Sound	.243	.076	.121	.034	.450
PHASE B	Touch	.233	.326	.116	.065	.411+
	Vocalization	.251	.261	.097	.061	.359
	Nonvocal Sound	.114	...	.043	.086	.118-
PHASE C	Touch	.422	.229	.333	.182+	.390
	Vocalization	.306-	.253	.310	.122	.345
	Nonvocal Sound	.373	.103	...	...	.347

P_0 = Observed Probability

+ = $P_0 \geq P_E$, $p \leq .001$

- = $P_0 < P_E$, $p \leq .001$

... = Insufficient observations for analysis.

Table 38.

EFFECT OF SELECTED MATERNAL BEHAVIORS ON INFANT POSITIVE FACIAL EXPRESSIONS AT LAG-1

	MOTHER'S BEHAVIOR AT INTERVAL X-1:	P_0: INFANT SMILE AT INTERVAL X INFANT: A	B	C	D	E
PHASE A	Touch	.043	.305+	.210+	.214	.104
	Vocalization	.064	.268	.198+	.276+	.150
	Nonvocal Sound	...	.017-	.060-	.164	.300+
PHASE B	Touch	.109	.309+	.304	.241	.166+
	Vocalization	.154+	.199	.297	.303+	.135
	Nonvocal Sound	...	...	...	.102-	...
PHASE C	Touch	.138	.359+	.553	.524+	.132
	Vocalization	.157+	.365+	.540	.431	.130
	Nonvocal Sound	...	.151	...	.306	.120

P_0 = Observed Probability

+ = $P_0 \geq P_E$, $p \leq .001$

- = $P_0 \leq P_E$, $p \leq .001$

... = Insufficient observations for analysis.

Table 39.

EFFECT OF SELECTED MATERNAL BEHAVIORS ON INFANT SPONTANEOUS MANUAL GESTURE AT LAG-1

	MOTHER'S BEHAVIOR AT INTERVAL X-1:	P_0: INFANT GESTURE AT INTERVAL X INFANT: A	B	C	D	E
PHASE A	Touch	...	.049	.060	.114+	...
	Vocalization	...	.058	.058	.160+	...
	Nonvocal Sound	...	.059	.048	...	...
PHASE B	Touch	...	.078	.217	.111+	...
	Vocalization	...	.093	.255+	.091	...
	Nonvocal Sound	...	...	...	.047	...
PHASE C	Touch	...	...	...	.182	...
	Vocalization	...	...	...	.127	...
	Nonvocal Sound	...	...	...	.177	...

P_0 = Observed Probability

\+ = $P_0 \geq P_E$, $p \leq .001$

\- = $P_0 \leq P_E$, $p \leq .001$

... = Insufficient observations for analysis.

Tbale 40.

EFFECT OF SELECTED MATERNAL BEHAVIORS ON INFANT REACHING FOR TOY AT LAG-1

	MOTHER'S BEHAVIOR AT INTERVAL X-1: \ P_0: INFANT REACH FOR TOY AT INTERVAL X — INFANT:	A	B	C	D	E
PHASE A	Touch	...	.119	.171	.143-	.109-
	Vocalization	...	.158	.212	.159	.178
	Nonvocal Sound	...	.322+	.222	.216	.263+
PHASE B	Touch	...	...	.191	.042	.250
	Vocalization	...	.300	.116	$.040_{1-5}$	.261
	Nonvocal Sound	...	...	.283+	.063	.324+
PAHSE C	Touch	...	.106	...	$.076_{1-5}$	.191
	Vocalization	...	.067	...	.074	.226
	Nonvocal Sound	...	.154+	...	.194+	.333+

P_0 = Observed Probability

+ = $P_0 \geq P_E$, $p \leq .001$

- = $P_0 \leq P_E$, $p \leq .001$

... = Insufficient observations for analysis.

Table 41.

EFFECT OF SELECTED MATERNAL BEHAVIORS ON INFANT

TOY MANIPULATION AT LAG-1

	MOTHER'S BEHAVIOR AT INTERVAL X-1: \ P_0: INFANT MANIPULATE TOY AT INTERVAL X — INFANT: A	B	C	D	E
PHASE A	Touch	.073	.092-	.165-	.175-	.227-
	Vocalization	.048	.107	.212-	.460+	.347-
	Nonvocal Sound	.064	.093-	.153	.095-	.483
PHASE B	Touch	.080	$.262_{1-5}$	.074-	.313	.120-
	Vocalization	.094	.380	.233	$.253_{1-5}$	.176-
	Nonvocal Sound	.114	...	.087-	.148-	.118-
PHASE C	Touch	.107-	.106	...	$.122_{1-5}$	.360
	Vocalization	...	.067	...	.185	.333-
	Nonvocal Sound	.217	.179+	...	.065-	.387

P_0 = Observed Probability

+ = $P_0 \geq P_E$, $p \leq .001$

- = $P_0 \leq P_E$, $p \leq .001$

... = Insufficient observations for analysis.

Tbale 42.

EFFECT OF SELECTED MATERNAL BEHAVIORS ON INFANT

AUDITORY-NONVOCAL BEHAVIOR AT LAG-1

	MOTHER'S BEHAVIOR AT INTERVAL X-1: \ P_0: INFANT NONVOCAL SOUND AT INTERVAL X — INFANT: A	B	C	D	E
PHASE A					
	Vocalization	.048-	.130	.212-	.254	.396-
	Nonvocal Sound	.064-	.153	.206-	.086-	.600+
PHASE B					
	Vocalization	.078-	.320	.256	$.200_{1-5}$	.183-
	Nonvocal Sound	.096	...	.130-	.133-	.235-
PHASE C					
	Vocalization	...	.105	...	.284	.379-
	Nonvocal Sound	.265	.179	...	.210	.467

P_0 = Observed Probability

+ = $P_0 \geq P_E$, $p \leq .001$

- = $P_0 \leq P_E$, $p \leq .001$

... = Insufficient observations for analysis.

when mother vocalizes, the infant's undivided attention, reflected by silence, may be the safest response. Perhaps the blind infant finds solitary situations, when the environment does not require close attention, to be "safer" situations for vocalizing.

Maternal Responsiveness to Infant Communicative Behaviors

Tables 43 - 45 (pp.186 -188) compare the Lag-1 transitional probabilities of individual maternal behaviors following selected infant behaviors across subjects. Maternal responsiveness was inferred from the likelihood that the expected probability of maternal behaviors would be altered by antecedent infant behaviors. Both tactile and vocal behavior on the mothers' parts showed frequent deviations from expected probabilities following infant behaviors.

Maternal Response to Vocalizations

Mothers B, C and D typically responded to infant vocalizations with immediate and recurrent increases in their own vocalizations (see Table 43, p. 186). Only Mother A decreased her vocalization rate in the interval immediately following her infant's vocalizations. The data, however, show that very few of these maternal vocalizations included actual imitation of infant vocalizations, with imitation rates ranging from 0% to only 4% of intervals (see Table 35, p.171). Infant B's mother, predictably, engaged in vocal imitation most frequently. Mothers B and D generally increased Tactile stimulation following infant vocalizations (see Table 44, p.187). Only Mother C showed a reliable decrease

in Nonvocal Sound following her infant's vocalizations (see Table 45, p. 188).

Maternal Response to Manual Gestures

Infant B's mother actually decreased both Vocal and Tactile behavior following her infant's gestures in Phase A. This was at a time, however, when great emphasis was being placed on the development of her repertoire of elicited manual gestures, which were invariably strongly reinforced. Of the other two infants who produced sufficient numbers of spontaneous manual gestures for analysis, Mother D increased both Vocalization and Touch in the first two Phases, but only Vocalizations in Phase C in response to this behavior. Mother C at first increased only Vocalization following infant gestures, but in Phase B increased both Touch and Vocalization. The maternal responses to gestures were much more sustained or persistent than were their responses to vocalizations, which were more likely to be cyclical in pattern.

Maternal Response to Infant Smiles

By far the most consistent and sustained changes in maternal Vocal and Tactile behavior occurring across subjects appeared following Infant Smiles. In 12 out of the 15 Phases, Maternal Vocalization increased in the interval immediately following Infant Smile. Nine out of the 15 Phases showed increased probabilities of Maternal Touch in the immediately following interval. Obviously the smile was a powerful elicitor of maternal behavior.

Table 43.

EFFECT OF SELECTED INFANT BEHAVIORS ON MATERNAL AUDITORY-VOCAL BEHAVIOR AT LAG-1

	INFANT'S BEHAVIOR AT INTERVAL X-1:	P_0: MATERNAL VOCALIZATION AT INTERVAL X				
	MOTHER:	A	B	C	D	E
PHASE A	Vocalization	.337	.842+	.488+	.490+	.424-
	Smile	.514+	.853+	.514+	.469+	.397-
	Gesture	...	.674-	.512+	.673+	...
	Manipulate Toy	.211	.483-	.172-	.149	.381-
	Reach for Toy	...	...	.150-	.181	.282-
PHASE B	Vocalization	.744+	.602	$.633_{1-5}$+	...	.592
	Smile	.929+	.612	.682+	.368+	.761+
	Gesture	...	$.806_{1-5}$+	.740+	$.380_{1-5}$+	...
	Manipulate Toy	$.277_{1-5}$	.432	.271	.068	.333-
	Reach for Toy	...	.314	$.158_{1-5}$-	$.129_{1-5}$+	.557
PHASE C	Vocalization	.224-	.775+	.778	.750+	.594
	Smile	.409+	.843+	.836	.739+	.750+
	Gesture	...	$.778_{1-5}$+	...	.762+	...
	Manipulate Toy	.100	$.400_{1-5}$	...	...	.581
	Reach for Toy	...	$.427_{1-5}$	...	...	.552-

P_0 = Observed Probability

+ = $P_0 > P_E$, $p < .001$

- = $P_0 < P_E$, $p < .001$

... = Insufficient observations for analysis.

Table 44.

EFFECT OF SELECTED INFANT BEHAVIORS ON MATERNAL TACTILE BEHAVIOR AT LAG-1

	INFANT'S BEHAVIOR AT INTERVAL X-1:	P_0: MATERNAL TOUCH AT INTERVAL X MOTHER: A	B	C	D	E
PHASE A	Nonvocal Sound	.756-	.362-	.138-	.104-	.104-
	Vocalization	.983+	.744+	.409	.622+	.323
	Smile	.838-	.840+	.552+	.547	.231-
	Gesture	...	.419-	.415	.731+	...
	Manipulate Toy	.789-	.328-	.140-	.143-	.126-
PHASE B	Nonvocal Sound	$.752_{1-5}$-	.214	.096-	.204	.141-
	Vocalization	.956	.731+	$.958_{1-5}$+	...	.678+
	Smile	.976+	.940+	.970+	.439	.870+
	Gesture	...	.581	.880+	$.580_{1-5}$+	...
	Manipulate Toy	$.619_{1-5}$-	.114	.130-	.271	.153-
PHASE C	Nonvocal Sound	.129-	.194	...	.024-	.360-
	Vocalization	.805	.400	.911	.813+	.545
	Smile	1.000+	.490+	.904	.685+	.531
	Gesture	...	$.426_{1-5}$+	...	.571	...
	Manipulate Toy	.133-	$.133_{1-5}$	...	$.067_{1-5}$-	.410

P_0 = Observed Probability

+ = $P_0 > P_E$, $p < .001$

- = $P_0 < P_E$, $p < .001$

... = Insufficient Observations for analysis.

Table 45.
EFFECT OF SELECTED INFANT BEHAVIORS ON MATERNAL

AUDITORY-NONVOCAL BEHAVIOR AT LAG-1

	INFANT'S BEHAVIOR AT INTERVAL X-1:	P_0: MATERNAL NONVOCAL SOUND AT INTERVAL X MOTHER: A	B	C	D	E
PHASE A	Nonvocal Sound	.537-	.275	.228-	.063-	.119
	Vocalization	.733	.341	.370-	...	.082-
	Smile	...	.043-	.390	.192-	.162+
	Manipulate Toy	.500-	.350-	.167-	.099-	.148-
PHASE B	Nonvocal Sound	$.376_{1-5}$-	.214	.096-	.204	.098
	Vocalization	$.522_{1-5}$	...	$.022_{1-5}$-	...	.069
	Smile	...	...	...	.351-	$.048_{1-5}$
	Manipulate Toy	$.454_{1-5}$	.091	.087-	.322-	.097
PHASE C	Nonvocal Sound	.242-	.194	...	.286-	.228
	Vocalization	.488	...	...	...	.188-
	Smile	$.022_{1-5}$-	$.144_{1-5}$	...	.361	.281
	Manipulate Toy	.200-	$.181_{1-5}$	...	$.378_{1-5}$	.222

P_0 = Observed Probability

+ = $P_0 > P_E$, $p < .001$

- = $P_0 < P_E$, $p < .001$

... = Insufficient observations for analysis

Patterns of Mother-Infant Interaction

The mutual cycling of maternal and infant behavior states has been described by Tronick, Als and Brazelton (1977), who measured the synchrony and dyssynchrony of involvement states within dyads. Bell (1974) proposes a homeostatic model of mother-infant interaction, wherein both partners strive to maintain the interaction within tolerable bounds of excitement and quiescence by the mutual regulation of behaviors. The normal mother-infant interaction seems to involve bursts of activity preceded by gradual build-ups of activity by both partners, and followed by decreases in activity and occasional interruptions of mutual attention (Brazelton, 1972).

The homeostatic mechanisms seem to break down in the interactions observed for all infants except Infant B, with the mothers bearing the burden of initiating and maintaining the interaction. Interestingly, in the Toy sequences especially, the mother was often positioned behind the infant, manipulating the infant's hands through the appropriate motions. The demands of this strategy would confound the possibility of reciprocal behavior. An examination of the States of Involvement and of the cyclicity of individual maternal and infant behaviors bears out the clinical impression of a lack of mutual cyclicity in the subject pairs.

States of Involvement

The examination of Involvement States showed that Infant Low-Involvement States were followed by increases or decreases in Maternal

High-Involvement States in 12 of the 15 Phases analyzed across subjects. The infants did not show a reciprocal responsiveness to Maternal State. When Maternal Low-Involvement States occurred, only 6 out of the 15 Phases showed subsequent changes in Infant Vocalization rates, and five of these changes involved decreases in Vocalization rate. Maternal High-Involvement States preceeded decreases in Infant Vocalization or increases in Infant Low-Involvement States in 5 of the 15 Phases. In 5 Phases, Infant Vocalizations increased following Maternal High-Involvement; and in 5 Phases, no effect was found. Only Infant B showed consistent responses to Maternal High- and Low-Involvement States, decreasing Vocalization following Maternal Low-Involvement and increasing Vocalization following Maternal High-Involvement. The other infants showed inconsistent patterns of responsiveness across Phases.

Cyclicity of Infant and Maternal Behavior

An examination of the lag profiles of the autocontingencies of individual infant and maternal behaviors shows startling differences in cyclicity between mothers and infants. Simple visual inspection of these autocontingency curves (see Appendix F) is sufficient to reveal a striking cyclicity in infant behaviors contrasting with a lack of cyclicity in maternal behaviors. Whereas the infants' behaviors appear to wax and wane with fair consistency over time, the mothers seem, after initiating a behavior, to persist in that behavior almost stereotypically for a considerable time period.

A proportional measure of behavioral cyclicity was derived by counting the number of reverses in the direction of the autocontingency curves and dividing this by the number of opportunities for direction reversal with one curve or set of curves (a maximum of 14 direction reversals could occur in a 15-lag profile). Direction reversals were not counted unless they occurred in an area of a curve in which there was at least a .40 absolute difference in value between the peak and the trough. Table 46 (p.192) displays these measures of infant cyclicity for all infants, collapsed across Phases. Table 47 (p.193) displays the maternal cyclicity measures, similarly collapsed. The figures in these tables bear out the impressions left by visual scanning of the lag profiles. The highest proportion of maternal cyclicity (averaged across behaviors) was .14 (Mother E), with average proportions ranging downward to .07. The lowest proportion of infant cyclicity (averaged across behaviors) was .17 (Infant D), with proportions ranging upward to .34.

Table 46. INFANT CYCLICITY: PROPORTION OF CYCLICITY* IN AUTOCONTINGENCY CURVES FOR SELECTED INFANT BEHAVIORS (COLLAPSED ACROSS PHASES A, B, and C)

	INFANT					
INFANT BEHAVIOR	A	B	C	D	E	$\bar{X}$
Vocalization	.29	.24	.36	.13	.19	.25
Smile	.17	.31	.24	.17	.19	.22
Gesture	...	.40	.29	.11	...	.24
Reach for Toy	...	.57	.29	.14	.40	.39
Manipulate Toy	.36	.39	.25	.18	.19	.26
Nonvocal Sound	.57	.31	.18	.21	.14	.24
$\bar{X}$	.30	.34	.26	.17	.22	

... = Insufficient observations for analysis.

* Proportion of Cyclicity =

$$\frac{\text{\# direction reversals within autocontingency curves}}{\text{\# opportunities for direction reversal within autocontingency curves}}$$

A direction reversal is counted only if the absolute difference in value between the high and low points of the area of the curve in which it occurs equals or exceeds .40.

Table 47.

MATERNAL CYCLICITY: PROPORTION OF CYCLICITY* IN AUTOCONTINGENCY CURVES FOR SELECTED MATERNAL BEHAVIORS (COLLAPSED ACROSS PHASES A, B, and C)

	MOTHER:					
MATERNAL BEHAVIOR	A	B	C	D	E	$\bar{X}$
Vocalization	.05	.05	.12	.17	.21	.12
Touch	.00	.05	.07	.07	.07	.05
Nonvocal Sound	.17	.14	.25	.17	.14	.17
$\bar{X}$	.07	.07	.13	.13	.14	

* Proportion of Cyclicity =

$$\frac{\text{\# direction reversals within autocontingency curves}}{\text{\# opportunities for direction reversal within autocontingency curves}}$$

A direction reversal is counted only if the absolute difference in value between the high and low points of the area of the curve in which it occurs equals or exceeds .40.

Clinical Implications

Clearly, the infants achieved a great degree of control over their mothers' behavior, while the reverse was not true. The mothers, who among them displayed very varied rates of behavior overall, changed behavior rates quickly and frequently in response to infant behavior. The infants, on the other hand, most frequently did not change behavior rates in response to maternal behavior. Thus, the infants were more efficient at controlling their partner than were their mothers. The failure of the mothers to clue into their infants' naturally rhythmic behavior patterns by producing mutually cyclic behavior confirms Fraiberg's observation that mothers need to be trained to communicate with their blind infants, despite their most earnest efforts.

All the mothers in this project were encouraged to implement home programs for their infants by the CSC. These programs generally included instruction in tactile stimulation, vestibular stimulation, locomotor training, and language stimulation. It seems that a more general program of parent behavior would be a useful addition to the programs which emphasize the delivery of specific types of stimulation to the infant. The mothers seem to need help in learning to pace themselves with their infant and to pattern their behavior in a reliable, but non-stereotypic fashion. Perhaps the mothers (and fathers) could be trained

to consciously adopt their infants' strategies of rhythmically increasing and decreasing rates of behavior. Instruction might be offered in the systematic alternation of vocalization and silence, the presentation and withdrawal of tactile stimulation, and the production and cessation of nonvocal sounds. Suggestions for a program of maternal vocalization and maternal response to infant vocalization are offered below.

Strategies for Enhancing Communicative Vocal Behavior in Visually Impaired Infants

Typical suggestions for language stimulation offered to these mothers included the following:

Place the infant's hands on your throat, mouth, teeth, tongue as you speak, then place the infant's hands on his/her own oro-facial structures;

Talk with your lips placed against the infant's cheek or ear;

Accompany verbal directives to the infant with tactile signals;

Keep up a running verbal commentary as activities are performed with the infant;

Start talking as soon as you enter the infant's room, continuing to talk as you approach the infant;

Read stories to the infant;

Imitate both verbal and nonverbal vocalizations of the infant.

Without training in the proper timing of such techniques, it seems likely that some of these strategies might actually work to reduce vocalizations in a sightless infant.

Given the importance of auditory input to the blind infant, it would seem that an appropriate maternal response to infant vocalizations would include the cessation of vocal and nonvocal auditory stimuli. The occurrence of auditory stimuli does not seem to be at all conducive of infant vocal behavior. Thus, it would seem appropriate that vocalizations be reinforced immediately in the Tactile rather than the Vocal mode. If Vocal reinforcement is required due to the physical separation of mother and infant, then it should be delayed until the infant clearly pauses, so that the interruption of infant vocalization does not occur. Thus, concurrent vocalization would not be a wise strategy. The strategy of moving the infant's hand back and forth between mother's and infant's oro-facial structures may be confusing to the infant, particularly if mother continues to talk as she moves the infant's hand back to his or her own mouth or throat. Perhaps this general strategy could be altered, however, to provide the infant with a cue that mother has stopped talking, is not about to talk again right now, and thus that it is "safe" for the infant to vocalize. The mother might hold the infant's hand on her own throat while she vocalizes and also for a short period after she has stopped vocalizing. Then the infant's hand could be replaced on the infant's throat, while mother maintains her silence.

A carefully prescribed and consistent response to infant vocalizations seems to be lacking in the environments observed in this project. Given that vocal-verbal behavior will probably be the first recognizably

referential behavior in sightless children, a tightly structured program for maternal response to vocalizations should be beneficial. The considerations outlined above suggest a carefully engineered program for vocal stimulation in blind infants. Such a program would be structured around the following principles:

Infant vocalizations should be reinforced as frequently and consistently as possible.

While an infant is actually vocalizing, tactile reinforcement may be appropriate, but vocal reinforcement should be withheld.

Vocal reinforcement may be provided a short time after the infant ceases to vocalize.

Vocal reinforcement should include the imitation of the infant's nonverbal and verbal sounds.

The infant should be cued to the appropriate moments for vocalization by emphasizing the difference between periods of maternal vocalization and maternal silence. This could be accomplished either by maintaining the infant's hand on the speaker's mouth or throat for a short period after vocalization ceases, or by the mother continuing to hold her mouth against the infant's mouth or cheek during periods of silence.

A constant barrage of verbal commentary by the mother may not be advisable. Although a certain quantity of language stimulation is important, the quality of such stimulation might be improved by offering short bursts of commentary, interspersed with short periods of silence.

The effectiveness of the individual strategies suggested above could be tested separately in experimental situations. If any of these techniques do increase infant vocalization rates during mother-infant interactions, then a vocal stimulation program should be designed incorporating these techniques. The implications of such a program for subsequent language acquisition could be assessed following a suitable implementation period.

Prediction: The Utility of the Pragmatic Perspective

Development of the Gestural Complex

Bates (1977a) proposes an "expansion" model of communication development--a model in which linguistic structures are added to the existing communicative repertoire, rather than replacing it. The nonverbal communicative repertoire which is expanded consists largely of conventional signals which did not appear for the most part among the subjects of this study. Nevertheless, it seemed fruitful to look at the development of the nonconventional gestural complex in these subjects in the hope of finding parallels with the conventional gestural complex investigated by Bates. Table 48 (p. 200) shows the frequency of communicative gestures in the five blind subjects as well as of smiles and vocalizations and combinations of these behaviors which included gestures. Bates' expansion model would receive some support from a progressive decrease in the occurrence of single-component communicative events and an increase in multi-component communicative events over time, or a "progressive complication of the basic communicative function," to reiterate Clarke's phrase. Once again, Infant B stands out, showing a very clear pattern of increasing complexity of communicative events. In Phase A, 72% of her gestures were unaccompanied by either smiles or vocalizations, while in Phase C, only 36%

Table 48. GESTURAL COMPLEX

	Pair A			Pair B			Pair C			Pair D			Pair E		
Phase:	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C
Gesture Alone*	.23	.00	.25	.72	.48	.36	.29	.78	.40	.26	.45	.21	.50	1.00	.00
Gesture + Smile*	.23	.00	.25	.09	.06	.18	.26	.16	.20	.51	.30	.49	.00	.00	.25
Gesture + Vocalize*	.08	.00	.00	.05	.30	.09	.21	.02	.40	.08	.05	.14	.50	.00	.50
Gesture + Smile + + Vocalize*	.00	.00	.25	.14	.15	.36	.14	.00	.00	.15	.20	.16	.00	.00	.75
Total Gestures**	.02	.00	.01	.07	.09	.03	.06	.18	.03	.08	.07	.15	.00	.00	.01
Total Smiles**	.05	.10	.10	.23	.19	.26	.15	.23	.52	.20	.20	.40	.14	.10	.11
Total Vocalizations**	.26	.22	.41	.21	.27	.21	.18	.08	.32	.06	.09	.11	.47	.35	.36
Concurrent Vocalizations**	.09	.14	.10	.17	.16	.16	.07	.05	.23	.03	.02	.08	.19	.19	.21

* Out of total # gestures

** Out of total intervals

of her gestures were solitary events, and 36% were accompanied by both smiles and vocalizations. The other subjects showed no clear pattern of gestural development.

Pragmatic Prerequisites for Language Development in Visually Impaired Infants

Let us turn now to the development of more general pragmatic structures in the subjects of this study. Table 49 (p.202) presents the results of the Bates interview administered at the beginning and end of this project. Since only Infant B attained the locutionary stage, and since she was also so far advanced in all areas of development, it is not possible to draw firm conclusions regarding the general applicability of pragmatic theory to these subjects. However, some tentative implications of the data are discussed below.

All the subjects displayed some repertoire of nonconventional, expressive gestures. All subjects also became more adept at obtaining objects for themselves and attracting attention to themselves over the course of the study. All of them engaged in some vocal imitation, and all developed some sort of receptive vocabulary. But Infant B alone began to use words spontaneously and communicatively, and Infant B alone used any conventional gestures. Bates suggests that the components of the gestural complex (Giving, Showing, Communicative Pointing and Rutualized Requests) are associated by a factor involving (a) a communicative function, (b) the use of conventional signals, and (c)

Table 49. Pre- and Post- Project Scores on Bates Communicative Skills Interview

Subject:	A		B		C		D		E	
Age in Months (Pre and Post):	10	16	14	21	16	22	29	36	32	37
GESTURAL COMMUNICATION										
Points								?		
Shows										
Gives				x						
Expresses Desire:										
Cries/Whines	x	x			x	x			x	x
Agitates					x	x	x	x		
Reaches		x	x	x	x	x	x	x	x	x
Special Sound	x	x	x	x			x	x		x
Word				x						?
Moves to Object				x				x	x	x
Expresses Dislike:										
Cries/Fusses	x	x	x	x	x	x	x	x	x	x
Agitates		x							x	x
Special Sound		x			x	x		x		x
Pushes Away		x			x	x		x	x	x
Averts Head		x			x	x	x	x	x	x
Shakes Head				x						?
Word				x						
Shows Off			x	x		?				
Laughs with Others	x	x	x	x	x	x			x	x
Repeats Behavior for Laughter				x	x	x				
* # Nonconventional Gestures in Films	9	24	13	18	4	47	5	44	5	14
# Conventional Gestures	0	0	2	12	0	0	0	0	0	0

* Pre-score = # different gestures produced in four films from 1st observation: Post-score includes all new gestures produced in subsequent films.

Table 49, continued

	A		B		C		D		E	
	10	16	14	21	16	22	29	36	32	37
PLAY/IMITATION										
Likes Music			x	x	x	x	x	x	x	x
Dances to Music				x						
Sings to Music			x	x						
Combinatorial Play				?	?	x				
Pretends										
Imitates Vocalization		?	x	x	x	x	x	x	x	x
Imitates Gestures			x	x	?	x				
Imitates Activities			x	x	?	x				
# Games Played	0	0	5	10	2	5	3	5	5	8
LANGUAGE										
Understands "no"			x	x	x	x			x	x
Responds to "where is"			x	x		x				x
Responds to "go find"				x						?
Excitement Response to Pleasant Words			x	x	x	x	x	x	x	x
Negative Response to Unpleasant Words				x		x				
Touches Named Item			x	x						
# Words Comorehended	0	3	10	60	5	9	4	6	8	?
# Words Spontaneously Produced	0	0	10	42	0	0	1	1	0	1

some external reference. Infant B's behavior fits this notion nicely. The appearance of her conventional gestures was associated with an increasingly sophisticated receptive vocabulary. Her conventional gestures appeared as tricks, in response to commands by adults, and they did not include showing, pointing or giving. Thus, the closest behaviors to conventional illocutionary ones did not appear until locutionary behavior also appeared. This developmental sequence might be explained by a delay in the concept of an external referent. Not until a distal referent may be indicated would indicating gestures be expected to appear. It is quite likely that the function of distal reference may first be accomplished through verbal behavior by the blind child. It is noteworthy that Infant B's early conventional gestures involved touching her own body parts, while as her linguistic skills increased, she became able to gesturally indicate (through touch) the same body parts on other people. The other four infants all seemed to acquire the communicative function, and some conventional gestures were emrging in Infants C, D and E--but none of them demonstrated a clear concept of external reference.

To understand why the traditional pragmatic gestural performatives did not appear in these subjects, one need only examine the behavioral descriptions of the stages of performative acquisition offered by Snyder (1978) which were listed in Table 1 (p. 11). The imperative descriptions all include looking, pointing, or extending the arm towards an object or adult, except at the highest stage (locutionary),

when a linguistic symbol is used. The blind child does not look or point. He or she may extend an arm toward an object in reaching, but a reach is only likely if the object is known to be within reach. Using Snyder's definitions, it is unlikely that a blind child would produce a gestural imperative (the use of an adult to obtain an object). The blind child may develop the means to obtain objects independently before he/she develops the ability to enlist help in obtaining an object. Trying to coordinate an unseen adult with an unseen object, both of which may be beyond reach, without truly referential behavior would be exceedingly difficult.

In terms of declarative performatives (obtaining adult attention through the use of objects), the early attention-getting devices (showing off, direct manipulation of an object) may exist in the blind child, but they are more likely designed to attract attention to the self than to an object. Here again, the intermediate stages of declarative behavior include looking, pointing, and other visually guided behaviors cannot be reasonably expected in a blind child. It is these visually guided behaviors which enable the dual-orientation in the sighted child that allows the coordination of person and object relationships. Only when the sightless child begins to use words will it become clear that the intent of a behavioral display is to direct attention to an external object rather than to the self.

Even the more global behaviors of giving and showing, which normally form the basis of early games and turn-taking rituals, are of

little relevance with these subjects. Showing, of course, requires visual monitoring as well as the ability to comprehend another person's visual attention. Giving is a behavior that can eventually be expected in the blind child, but it too requires dual-orientation, not to mention object permanence, person permanence, and the ability to distinguish between the self and others. In short, most of the gestural responses which form the basis of what Bates calls illocutionary behavior are absent in the blind child. The blind child can be expected to indicate a referent only through touch or vocal behavior. If an object is close enough to be touched, then there is no need to enlist adult help in obtaining it. If it is not within reach, then the child must refer to it at least on the level of special sounds or proto-words. Just as the blind child may go directly from sitting to walking, unable to explore the distal environment at all until posturally mature enough to walk, so he/she seems to make a tremendous leap in communicative development in terms of the pragmatic model, skipping from perlocutionary to locutionary behavior, without ever displaying the proto-imperatives and proto-declaratives characterizing the illocutionary stage. Given the improbability that a blind child will acquire conventional referential gestures prior to speech, it is questionable whether a program designed to increase an infant's natural repertoire of expressive gestures would be terribly fruitful. It would be interesting to investigate whether the conventional indicating gestures could be trained imitatively in a blind child, but it is doubtful that

the communicative intent associated with these gestures could be trained.

Cognitive Structures and Pragmatic Theory

Bates (1977a) describes the relationship between cognitive and communicative structures via a "local homology" or skill-specific model, with the various communicative and cognitive measures related by particular subsets of schemes. According to this model, related cognitive and communicative behaviors would appear at roughly the same time, but no particular order would be imposed upon their emergence. Greenwald and Leonard (1979) examined the utility of Bates' perspective in Downs syndrome children and found that their performative behavior was strongly associated with sensorimotor stage, especially with younger subjects. No adequate assessment of cognitive development in blind infants exists, so it was not possible to characterize the subjects of the current study according to Piagetian stages. It does seem, however, that cognitive schemes would be especially critical to language development in the blind child.

If gestures are dependent upon a concept of external reference, then the blind child would be at a severe disadvantage. The sighted child may through casual observation absorb the concepts of agent, action, object and the relationships between them. The sightless infant, however, probably depends upon more active exploratory experiences, requiring a high degree of locomotor ability, to acquire these relationships critical to dual-orientation and the establishment of joint,

external reference. No doubt, Infant B's advanced locomotor abilities were critical to her advanced cognitive development.

The play measures investigated by Bates--combinatorial and symbolic play--did not serve the predictive value that they did for her sighted infants, where they were highly correlated with the gestural complex. Both types of play were notable for their absence among the five infants. This is most surprising in the case of Infant B. The lack of combinatorial play, however, may reflect the lack of importance attached to object relation training in the home and may be an experiential rather than a cognitive deficit. The delay in symbolic play would be expected, given the self/other confusion typically manifested in the pronoun useage of visually impaired children.

The development of Infant B in several areas simultaneously, and the lack of development in the other infants across areas would be compatible with a theory stressing the interrelationship of locomotor, cognitive and communicative behaviors. The data do not, however, permit a choice between Piagetian (or stage-dependent) and neo-Piagetian models of development.

Summary

The pragmatic model of language development simply does not fit these data comfortably. Certain elements of conventional preverbal or proto-conversational behavior were exhibited by the infants, but many others were not. Furthermore, a number of cognitive constructs or schemes considered to be strongly related to language acquisition by

Bates were absent. Still, the infants managed to communicate enough to exert a great deal of control over their mothers. No doubt, these infants had all exhibited truly perlocutionary (pre-intentional, expressive) behavior at younger ages, prior to the start of this project. Subsequently, however, they seemed to move through a stage of idiosyncratic, but highly intentional expressive behavior to a stage of filling their own needs rather than trying to communicate them. This stage of doing for oneself had been superceded by vocal-verbal referential behavior only in Infant B. In short, the severe deviations of these visually impaired subjects from the pragmatic model of language development suggest that the model is highly specific to a normal population, at least as it is traditionally operationalized.

EPILOGUE

The CSC personnel were contacted six months after the last observations of the subjects and were asked to update the accomplishments of these infants. Infant B is currently initiating three-word combinations, walks independently, and can choose a named item from a three-choice array. Her deficits lie in feeding skills and motor planning. None of the other infants is yet using words spontaneously. Infant A continues to improve postural and exploratory skills. She reaches in any direction to a sound cue, comprehends several words, and will gesturally indicate (by patting) her desire for an activity to continue. Infant C had started to cruise around her environment, but because of recent hospitalizations has not made dramatic improvements in the last six months. Infant D, whose parents felt that her abilities were regressing, has been placed in a residential care facility, where she reportedly interacts eagerly with attendants and responds well to therapy classes. Infant E's vision continues to improve, but he has made little progress and still does not walk. He has not been followed by the CSC since this project terminated, due to lack of parent follow-through of home programs. He is reported to have used two words spontaneously as a request, but not consistently.

As time progresses, additional handicaps may be revealed in these infants which would explain their painfully slow development. Alternatively, the considerable delay in the diagnosis of visual impairment and the subsequent delay in the onset of therapeutic intervention may constitute the critical disparities between Infant B and the other infants. For approximately six months, the other infants were not known to be without sight and presumably were treated as normal infants. The inappropriate interaction patterns fostered by this assumption must have operated to produce frustration in the parents and confusion in the infants. If the foundations of social-interactive behavior are normally established in the first few months of life, then the failure to establish mutually satisfying communicative interactions during these critical first months would be difficult to remediate. The time required to undo ineffective interaction patterns and to forge new, effective ones may far exceed the time it took to establish faulty patterns through the implementation of inappropriate strategies.

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Appendix A

Glossary of Infant and Maternal Behaviors for Film Analysis: Communication in Visually Impaired Infants

GLOSSARY OF INFANT AND MATERNAL BEHAVIORS FOR FILM ANALYSIS:

COMMUNICATION IN VISUALLY IMPAIRED INFANTS

1) Where more than one behavior occurs in the same interval within one category, score the behavior which appears highest on the page. The subcategories are ranked so that from the top to the bottom of a category, behaviors should go from most communicative and most involved with persons and things other than the self to least communicative and least involved. However, if a behavior occurs that seems extremely important, but it is outranked by a co-occurring behavior in the category, then score both behaviors, scoring the first with a 1 and the second with a 2. This way the information can be either used or ignored later as we see fit. One example is the "release" subcategories which are probably very important in an interaction, but which will probably be immediately preceded in an interval by "manipulate" or "hold," which have higher priorities overall. The other very important subcategory is "reach," which will probably be followed by "hold" or "manipulate" within the same interval. If either "release" or "reach" behaviors occur, be sure to score them in addition to any higher priority behavior that might co-occur.

2) Remember: when conflicts occur, we are interested in behaviors that may be communicative, and we are more interested in the infant's behavior than in the mother's.

3) Whenever you see immediate imitation by either mother or infant of a vocalization, put an asterisk by the scored behavior for the partner who performed the imitation (not the one who was imitated).

4) When you're really stumped by a behavior, put it under "other" or "none." If something very new or interesting or confusing appears which we might want to adapt our analysis to accommodate, be sure to describe it in detail, along with its location on the film, on the Comment sheet, so that we can discuss it later.

5) The actual data sheet was designed for an earlier version of this code. Therefore, you will find some codes here which need to be written onto the data sheet, since there is no space for them. In addition, the priority of codes in this glossary takes precedence over the order of codes as they are listed on the data sheet. Codes here are listed in order from highest to lowest priority.

Infant

Aud/NV (Auditory/Nonvocal)

This category should indicate whether the infant causes a sound to be made that is not vocal (not made by the voice). This would include sounds made by moving toys (whether they seem deliberate or not), banging hands or toys on the floor, clapping hands, etc. While many of the sounds won't be deliberate, they may still serve to attract mother's attention.

Nonvocal sound (1): Score if a sound as described above is made by the infant. If mother is responsible for making the infant make a

noise with a toy (for instance if mother forces infant to hold a toy and forces infant to rattle toy), then mother should be credited for the nonvocal sound in Aud/NV under Mother behavior.

None (0): Score if no such sound is caused or made by the infant.

Aud/Voc. (Auditory/Vocal)

This category should reflect whether or not the infant makes a noise using her voice. This would include laughing, babbling, talking, etc.

Linguistic (2): Score if a recognizable English word is produced. It does not have to be perfectly produced; it may be an attempted imitation. List words produced in Appendix I.

Nonlinguistic (1): Score if a vocal sound is made that isn't a word (burbling, cooing, crying, coughing, babbling, etc.).

None (0): Score if no vocal sound is made.

Head

Here we are only interested in two aspects: distinct gestures and visual orientation (for the two partially sighted infants only). There may be many other types of head movements.

Gesture (4): Score if infant seems to nod or shake head deliberately (not just because the rest of the body is moving) or if some other gesture-like motion appears. Be sure to list these gestures in Appendix I.

Orient (2 & 3): This subcategory covers visual orientation for Danielle and Clinton (who are able to orient visually). Score VA (code = 3) for appropriate visual orientation (orienting to the object or person that is the focus of the current interaction). Write VI (code = 2) for inappropriate visual orientation (orienting toward something that is not focal to the interaction). VA has higher priority than VI. Unless there is a head gesture, these two infants will always receive a score of 2 or 3.

Other (0): Score for all other head activities, whether they include movement or not. This category will only be used with the totally blind infants.

Face

Here we're interested only in the presence or absence of very obvious facial expressions.

Positive (2): Score if infant smiles or laughs or makes a similar clearly positive facial expression.

Negative (1): Score if infant frowns, grimaces, cries, or makes other clearly negative facial expression.

Other (0): Score for any facial expression not easily identifiable as positive or negative.

Hands

This is a difficult but crucial category, since the tactile sense is so important to the blind.

Spontaneous gesture (13): Score if you see any hand movements that do not fit the other subcategories and that you interpret as being expressive. In these children, gestures will probably be limited to expressions of affective state: you may see such behaviors as waving arms or clapping hands when excited, or clenching fists and abducting arms when unhappy. This will be a very subjective judgment, but try to remain alert for possible gestures. Do not score as gesture any manual behavior occurring during stereotypic behavior. Be sure to list all these gestures in Appendix I.

Exploratory space (2): Score if infant seems to reach out and move hands to determine if anything is out there, rather than in an attempt to find a specific item. The ambulatory child may explore the surrounding air space while engaged in locomotor activity; the nonambulatory child may feel the surfaces around herself while she sits on the floor or on a couch.

Elicited gesture (71): Score if infant produces a gesture in response to mother's request for a specific one. Examples would be touching the nose in response to, "Where's your nose?", waving in response to, "Wave bye-bye," clapping hands in response to, "Patty-cake," etc.

Reach for mom (8): Score if infant makes a reaching movement that is clearly directed towards mother (this may be a fairly subjective judgment). Score whenever reaching occurs. If a higher priority behavior co-occurs, score it also.

Reach for toy (7): Score as above, but involving toys. Score whenever reaching occurs. If a higher priority behavior co-occurs, score it also.

Release mom (6): Score if infant has been manipulating or holding mother and deliberately releases her grasp on mother. Score whenever releasing occurs. If a higher priority behavior co-occurs, score it also.

Release toy (5): Score if infant has been manipulating or holding toy and deliberately releases her grasp on it. Score whenever releasing occurs. If a higher priority behavior co-occurs, score it also.

Explore mom (10): Score if infant is touching mother, but more with the fingertips and a flat palm than with fingers moving to grasp and manipulate. The hand may be moving, but the fingers are moving only to feel, not to grip. The hands are being used as sense organs, rather than as tools.

Explore toy (9): Score if infant is touching toy as above.

Manipulate mom (12): Score if infant is actively using hands while touching mother. Infant should be using a firm grip or moving hand and fingers while touching mother or making mother move. Score if infant is holding mother in order to support herself, for instance in a standing position.

Manipulate toy (11): Score if infant is touching toy and using hands actively as described above.

Hold mom (4): Score if infant is passively holding onto mother--this would be less active than "manipulate" or "explore mom."

Hold toy (3): Score if infant is passively holding onto toy; infant may be doing something else with the hand while holding the toy, as if the toy weren't even there.

Withdraw hand from mom (73): Score if infant withdraws hand after touching mother. This is similar to release, except that infant has not actually grasped mother.

Withdraw hand from toy (70): Score if infant withdraws hand after touching toy, as above.

Push away mother (74): Score if infant seems to actively ward off, push away, or raise arm against mother while she is in physical contact with infant.

Touch self (1): Score if infant's hands manipulate or explore her own body. The fingers should be moving at least slightly. If hands simply fall into contact with infant's body and simply rest there, score for the initial contact; thereafter (while hands remain in passive contact with body), score as "other" (see below). Score if infant sucks thumb.

Other (0): Score for all hand movements not categorized above. Score if hands rest in passive contact with body (see "touch self"). Score if mother holds infant's hands and controls their activity.

Body

Here we want to note general body orientation towards the mother to get an idea of the infant's level of involvement and emotional state.

This category can describe either the body posture of the sitting child or the direction of movement of a child who is crawling or walking around. We are only interested in obvious changes in body orientation.

Approach mom (2): Score if infant actively walks, crawls, or moves toward the mother, or if the sitting child actively leans toward mother apparently to get closer to mother, not just to find a toy that might be close to mother.

Avoid mom (1): Score if child actively withdraws from or draws away from mother by actually moving away or by simply leaning or pulling back from mother. Child should be expressing negative affect; do not score if child withdraws from mother in the process of approaching a toy or another person.

Other (0): Score for all other postures or orientations.

Stereotypic Behavior

Here we want to note the presence or absence of self-stimulatory behavior such as rocking or of inappropriate stereotypic behavior with a toy such as constant banging of a toy on the ground without appropriate exploratory play.

Stereotypic toy (2): Score if infant engages in repetitive, inappropriate use of a toy or any inanimate object. Score if infant engages in stereotypic body behaviors while holding a toy, even if toy is not actively manipulated.

Stereotypic body (1): Score if infant engages in repeititious self-stimulatory behavior such as rocking, eye-rubbing, hand biting, etc., involving infant's own body.

Self-abusive stereotypy (75): Score if infant engages in clearly self-abusive behavior, such as hand-biting or head-banging.

None (0): Score if no stereotypic behavior occurs.

Mother

Tactile

This category should reflect whether the mother touches the child with her hands or with her face. Thus it may include mother nuzzling infant with her face or kissing infant. It should not include touching by other parts of the mother's body.

Touch baby/caress (3): Score for all instances where mother touches infant in a definitely tender, caressing manner. This will not include passive touching or holding of the infant, but only more positive caresses such as embracing, stroking, tickling, etc.

Touch baby/restrain (2): Score if mother touches infant in order to stop infant's activity or to prevent infant from starting to do something. This includes removing an object from the infant's grasp.

Touch baby/direct (1): Score if mother touches infant in order to direct or guide infant's behavior. This category will include passive touching or holding. Mother may be holding infant's hands to guide them through a motion, she may rearrange infant on floor, or she may nudge infant with a toy or put a toy in contact with the infant to direct infant's attention to it. Indirect touching with an inanimate object should be scored.

Visual direction (70): Score if mother holds up an object or holds out a hand for the infant to see, without touching the infant. Obviously, this category is only applicable to the two partially sighted infants.

Not touch infant (0): Score if neither hands nor face of mother are in contact with infant and if there is no "visual direction."

Aud/Vocal (Auditory/Vocal)

This category should reflect whether the mother makes a sound using her voice.

Linguistic-positive (4): Score if mother utters a word or words with a positive meaning that is reflected in at least one word with an objectively positive meaning such as "good," "pretty," "smart," and other such words of praise or affection. Do not score for an utterance with a positive tone, but no word that can objectively be described as positive. Do not score for a phrase such as, "Aren't you going to be a good girl today?" which has a positive word (good) in it, but which has a tone of threat or reprimand to it.

Linguistic-negative (3): Score if mother utters a word or words with a negative meaning that is reflected in at least one word with an objectively negative meaning such as "bad," "stop," "no," "don't," etc. Do not score if utterance is negative in tone, but there is no word that can be objectively described as negative.

Linguistic-other (2): Score if mother utters a word or words that cannot be clearly categorized as positive or negative in both

meaning and word content. Include such quasi-words as "uh-huh," that carry conventional meaning.

Nonlinguistic (1): Score if mother makes a vocal sound that does not include recognizable English words. This may include laughing, sneezing, imitating infant's babbling, etc.

None (0): Score if mother makes no vocal sound of any sort.

Aud/NV (Auditory/Nonvocal)

This category should reflect whether or not mother causes a sound to be made that is not vocal.

Nonvocal sound (1): Score if mother causes a sound to be made that is not made by her own voice. This would include sounds made with inanimate objects and with her own body. Score here if mother causes infant to make a noise (by making infant rattle a toy or clap hands, etc.).

None (0): Score here if mother does not cause such a sound.

Appendix B

Observational Code Check List and Data Sheets

Infant _____ Observer _____

Date of Analysis _____ Date of Film _____

Page # _____ Seconds per Interval _____ Film # _____

			Interval: 1	2	3	4	5	6	7	8	9	10	11	12	13	14
	I N F A N T															
Aud NV	nonvocal sound	1														
	none	0														
Aud/Voc	linguistic	2														
	nonlinguistic	1														
	none	0														
Head	gesture	2														
	orient	1														
	other	0														
Face	positive	2														
	negative	1														
	other	0														
Hands	gesture	13														
	manipulate: mom	12														
	toy	11														
	explore: mom	10														
	toy	9														
	reach for: mom	8														
	toy	7														
	release: mom	6														
	toy	5														
	hold: mom	4														
	toy	3														
	explore space	2														
	touch self	1														
	other	0														
Body	approach mom	2														
	avoid mom	1														
	other	0														
Ster	stereotypic: toy	2														
	body	1														
	none	0														
	M O T H E R															
Tactile	touch baby: caress	3														
	restrain	2														
	direct	1														
	not touch baby	0														
Aud/Vocal	linguistic: pos.	4														
	neg.	3														
	other	2														
	nonlinguistic	1														
	none	0														
Aud NV	nonvocal sound	1														
	none	0														
			1	2	3	4	5	6	7	8	9	10	11	12	13	14

Appendix I

Infant _____ Observer _____

Date of Analysis _____ Date of Film _____

Page #	Interval #	Description	INFANT'S GESTURES

Page #	Interval #	Description	INFANT'S LINGUISTIC UTTERANCES

Page #	Interval #	Description	GAMES PLAYED

Appendix II

Infant _____ Observer _____

Date of Analysis _____ Date of Film _____

Page # (if appropriate)	Interval #	COMMENTS

Appendix C

Average % Relaiability for Each Subject

AVERAGE % RELIABILITY FOR EACH SUBJECT

	Pair A	Pair B	Pair C	Pair D	Pair E	Average
INFANT BEHAVIOR CATEGORIES						
Auditory Nonvocal	100	97	96	96	98	97
Auditory Vocal	93	96	97	100	92	96
Head	100	97	97	89	86	94
Face	91	95	95	95	87	93
Hands	95	90	94	93	92	93
Body	98	96	100	100	94	98
Stereotypy	100	100	99	100	95	99
MATERNAL BEHAVIOR CATEGORIES						
Tactile	93	95	94	96	95	95
Auditory Vocal	*76	92	90	94	91	89
Auditory Nonvocal	95	98	97	98	98	97
AVERAGE	94	96	96	96	93	

* This mother's voice was often inaudible.

Note: %Reliability was assessed using the Following formula:

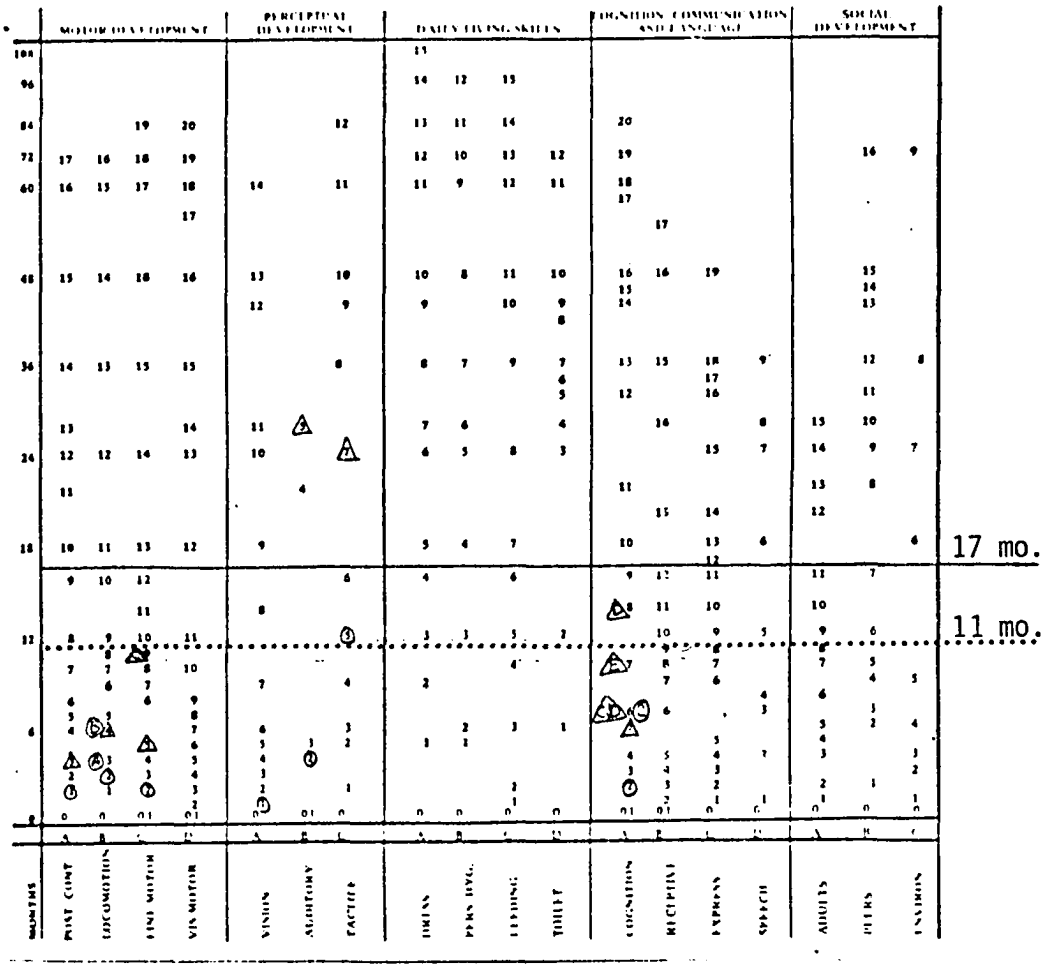
$$100 \times \frac{\text{\# Agreements}}{\text{\# Agreements + \# Disagreements}}$$

Scores above represent % reliability acheived across sessions scored after the minimum criterion of 80% reliability per subject per category had been reached.

Appendix D

Callier-Azusa Profiles for Each Subject

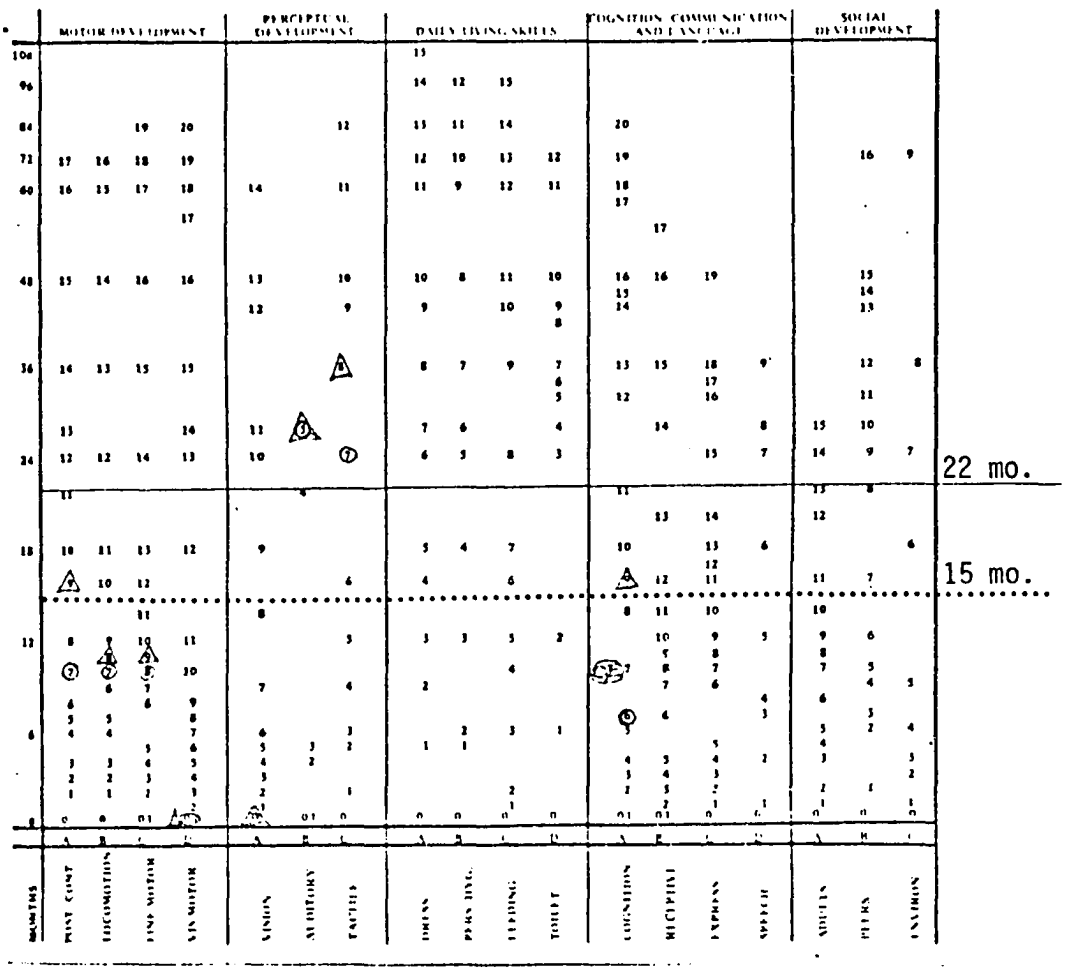
CALLIER-AZUSA SCALE



INFANT A

○ = 11-1978 (11 mo.) △ = 5-1979 (17 mo.)

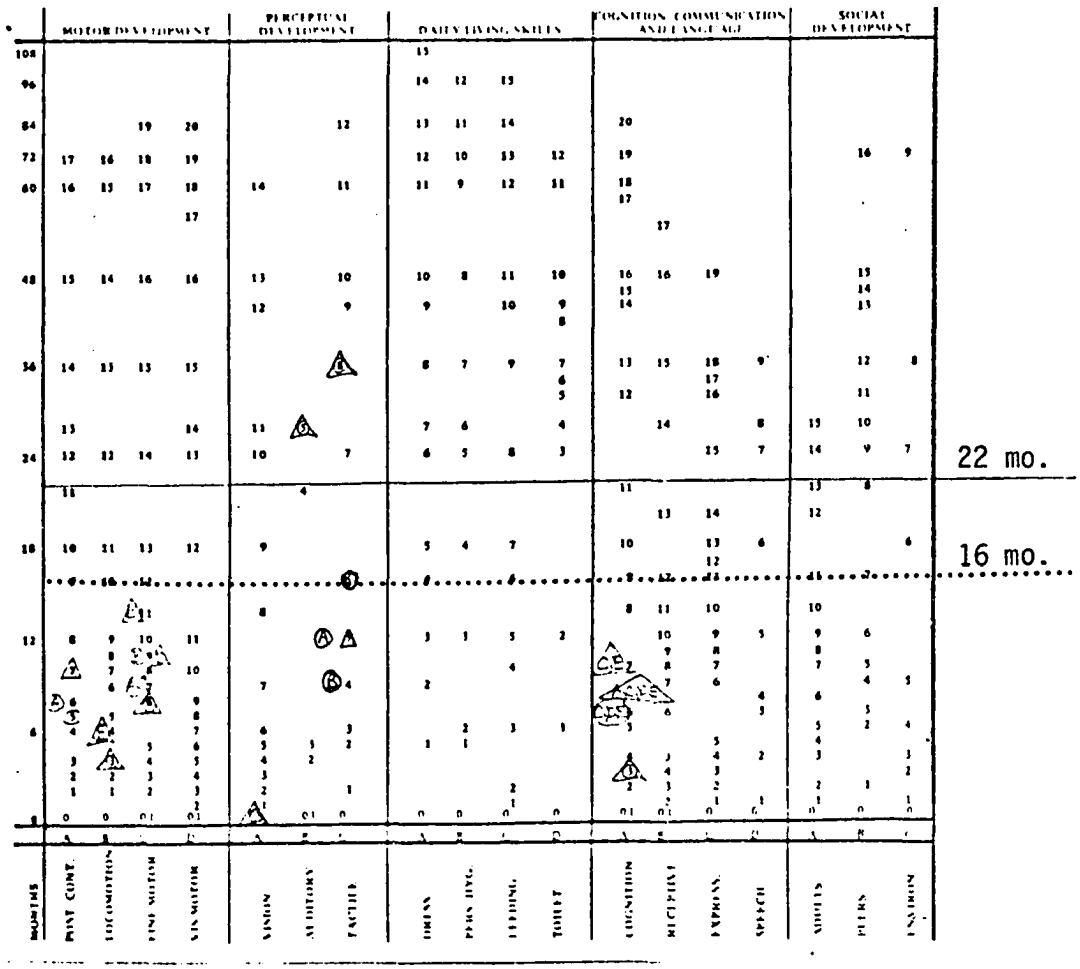
CALLIER-AZUSA SCALE



INFANT B

○ = 10-1978 (15 mo.) △ = 5-1979 (22 mo.)

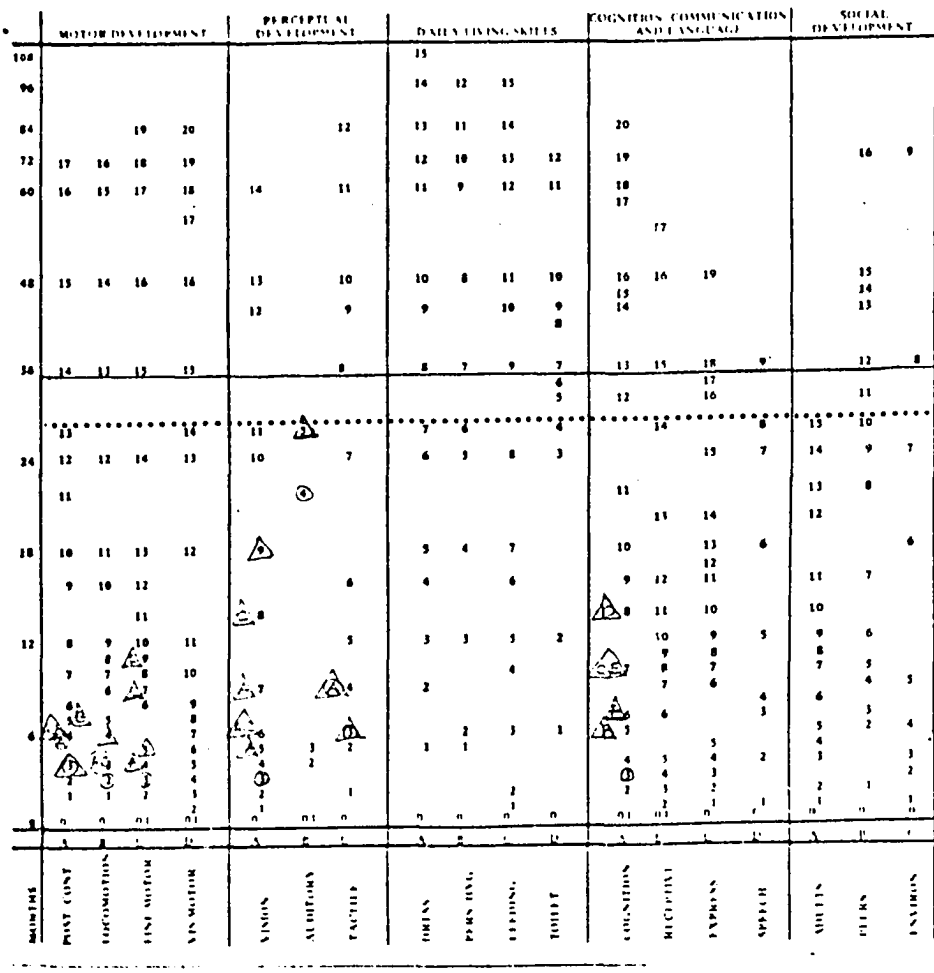
CALLIER-AZUSA SCALE



INFANT C

O = 10-1978 (16 mo.) Δ = 4-1979 (22 mo.)

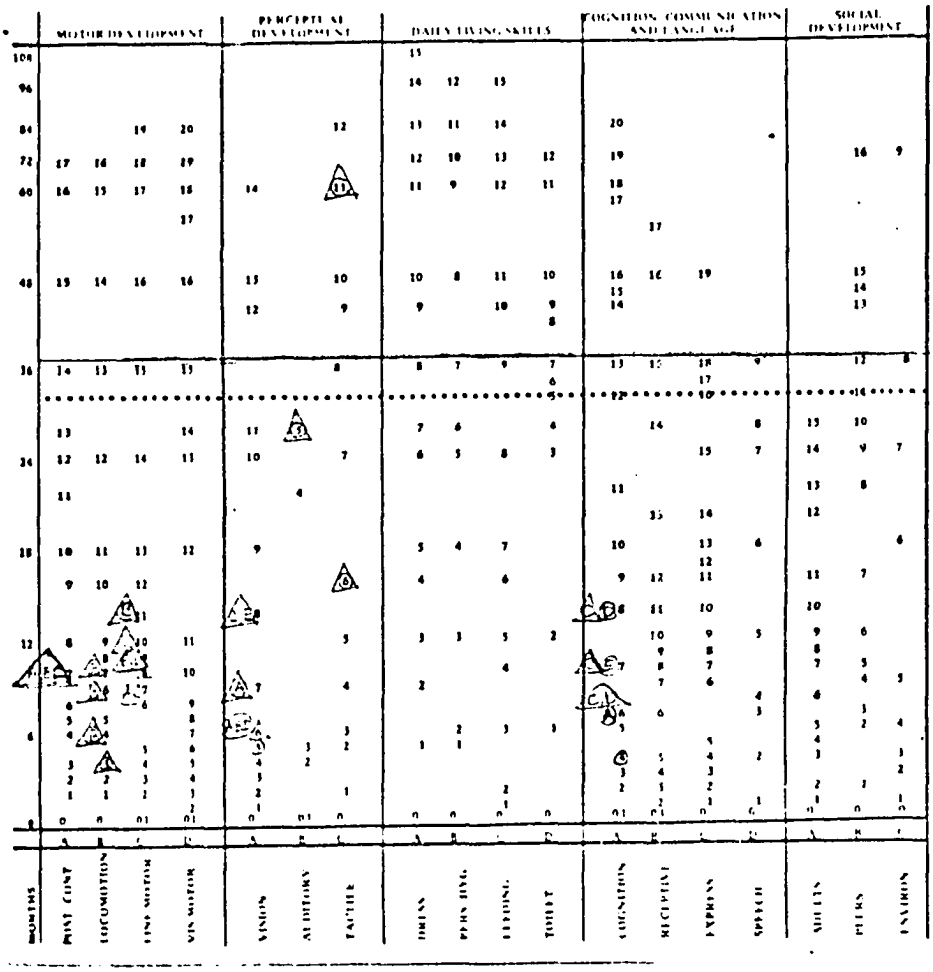
CALLIER-AZUSA SCALE



INFANT D

○ = 11-1978 (29 mo.) △ = 5-1979 (36 mo.)

CALLIER-AZUSA SCALE



INFANT E

O = 10-1978 (32 mo.) △ = 3-1979 (37 mo.)

Appendix E

Gestures Produced by Each Subject

Infant A

Age in Weeks	Film #	New Gestures
48	1	Smiles, vocalizes, moves hands and arms to side Kicks legs, vocalizes Left hand fingers splay - hand moves up a bit as Mom squeezes ball at her Whole body stiffens, smiles, as Mom squezes ball at her Kicks legs as Mom squeezes ball at her Left hand splays and rises to mouth which opens wide Closes eyes, averts head, smiles as Mom squeezes ball at her
48	3	Both hands splay open at once, by side, as Mom squeezes ball Left arm at side, hand flexes in air
49	5	Right hand, index finger extended, waivers as cries Wave hand (holding toy) crying Right hand opens wide 1/2 crying, brings both arms up, as if protesting, right arm goes to head Holds rattle, hand against face, fingers waving Hand waivers, index finger pointing Hand is still, index finger pointing Holds rattle, fingers splay, hand waivers, crying
55	10	Lifts left hand, smiles, as Mom tickles her ?
57	11	Hand bends out away from mouth as sucks thumb ? Left hand still, thumb protruding ? While playing with mouth, hand flies out twice, then back to mouth
57	12	Lifts 1 hand and flaps it, waves it Covers and uncovers mouth with hand Waves hand near chest
59	14	Flexes hand at wrist, vocalizing
61	16	Pats stomach
72	19	As Mom tickles her, right hand reaches toward Mom's hand, then moves over head, down and behind body As Mom tickles, K. laughs, hand goes from Mom's hand behind self and she twists body in pleasure As Mom tickles, both hands go down to sides suddenly Right leg kicks, vocalizes, and left hand goes to mouth Twists onto side, bringing right arm down emphatically, vocalizing in protest

Age in Weeks	Film #	New Gestures (Infant A)
72	20	Throws head and arms back, starting to vocalize in protest
72	21	Left hand waves over head
72	22	Grunts, moves whole body, smiles, flings both hands back - may be effort to get hands away from Mom

Infant B

Age in Weeks	Film #	New Gestures
63	1	Claps hands Claps hands on knees Moves arms in air Claps Mom's hands Motions with hands Head moves emphatically while saying "Mom" Arms fly up slightly as vocalizes
63	2	Head moves to one side and back to center as brings her hands up to clap Head goes from side to side Shakes head no
64	3	Brings both arms up, one hand holding other turns head to side as laughs Left hand comes up, forward, seems to swipe at Mom's knee as she says "mama": may be a reach that slipped
64	4	Right arm darts out suddenly as laughs
65	5	Opens hand with pleasure/excitement
66	7	Plays with fingers
66	8	Giggles, fists to mouth, then clasps stomach and giggles Claps hands, moves both up and down to "2 little apples"
69	10	Both arms move straight up and forward towards Mom as she stands - but she doesn't throw self at Mom.
69	10	Mom moves away and calls Tish, Tish reaches for Mom, then turns head away, moves left arm back and starts to whimper. Turns head to one side and back to center as cries Shakes head a little as laughs
71	11	Waves and claps hands excitedly Lifts hands to face
71	12	Shakes head once as vocalizes one syllable Left hand goes up and comes down, hand on belly as vocalizes and smiles Pats belly several times, vocalizes, smiles

Age in Weeks	Film #	New Gestures (Infant B)
78	15	Claps one hand with Mom's hand Claps hand against Mom's arm
78	16	Waves to Mom's "bye-bye" Puts hand to muffle her mouth
82	18	Bats arms and legs, smiles, vocalizes, giggles squeezes shoulders together and lays head on one shoulder as Mom laughs
93	19	Embraces aunt
93	21	Right arm waves as she vocalizes, smiles Right arm shoots out, palm open, as Mom says "Can you say J.J.?". She seems to think that J.J. is there.

Infant C

Age in Weeks	Film #	New Gestures
69	1	Brings arms up as Mom shakes slinky
69	2	Waves arms excitedly Waves arms while vocalizing Nods head "yes", smiles
70	5	Hand waves up and down once, very slightly (as Mom jiggles toy on her knee)
70	6	Draws hands close to body - seems upset
72	7	Clinches fists, pulls arms back while crying Clinches fists, bats arms while crying
72	8	Clinches fists, retracts arms, smiling delightedly
74	9	Nods while opening and closing mouth silently Small nods Left hand swipe to side as smiles Nods while smiling Left hand, fingers move slightly, not contacting anything, arm not moving Head shakes as smiles Arms go up, hands go to head, as smiles, hands brush head, arms go down, but stay extended. Claps hands, smiles Shakes head as lifts hand to mouth
76	11	Left arm raises slightly as if to ward off Mom
76	12	Puts hand under chin, moving her jaw with it
78	13	Moves hands, describing curve over her head, then circling fists by ears (she is alone) Brushes hair with one hand Brushes hands with both hands Makes motion inwards toward her chest Waves arms with downward thrust, making crashing noise Whips one hand back and forth rapidly by face, brushing cheek.
78	14	Bats arms, claps hands
78	14.5	Waves arms above head smiles Bats arms, vocalizes, nods head twice while vocalizing Bats arms, smiles Bats arms, rocks

Age in Weeks	Film #	New Gestures (Infant C)
82	15	Holds arms at shoulder height, wiggles them from elbow
82	16	Waves arms, brings knuckles of fists together Claps - 1 hand open, 1 in fist Starts out clapping - then joins both hands behind head Nods head "yes" Nods head "yes" as makes blowing noises through lips Nods head, waves arms Nods head, waves wildly. Lifts legs off floor, rocks.
89	17	Nods head as does raspberries
89	18	Opens and closes hands once, arms abducted, vocalizes and rocks Bats arms, sticks tongue out repeatedly Waves arms, sticks tongue out, rocks Rocks, vocalizes, nods head emphatically, smiles.
94	20	Arms abducted, moves hands slightly as vocalizes emphatically Touches knees as vocalizes Touches knees, smiles, vocalizes Flexes hands, arms abducted, leans slightly forward vocalizes Vocalizes, smiles, flexes hands, nods head
94	21	One arm held over head, waivers as vocalizes emphatically
94	22	Both hands wave at wrist

Infant D

Age in Weeks	Film #	New Gestures
128	1	Flails both arms up and down - holding slinky in left hand. Vocalizes and jerks both arms back as if excited. Vocalizes, both arms move around and clasps hands Vocalizes, arms are bent and both hands go behind head
128	4	D interlocks thumbs, hands clasped to chest
129	5	Leans head back, opens mouth wide, waves arms excitedly
132	7	Right arm bats up and down, smiles Bats both arms Bats arms, brings hands together (patty-cake?) ? "moves" both hands slightly as looks up towards ceiling
134	9	With slinky in one hand, lifts other hand high, opens and closes fist-points and waves Drops slinky, brings hands up and clasps them together to her chest Clasps hands together
134	10	One hand tries to get free of Mom, reaches and points over Mom's arm off screen Where D. gazes Leans head back, mouth open wide, brings hands together - almost claps Opens hands wide, moves fingers, waves - head back, mouth open Leans forward, moves legs a bit, waves arms in air, smiles, excitement Head back, mouth open, hands in air, open and close, begin to wave Bring hands together, then clasps them, close to chest Clasps hands, moving fingers Draws both legs up, frees arms, waves, head back, mouth open Brings hands together (seems to avoid Mom) Waves hands, brings together, clasps them - makes sound Mouth open, head back, claps feet/legs together, waves hand Kicks legs together, wriggles finger, mouth open/straining, head back Kicks legs, waves arms, mouth open, head back, makes sound
138	11	Arms move, clasps hands over head as vocalizes and body moves excitedly Arms wave repeatedly, vocalizes, moves body One arm slaps floor twice

Age in Weeks	Film #	New Gestures (Infant D)
139	15	Bats arms, smiling Bats arms once, then clasps hands at forehead Left arm slaps Mom's arm
139	14	Bats arms, vocalizes, smiles Bats arms, vocalizes, hits slinky, clasps hands together, smiles Bats arms, waves them, smiles, laughs
142	15	Left hand goes out to side, away from Mom
148	18	Bats arms, kicks legs, smiles Bats arms, kicks legs, smiles, vocalizes Puts head on arms (lying prone) smiles, vocalizes
155	19	Flexes back,waves arms a bit (trying to approach toy?)
155	20	Left arm reaches out toward light Vocalizes, clasps hands Moves body to indicate wants to bounce Vocalizes, brings hands to mouth as stares at light One hand raised in front of eyes Bats arms, smiles, falls backwards
155	21	Bats arms, smiles, bounces on legs Bats arms, kicks legs, smiles, turns toward Mom Kicks legs, moves whole body, smiles as grasps Mom's hand
155	22	Lifts legs off floor to show that she wants to jump Arms wave over head (wanting Mom to take hands?)

Infant E

Age in Weeks	Film #	New Gestures
138	2	Waves both arms, almost bringing hands together. Waves both arms and brings legs up and down to bang foot on floor
138	4	Vocalizes and bats both arms sideways. Brings hand together, almost a clap Really seems to be clapping, watching hands closely
139	5	Reaches for things without looking (head turned away) and without them being sounded - from comments
139	6	Tries to free self from Mom's restraint, pushing his hands away, reaches out of her grasp (?)
143	9	Pulls arm away from Mom's grasp (?)
143	10	Shakes head Averts head from Mom, pulls away, tries to free from Mom's grasp (?) Clinton frees hands from Mom, puts hands in front of self C. actively avoids Mom, grimacing, shaking head.
145	11	Arm waving, leg banging, vocalizing ?
145	12	Turns head away from Mom abruptly as vocalizes
147	14	Moves jaw - opening and closing mouth
154	17	Shakes head, smiles, waves hands Vocalizes angrily, arms held stiffly out to sides, hands wave slowly Bangs head on chair, crying
154	18	Suddenly vocalizes and throws self back

Appendix F

Autocontingency Curves for Selected Infant and Maternal Behaviors

Fig. 48. AUTOCONTINGENCIES: MOTHER A

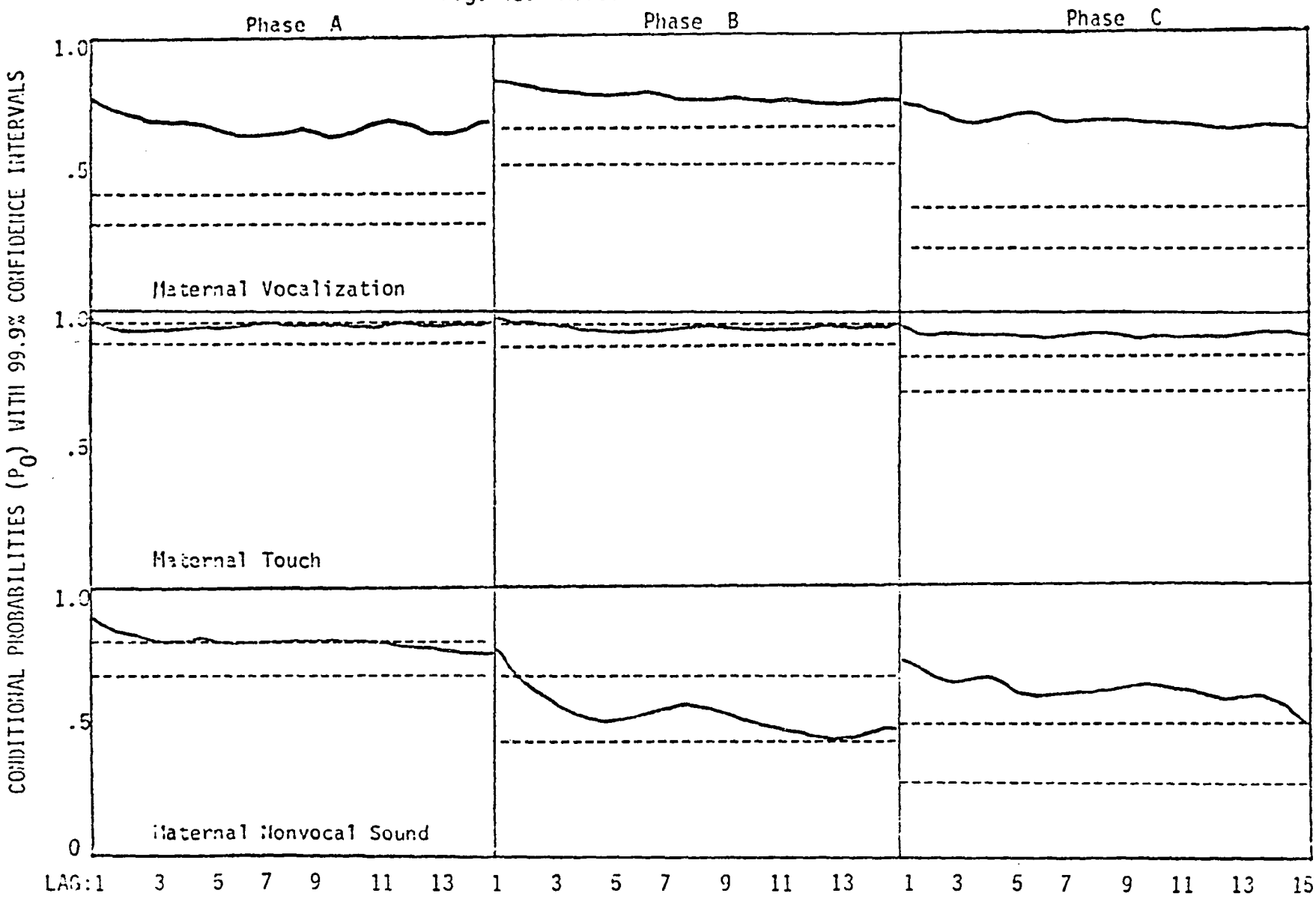


Fig. 49. AUTOCONTINGENCIES: MOTHER B

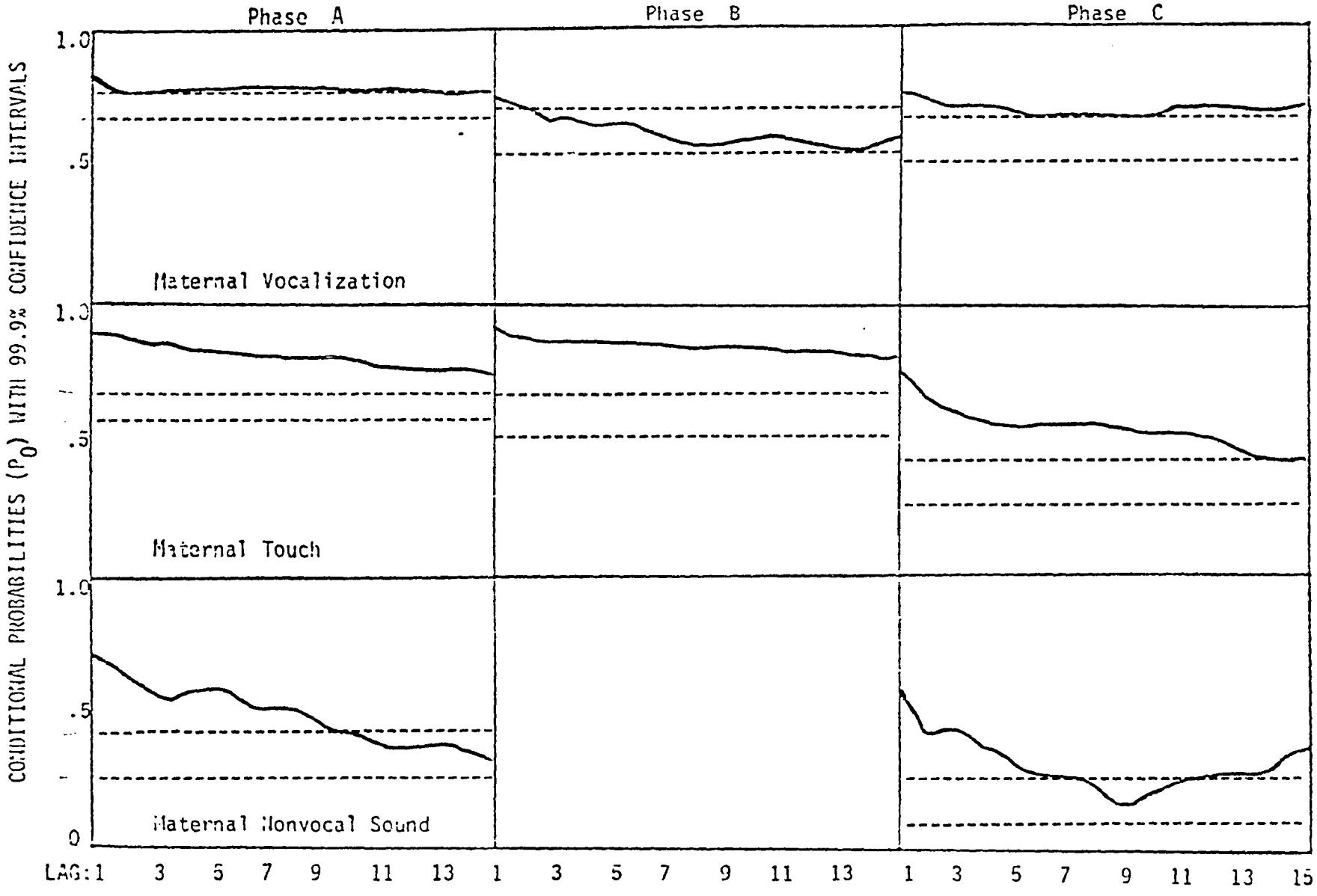


Fig. 50. AUTOCONTINGENCIES: MOTHER C

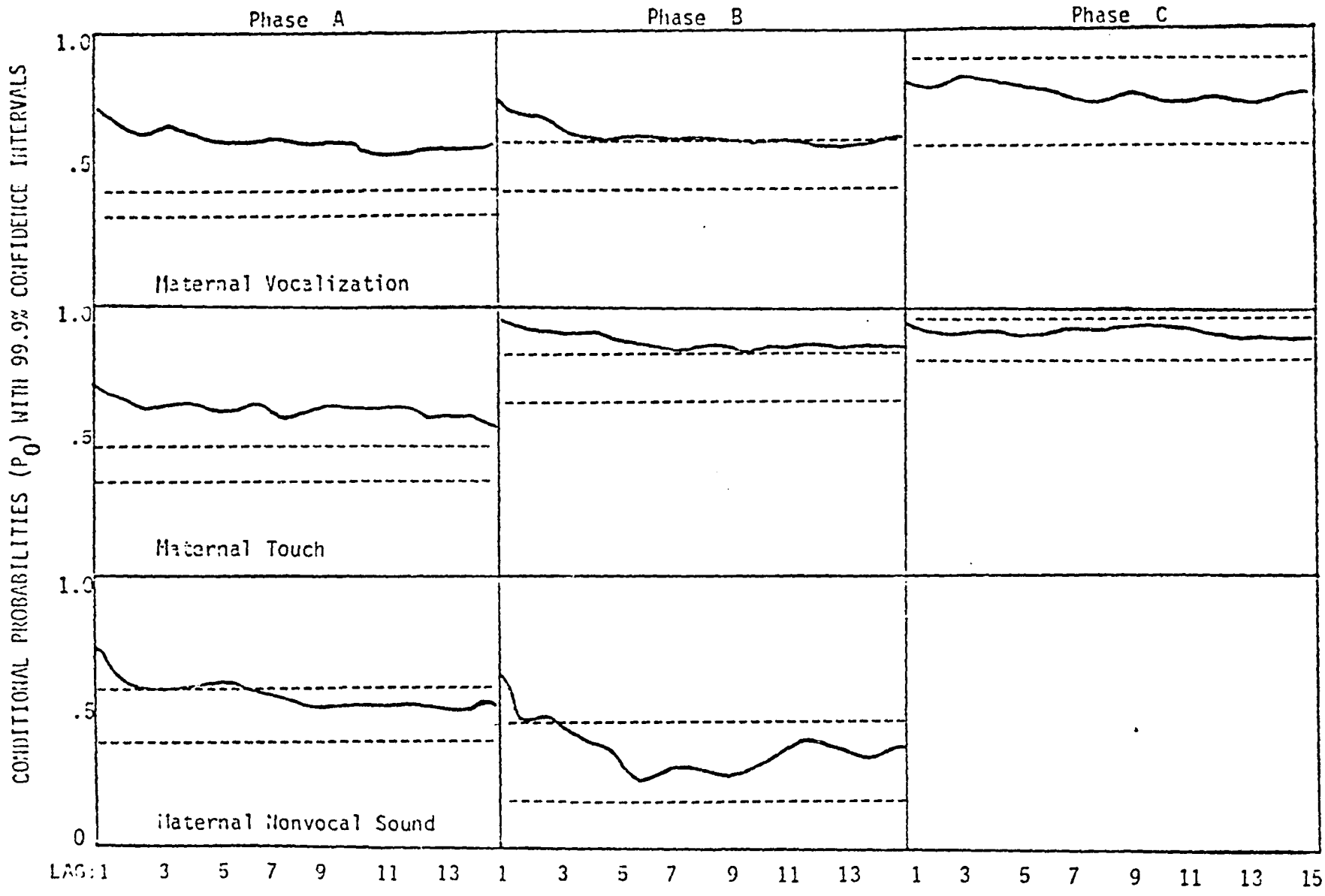


Fig. 51. AUTOCONTINGENCIES: MOTHER D

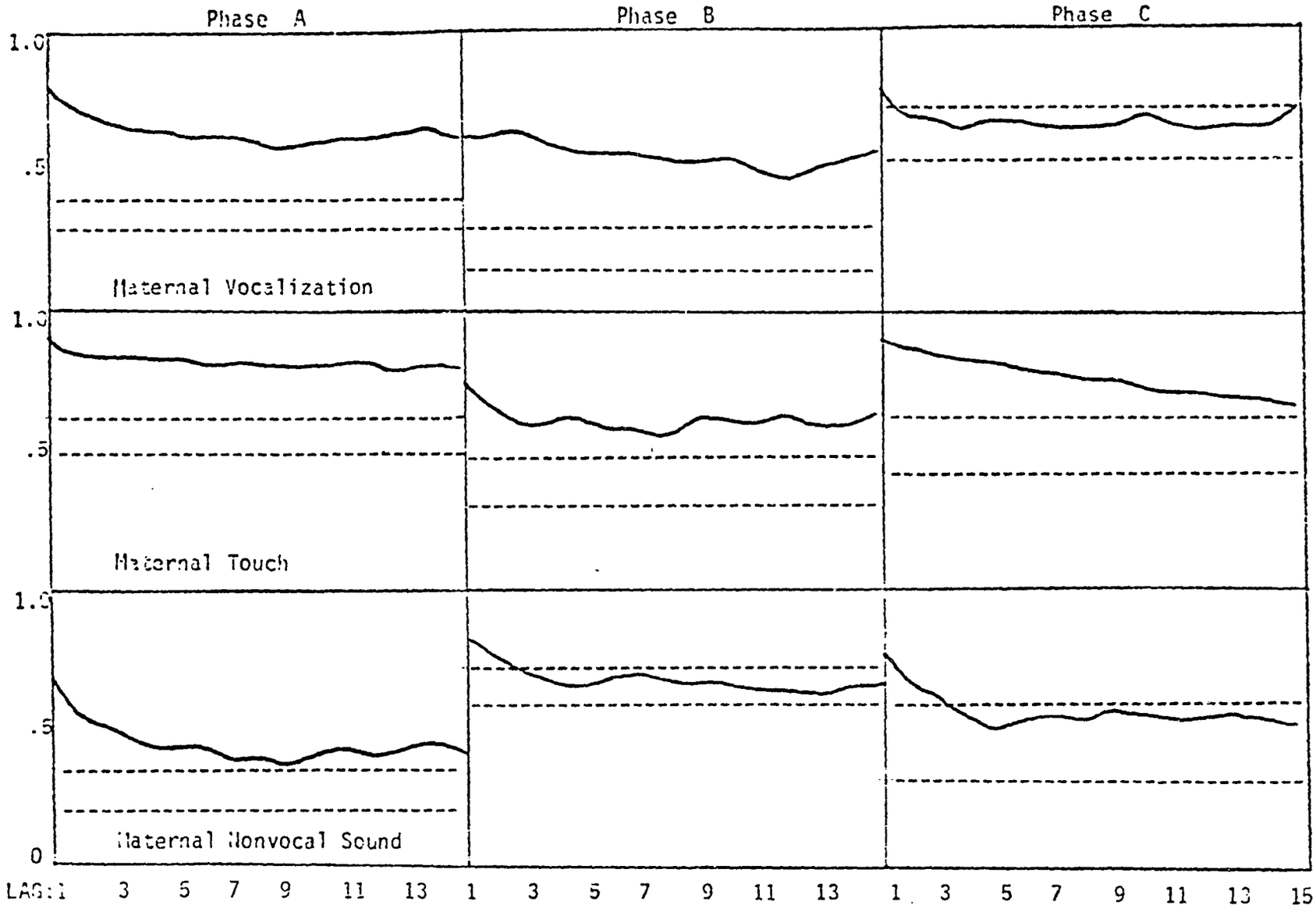


Fig. 52. AUTOCONTINGENCIES: MOTHER E

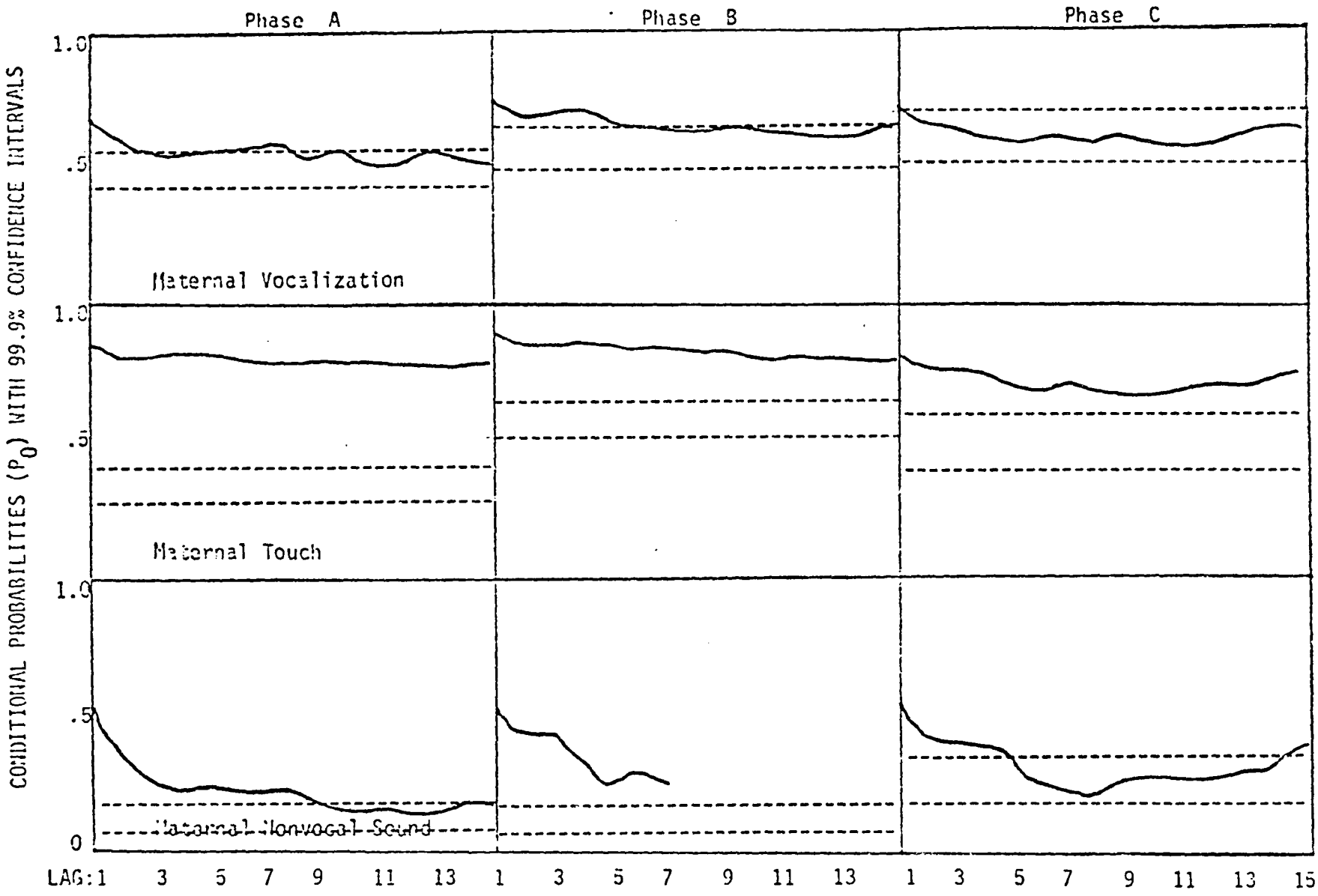


Fig. 53. AUTOCONTINGENCIES: INFANT A

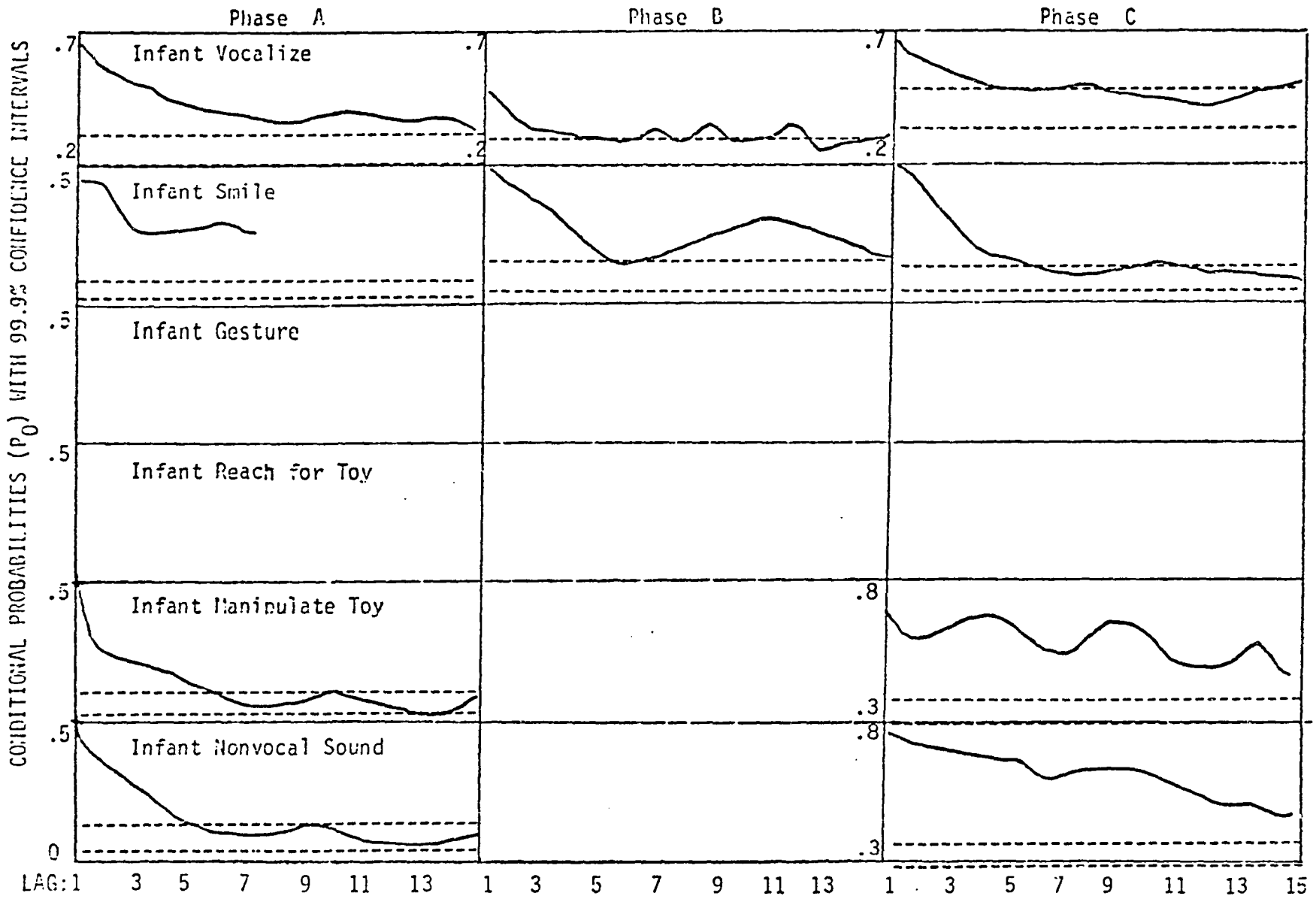


Fig. 54. AUTOCONTINGENCIES: INFANT B

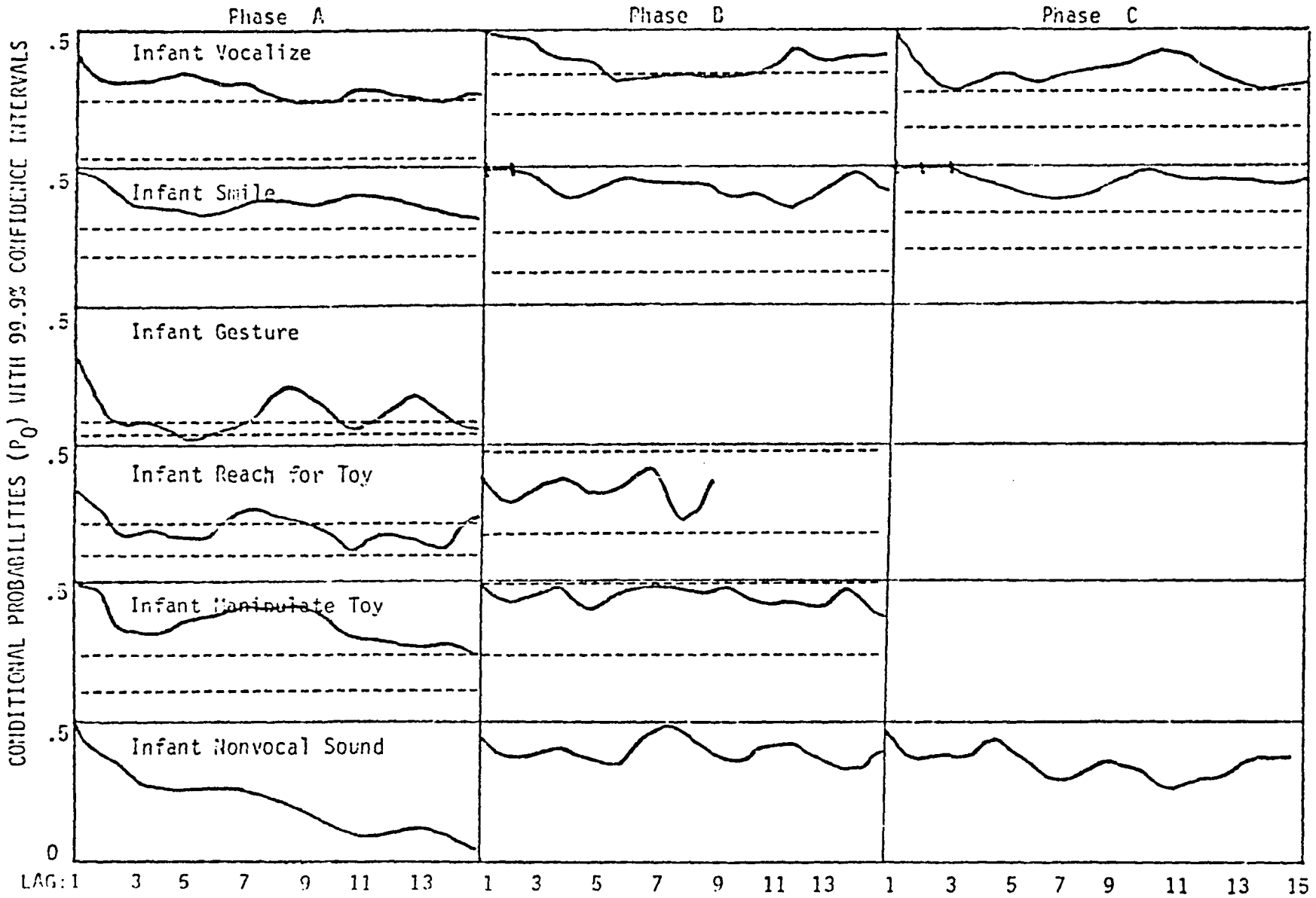


Fig. 55. AUTOCONTINGENCIES: INFANT C

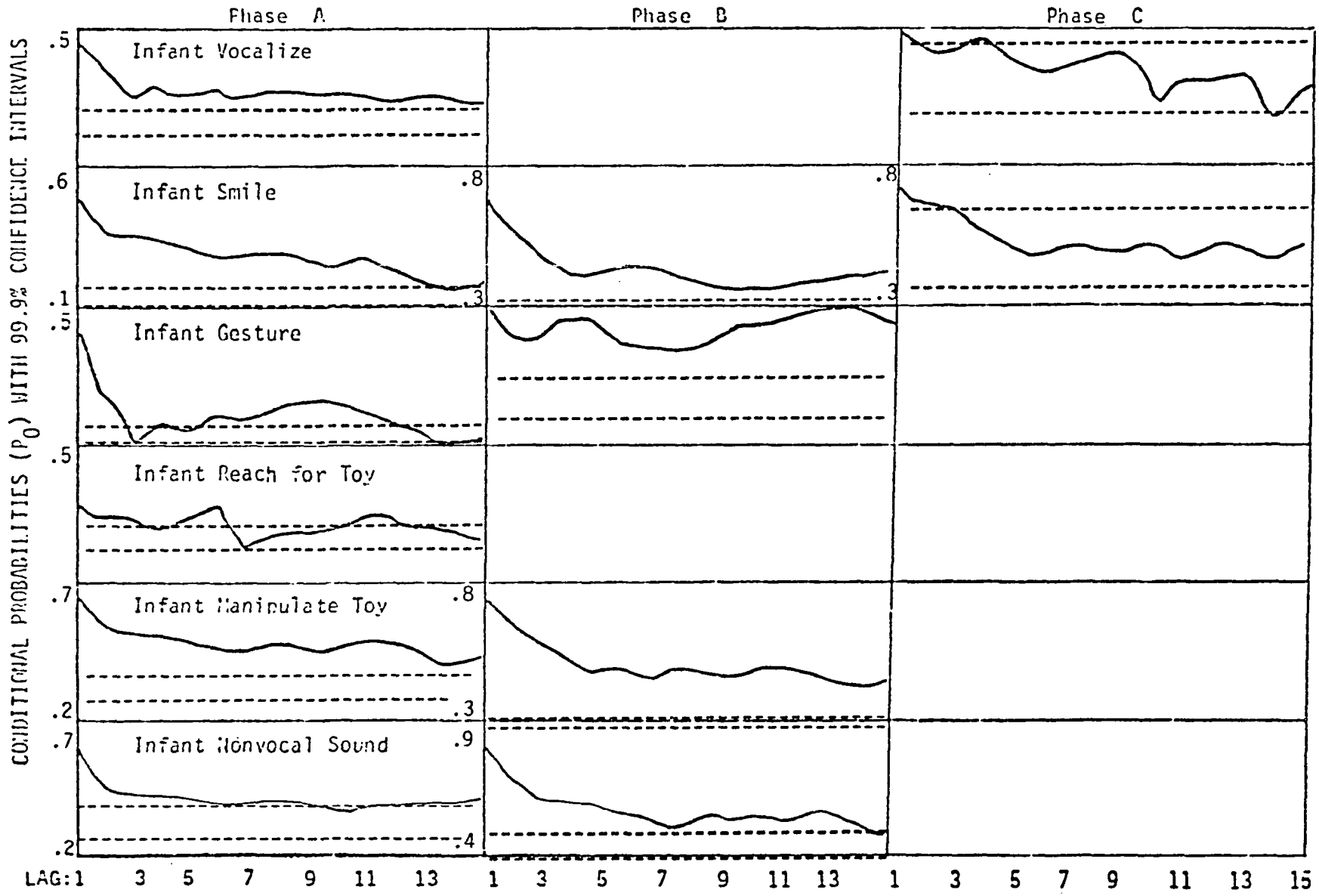


Fig. 56. AUTOCONTINGENCIES: INFANT D

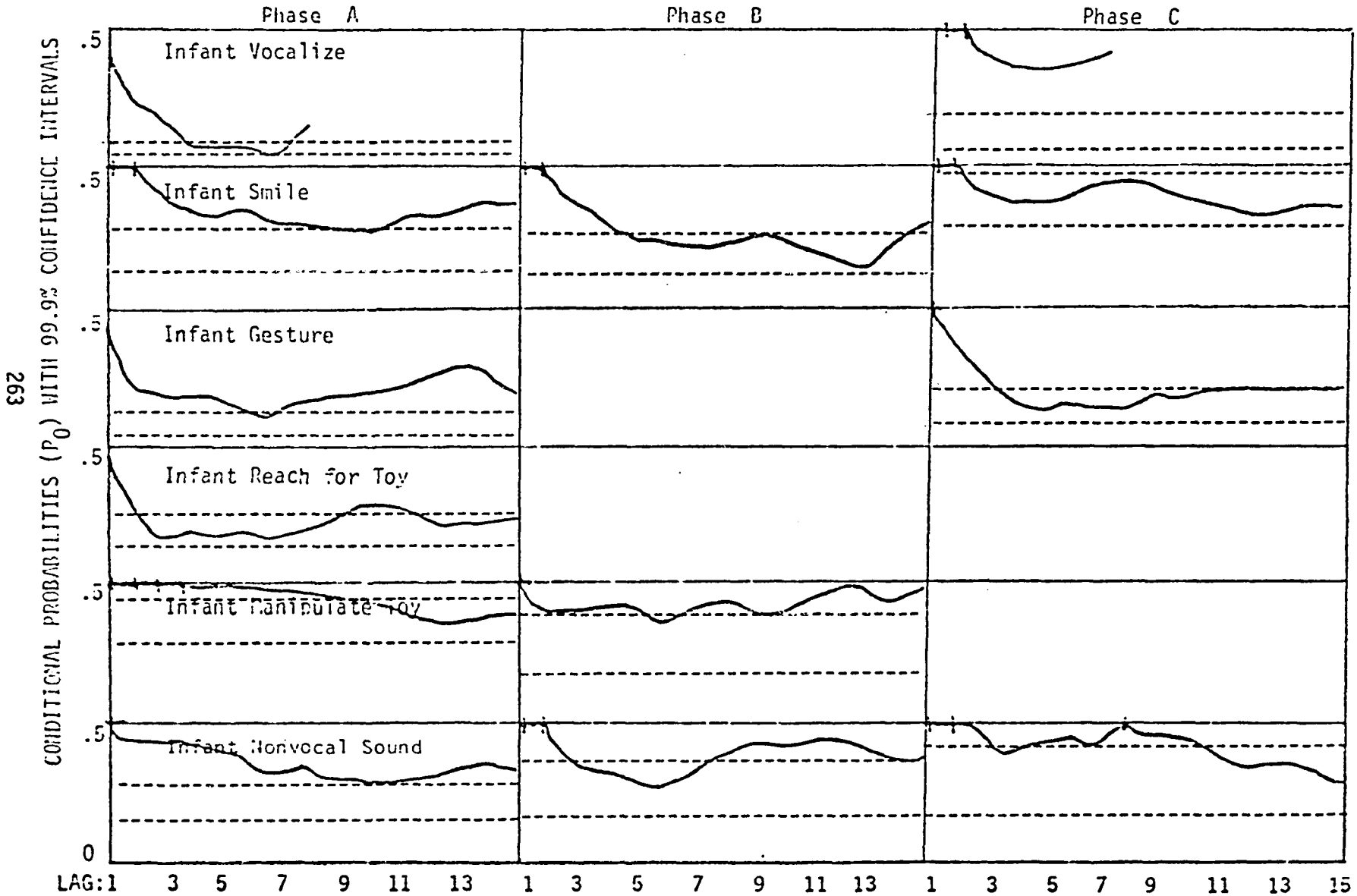


Fig. 57. AUTOCONTINGENCIES: INFANT E

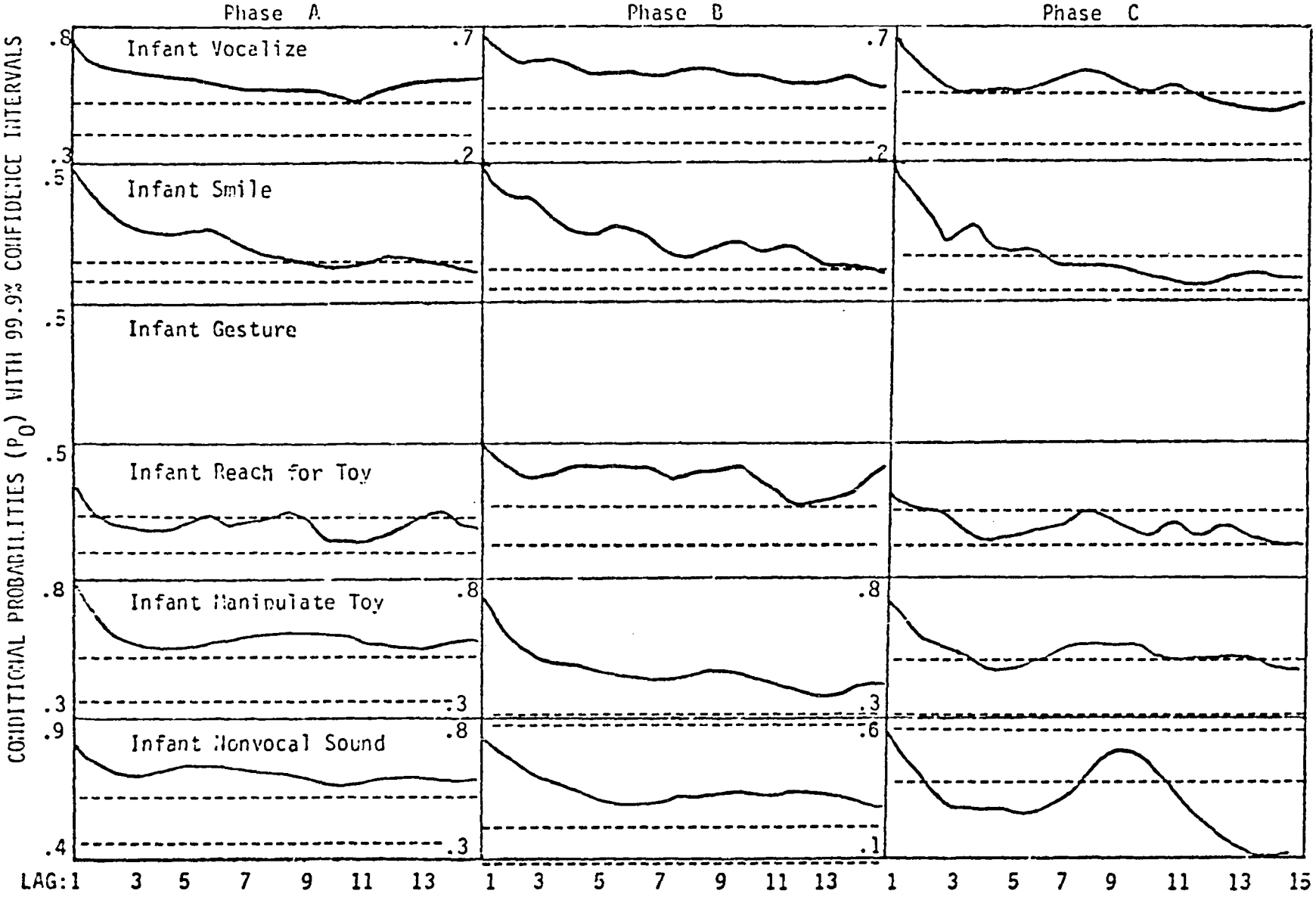


Fig. 58 . AUTOCONTINGENCY CURVES FOR CONCURRENT VOCALIZATIONS: ALL PAIRS