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The acquisition of prenominal adjectives and adverbs to sentence composition by deaf-aphasic children.

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THE ACQUISITION OF PRENOMINAL ADJECTIVES AND ADVERBS TO SENTENCE COMPOSITION BY DEAF-APHASIC CHILDREN

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By

William Lee Heward

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sertation is as much her product as mine. As a result, I dedicate this work to Barbara Schirmer and her students who served as subjects.

ABSTRACT

An experiment was conducted to assess the effects of token reinforcement and remediation on the rate, accuracy, and linguistic content of sentence composition by deaf-aphasic children. The eight subjects were 8-11 year-old deaf-aphasic students at a residential/day school for the deaf. Sixty-two experimental sessions were run in which subjects wrote sentences for a total of 10 minutes each session. The experiment was conducted in the visual response system, each subject utilizing an overhead projector so that his/her writing was directly visible to allow immediate consequation. The results indicate that effective control was established over the sentence writing behavior of the subjects. The instatement of reinforcement and remediation as consequences for grammatically and conceptually appropriate composition resulted in response rates and levels of accuracy markedly higher than baseline level. These sentences, however, were largely simple subject-verb-object structures void of modifiers of any kind. When maximum reinforcement was contingent upon writing correct sentences including prenominal adjectives, the subjects quickly began to include correctly prenominal adjectives in their sentences. A subsequent experimental phase made maximum reinforcement contingent upon writing correct sentences containing adverbs. Subjects then began to compose many correct sentences including adverbs. A final experimental phase made maximum reinforcement contingent upon writing correct sentences including both prenominal adjectives and adverbs.

Subjects wrote a high frequency of sentences containing both prenominal adjectives and adverbs during the final phase while maintaining high levels of accuracy.

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CHAPTER I

INTRODUCTION

The purpose of this investigation is to analyze the effects of a specific teaching methodology upon the acquisition of new linguistic components to sentence composition by deaf-aphasic children. The teaching methodology employed in this experiment is based on a compilation of principles and techniques derived from the experimental analysis of behavior and recent advancements in educational media. Chapter I outlines the typical language performance of deaf-aphasic children, the methods of language instruction most often used with such a population, applied behavior analysis with respect to language acquisition, the use of media in schools for the deaf, and the experimental objectives of this study.

Language Ability of the Deaf. Verbal behavior, that behavior which is reinforced through the mediation of other persons (Skinner, 1957, p. 14), is the principal means by which humans interact with each other. Speaking, reading, writing, listening to a speech, signing, gesturing, and blowing a bugle can all be acts of verbal behavior. Most verbal behavior consists of the production and reception of auditory stimuli and of the production and reception of visual stimuli (printed, written, and gestured symbols which are generally directly related to auditory correlates).

Language is a component, or more precisely a product, of human verbal behavior. Linguists describe language as a set of symbols,

along with the rules and customs for the use of those symbols, by which a social group interacts and communicates (Strauss & McCarus, 1958; Myklebust, 1955). The use of language represents the major form of verbal behavior. In hearing individuals, the primary channel for the acquisition of language is auditory. The visual mode plays a secondary role (Reed, 1971). In the deaf, auditory stimuli can serve neither as powerful discriminative stimuli, which set the occasion for certain behaviors to occur, nor as consequences for behavior (the reinforcers and punishers), which dictate the future probability of a behavior's occurrence.[1] As a result, speech, which relies almost entirely upon auditory signals (approximately one-third of the forty-odd phonemes that comprise spoken English are visible through speechreading, Davis and Silverman, 1970), and written language, which is a visual representation of speech, are difficult for the deaf to acquire.

Since the establishment of the first schools dedicated solely to the education of the deaf, disagreement has evolved concerning the form of communication to be used in teaching the deaf. Abbé Charles Michel de l'Épée founded the first public school for the deaf in Paris in 1775 and preferred the "manual" approach (signs and fingerspelling). During the same period, Samuel Heinicke organized the first public school for the deaf in Germany. Heinicke advocated and pursued the use of speech and speechreading for instructing the deaf. Silverman (1970) writes of the ramifications of the two educators' dispute:

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[1]The degree to which sound cannot serve as these environmental events depends upon an idual's level of hearing impairment.

> "So widespread was the influence of these two men (De l'Épée and Heinicke, ed.) that the pattern of their controversy was reproduced subsequently in many countries, the United States included." (in Davis and Silverman, 1970, p. 377)

This factionalism regarding communication methods for the deaf and the effects of those methods upon language acquisition in deaf children continues today with various schools for the deaf advocating and practicing one method or the other or a combination of the two (Mendal and Vernon, 1971).

Language instruction in schools for the deaf is typically structured to a high degree and often relies upon drilled recognition of the grammatical relationships among linguistic components. Most techniques of written language instruction for the deaf are based on a curriculum which requires the student to learn a symbol system in addition to the standard symbol system represented by the English language. One such widely used symbol system is the Fitzgerald Key (Fitzgerald, 1949), developed in 1926. The Fitzgerald Key consists of a set of six symbols, each representing a linguistic component, i.e., verb, connective, noun, etc. This system was designed to teach deaf students the functional relationships between various units of language and thus transmit grammatical principles and rules. Two other such symbol systems and the years in which they were developed are the Barry Five Slate System, 1899, and Wing's Symbols, 1883, (Silverman and Lane, 1970). The Barry Five Slate System utilizes five columns or slates visible in the classroom upon which the various parts of a sentence are printed.

Advocates of this system uphold that is important for the deaf student to be able to clearly analyze the relations among the parts of a sentence in order to understand language. Wing's Symbols is comprised of a set of symbols, most of which are letters and numbers, which stand for the functions of various units of language in a sentence.

All of these "analytical" or "grammatical" symbol systems require the deaf student to learn or acquire a structural analysis of language in order to be able to proficiently use language. Upon closer examination it appears that this structural awareness is often imparted to the deaf student at the expense of a functional or usable language. When assessing the writing ability of young deaf children who have been exposed to this type of patterned instruction, it is not uncommon to get 10 sentences reading "I see a dog," "I see a cat," "I see a tree," when the task assigned was to write 10 sentences describing a particular picture. This kind of stilted sentence structure is typical in spite of the fact that a deaf child may enter a residential school for the deaf at the age of two or three years and participate in almost daily practice drills and exercises in reading, writing, speechreading, and speaking for the next 16 years.

Irrespective of the form of communication taught to deaf students, their academic achievement, especially on tests of language performance, consistently falls below that of their hearing peers. Fusfield (1955) administered the Stanford Achievement Test to 280 deaf high school graduates who were candidates for admission to Gallaudet College (the only four-year college exclusively for the deaf). Mean grade equiva-

lency scores fell at the ninth grade level. Due to the selection factor, Fusfield's subjects probably faired better on the test than would the general deaf population. In another attempt to assess the language skills of deaf children (Wrightstone, et al, 1962), 1,075 deaf students age 15 and 16 were tested on the Reading Test of the Metropolitan Achievement Test Elementary Battery. The mean grade equivalency score for this group was 3.5, with only 12% of the subjects scoring a grade equivalent of 4.9 or above.

Since the sentence is the framework by which most language is transmitted, it is generally the unit of analysis in research of the language of deaf children (McCarthy, 1954). Several investigators have analyzed original[2] sentences written by deaf children. Walter (1959) studied sentences written by deaf students who were diagnosed as profoundly deaf and noted a lack of complexity, loose grammatical structure, and limited ways of expressing an assertion. Myklebust (1960) examined the written responses of deaf children (n=1,000, age range 7-17) to a picture stimulus. Myklebust rated the sentences according to syntax, length, and level of abstractness. Compared to a hearing control group, the deaf scored significantly lower on all three measures.

> ". . . at eleven years the mean (sentence length) for the deaf was 4.98 (words), and for the hearing it was 12.09. This emphasizes the fact that early deafness restricts

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[2]"Original" as used here refers to verbal discourse composed and initiated by the subject.

language acquisition and usage." (Myklebust, 1960, p. 383)

In a similar study, Heider and Heider (1940) report that deaf children wrote sentences with fewer words, fewer clauses, and utilized only simple "subject-verb-object" sentence structures. Eachus (1969) obtained samples of sentences composed by students in the fourth, sixth, and twelfth grade classes at a residential school for the deaf. Although the sentences were written by students spanning eight years of education and repeated language drill, little change in accuracy was observed. The types of errors (syntactical and conceptual) and number of errors made by the twelfth graders were similar to those committed by the fourth grade students.

Furth (1966) estimates that superior expressive language skills are attained by only 4% of the deaf individuals in this country. It appears doubtful, due to the many years in which they have been faithfully practiced, whether the continued use and development of teaching methodologies which require the learning of an additional symbol system will improve this estimate appreciably.

The Nature of Aphasia. A survey by Mullins (1969) reported that two-thirds of the residential schools for the deaf in the United States had students enrolled that were diagnosed as "aphasic". The word "aphasia" in classical Greek was used to identify the speechlessness induced by severe emotional trauma, such as extreme fear or surprise. Such conditions are termed "hysterical aphonia" today, and aphasia is a descriptor reserved for more general deficiencies of language performance such as retarded language development.

Three German physicians, Johann Schmidt, Peter Rommel and Johann A. P. Gesner, who published in the 17th and 18th centuries, reported some of the first medical accounts of aphasia (Benton, et al, 1963). Broca, 1861, opened the subject of aphasia for research and discussion when he introduced the theory of cerebral dominance and asymmetry of hemispheric function for higher mental (i.e., language) processes.

Most of the early writings on aphasia described adult cases who had lost previously acquired language skills due to a specific etiology (Kleffner, 1959). Cerebral-vascular accident, as evidenced by thromboses, embolisms, aneurysms, hemorrhages and ischemias, was noted as the common cause of adult aphasia. Brain tumors and trauma created by gunshot wound, falls and automobile accidents have also been known to cause aphasia in adults (Halpern, 1972). Some researchers have been concerned with categorizing various types of aphasis according to the location of brain damage and patient symptoms. The writings of Weisenberg and McBride (1935), Jones and Wepman (1961), Schuell et al (1964), and Luria (1964) present the classification schemes of the "locationists".

In educational circles the term aphasia has been used to describe children who, with normal environments and educational procedures, do not develop language. There are disagreements as to what technically constitutes aphasia in children as well as its causes (Best and Taylor, 1950; Kleffner, 1959; Nielson, 1962; Bay, 1963; Efron, 1963; Brain, 1963; Eisenson, 1968). However, the majority of the schools for the

deaf that responded to Mullins' (1969) survey agreed upon the following definition of an aphasic child:

> ". . . (a child) who has difficulty in understanding and/or expressing language symbols. The problem is not primarily the result of peripheral hearing loss, mental deficiency, defect in speech mechanisms, or emotional maladjustment."

The Central Institute for the Deaf, which has operated a program for the assessment and teaching of aphasic children for over 30 years, bases their diagnoses of aphasia upon the discrepancy between the child's language development and his/her level of hearing impairment and intelligence level.

Even though aphasic children are often inconsistent in their ability to discriminate sound (Reichstein, 1964; Monsess, 1958), respondents to Mullins' (1969) survey reported that 19.4% of the students they had classified as aphasic had partial hearing loss and 68.5% were considered to have severe hearing impairment. One-half of the schools replied that 90% of their aphasic children were originally admitted as deaf and later rediagnosed as aphasic.

Elliott (1967) tested the hearing of aphasic children at the Central Institute for the Deaf and found that nearly all demonstrated a very significant loss of hearing in the middle frequencies, or the range of most speech sounds. Most of the children Elliott tested displayed fairly good hearing at the very high and/or very low frequencies of the sound spectrum and had, as infants, reacted to loud noises. As a result their hearing impairment was often not detected

until the fourth or fifth year of life after normal speech had not developed. Not benefiting from early diagnosis, amplification and special communication methods, such children are sometimes mistaken as mentally retarded.

Davis (1970) suggests that the majority of children considered aphasic are actually children who have suffered from sensory deprivation due to hearing impairments that were not detected at an early age. Such children would conceivably be much behind their deaf peers, who had received early diagnosis and intervention, in language development.

Davis (1970) has offered the term "dyslogomathia" to specify "difficulty in learning speech and language" and suggests that the term aphasic be reserved for those relatively rare cases in which brain damage is a clear and unquestionable etiological factor.

In all areas of the education of children with special needs, the diagnosis, classification, labeling, and the resulting stigmas attached to certain terminology is a continuing cause for concern. In too many cases the so-called "prescriptive diagnosis" doesn't lead to more effective educational methods and environments for the child, but serves only to remove the child from the sight of those who have been unsuccessful in teaching him/her.

Compounding the perplexities inherent with differential diagnosis are the concepts of receptive aphasia and expressive aphasia. The terms imply that some children have more difficulty in the reception, or understanding of language, and that for others the major problem

is one of expressing language, i.e., speaking, writing, signing, etc. Schuell et al (1964) claims there are both receptive and expressive impairments evident in the language of all aphasics. DeRenzi and Vignolo (1962) have presented experimental evidence to support that view. Keenan (1968) writes that receptive impairments cannot possibly outweigh expressive difficulties due to the way in which language is acquired.

A behavioral analysis of verbal functioning, including language, would describe the various behaviors characteristic of either receptive or expressive language performance as differences in response topography, i.e., reading and writing may involve the same language units but are emitted in different forms, not as a dichotomy of language functions or separate learning centers (Skinner, 1957; Lovaas, 1968; Sloane and MacAulay, 1968; Guess, 1969; Sulzbacher and Costello, 1970). When a deficiency in a particular language behavior is observed in an individual, the resultant prescription would dictate shaping and strengthening those behaviors that are weak. Gray and Ryan (1973) have approached this situation as it relates to the practical task of teaching language to children who don't adequately possess it.

> "A more apt definition of a nonlanguage child is a nonperformer of the verbal-linguistic code. . . . A distinctive trait about that child is that, despite growing up in a verbal-linguistic environment, he fails to perform verbally himself. The complaint is that all code sending and

confirmation of reception is nonverbal--or if verbal, it violates syntactic rules of usage. Specifically, the verbal-linguistic performance of the child is not appropriate. It makes no difference what label is assigned to the fact of nonperformance (autistic, receptive aphasic, dysphasic, language delayed, brain damaged, etc.), the teaching job is still the same. The language teacher must change the child's code sending performance. All judgment about the adequacy of language ability must ultimately be based upon some performance on the part of the user. Giving a name to the reason why we think he has not begun to use the language in no way alters the teaching task, in all cases the job is to teach language." (Gray and Ryan, 1973, p. 6)

To the response that they are ignoring important individual diferences among children, Gray and Ryan reply:

"It might appear that we are insensitive to the quite obvious differences that exist among the various categories of non-performance listed above, such as autistic, hard of hearing, etc. We have all heard that no two children are alike and that as teachers we must respond to the individual differences of each student; however, the task is one of becoming selectively responsive to individual differences that are meaningful in terms of the teaching strategy. To indiscriminately respond to all observable differences is to invite failure.

> "Individual differences which specifically jeopardize a student's capacity to perform in the teaching situation should be dealt with; if he is hard of hearing, we must use amplification; if he is big for his age, we might have to find a larger chair and desk; etc. These types of alterations, while very important to the student's success with the procedure, do not represent gross changes in any basic instructional strategy. . . . Specifically, all language nonperformers have important characteristics in common: first, they don't use the language; second, they all learn behavior according to the same general principles as we currently understand them. The teaching strategy must be based upon these universals. (Gray and Ryan, 1973, pp. 6-7)

Presently the most widely used techniques employed for teaching language to children who are considered aphasic is the McGinnis or Element Association Method (Mullins, 1969). Various authors have detailed and outlined the techniques and procedures involved in the Association Method (McGinnis, 1963a, 1963b; Kleffner, 1958, 1959; Bender, 1968; Kirby, 1974). The Association Method can be described as a procedure for systematically presenting progressively more difficult units of language while demonstrating the relationships or associations, between the various concepts. Visual, i.e., syllables printed in different colors and cursive script to show the grouping of letters into words, and temporal cues, i.e., stopping after each spoken

phoneme in speech training, are used to aide the recognition of each unit of language. The Association Method can be characterized as highly structured and analytical in that it begins with the smallest units of language, i.e.,sounds and letters, and progresses through words, phrases and finally sentences.

Applied Behavior Analysis. During the past decade, the applied analysis of behavior has yielded an impressive amount of information regarding the understanding and modification of human behavior. Techniques and procedures derived from the principles of behavior discovered in the experimental laboratory (Skinner, 1938; Ferster and Skinner, 1957; Honig, 1966) have been adapted for use and testing in naturalistic settings. Although still an infant as sciences are concerned (Watson, 1924, 1930; Skinner, 1938), behaviorism has progressed from a handful of laboratory scientist to a large cadre of researchers and clinicians studying the principles of behavior as they operate in everyday environments. The application of the principles of behavior to human affairs, most often referred to as behavior modification, contingency management, behavioral engineering, and/or operant technology, has proven effective in producing desired behavior changes in a wide variety of subjects and settings (Krasner and Ullmann, 1965; Ulrich, Stachnik, and Mabry, 1966; Franks, 1969). The applied research being conducted in educational environments alone is producing a nearly continuous contribution to the science of human behavior. A number of volumes are available which contain many examples and case studies illustrat-

ing the successful use of behavior modification in education (e.g. O'Leary and O'Leary, 1972; Sulzer and Mayer, 1972; Ramp and Hopkins, 1971).

Skinner (1957) offers an extensive analysis of the conditions under which verbal behavior may be acquired, increased, refined, maintained and brought under stimulus control. This analysis has been effectively put to educational and theraputical use with subjects displaying many types of language disorders (Sloane and MacAulay, 1968; Rickard and Mundy, 1965; Lovaas, 1968; Kerr, Meyerson and Michael, 1965; Gray and Ryan, 1973).

In spite of its apparent effectiveness in the teaching of language skills and success when applied to other fields of special education (Valett, 1969; Jones, 1971), educators of the deaf have been slow to incorporate operant technology into their teaching repetoires. In 1969, the American Annals of the Deaf, a major professional journal for educators working with the deaf, published its first account of the principles of operant conditioning and their relationship to teaching the deaf (Osborne and Wageman, 1969). To date, only two studies (Eachus, 1971; Eveslage and Buchmann, 1973) which employed operant principles to the teaching of language skills to deaf children have been reported by that journal.

An explanation of the principles of behavior and their application to educational settings is not appropriate here; excellent descriptions can be found elsewhere (Whaley and Malott, 1971; Sulzer and Mayer, 1972; Michael, 1967). However, one widely used classroom

technique, the token economy, which has been directly derived from the principles of behavior and is relevant to this experiment, requires explanation at this point.

The Token Economy. A token economy is a motivational system that a teacher can operate in the classroom to modify a wide range of behaviors in an entire class of students simultaneously. A token economy is not a direct applied counterpart of a single principle of behavior known to operate in the laboratory, but a procedure for incorporating many of the variables and events that control human behavior into one, manageable and effective technique. Allyon and Azrin (1968) pioneered the extensive use of token systems in mental health wards and are credited with determining many of the principles by which they operate. Token systems have been put to use with high levels of success with a wide range of subjects in home, school, and work situations (Becker, 1971; Ferster and DeMyer, 1962; Bijou, 1965; Cohen, 1967; Wolf, Giles and Hall, 1968). The token economy is perhaps the most popular means of behavior modification in the classroom (Michael, 1967; Karraker, 1968; O'Leary and O'Leary, 1972; Axelrod, 1971; Bushnell and Brigham, 1971; Staats, Minke and Butts, 1970).

In order to use correctly operant procedures in the classroom, a teacher selects the behaviors to be strengthened and weakened in each student, identifies effective reinforcers and punishers, delivers the appropriate consequence when specified behaviors are emitted, and maintains a record of each occurrence in order to accurately evaluate the program. Since this entire process would, ideally, have to be carried

out with each individual student, the application of behavior modification techniques to academic behaviors is often not undertaken. As a result, a large portion of the educational community looks upon behavior modification as a collection of procedures, that while effective in producing behavior change, are best put to use in controlling disruptive behavior and "problem" students. Many teachers feel that if the steps outlined above had to be completed for every student as an integral part of each curriculum area, there would not be any time left to teach.

A token economy provides a method for incorporating behavior modification techniques into everyday teaching activities without making major demands upon a teacher's time. A token economy involves a system of intermediary "token" reinforcers (poker chips, points, gold stars, etc.) that can be earned by students and exchanged for free time, special privileges, activities, or other items of their choice. Tokens are delivered to students contingent upon their engaging in behavior that has been selected for strengthening. Regular exchange periods are held at which students are allowed to "buy" items of their choice from the list of available reinforcers providing they have accumulated enough tokens to meet the "price" of the desired item.

Allyon and Azrin (1968) have cited a number of advantages in using a token economy to modify behavior. First, the same system can be used to produce desired changes in different behaviors among a number of students simultaneously. A separate reinforcement program does not

have to be devised for each student. Secondly, by providing a large number of back-up reinforcers that can be purchased with tokens, the effectiveness of the tokens as conditioned reinforcers won't be dependent upon fluctuations in deprivation and satiation levels. Identifying appropriate reinforcers for individual students is often not conducted in the classroom. It is common for teachers to expect praise and approval to maintain the academic behavior of all students, and they will continue to rely on such consequences while attributing deficits in performance to other variables such as "laziness" or "unintelligence". By allowing students to participate in selecting the reinforcers to be employed in the token economy, a teacher can help insure the reinforcing value of the system. Thirdly, when the behaviors required to earn tokens are directly related to academic criteria, i.e., one token for every addition problem solved correctly, a built-in evaluation mechanism becomes available to the teacher. Levels of performance and progress can then be monitored simply by recording the number of tokens acquired by each student. Such a system of objective measurement of student performance can assist the teacher in pacing the presentation of new material and designing remedial work for students demonstrating such a need.

The Visual Response System. The Mediated Visual Response System (MIVR) was developed by Wyman (1968) as a means to raise the level of interaction and active participation in classrooms for the deaf. The MIVR system makes possible many of the features of programmed instruc-

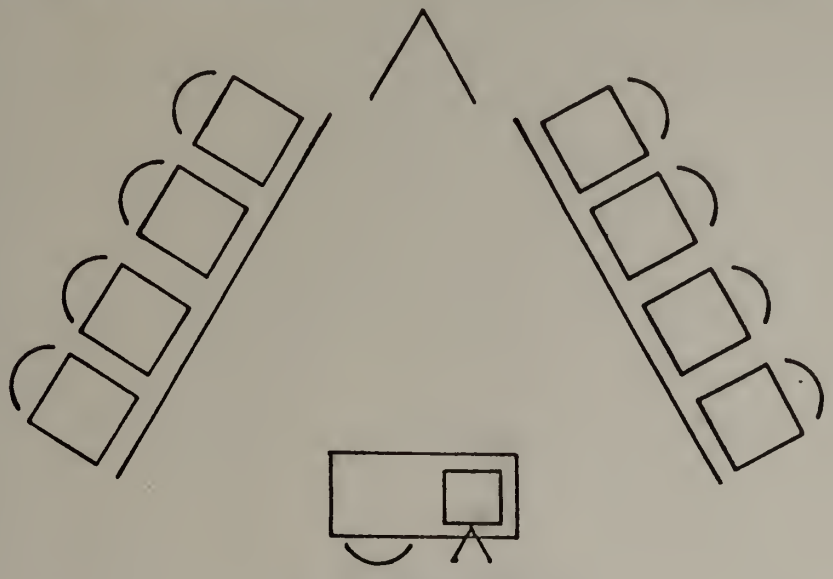
tion, while at the same time incorporates the desirable aspect of personal interaction (Wyman, 1969a, 1969b; Heward, 1974).

A MIVR system basically consists of a set of overhead projectors for use by a small class of students (usually six to ten) and one teacher. Illustration 1 shows some of the ways in which the MIVR system can be set-up in a classroom. The system is designed for small group interaction sessions revolving around some unit of educational material which requires active student response. There is no taking turns in the visual response system. All students respond simultaneously to all stimulus materials. In addition to the basal requirements for programmed instruction, the teacher's presence in the visual response system allows for immediate remediation as well as reinforcement of all student responses.

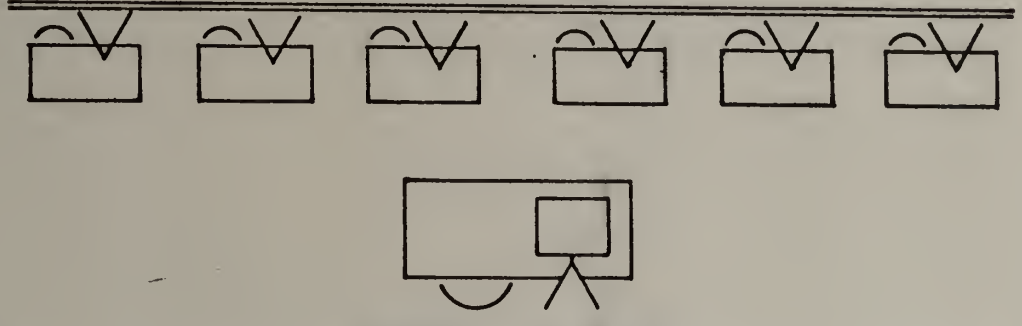
> "The primary purpose of the visual response system is to provide several students with individual but simultaneous visual feedback devices to their teacher in place of or in addition to the usual one-at-a-time oral response. Individual oral response certainly has an important place in education but is not the primary concern of the MIVR system." (Wyman, 1968, p. 1)

Since its conception in late 1967, the MIVR system has been installed and evaluated in various schools for the deaf. Anecdotal information supplied by teachers who used the MIVR system in its early stages suggested that the opportunity for direct and immediate conse-

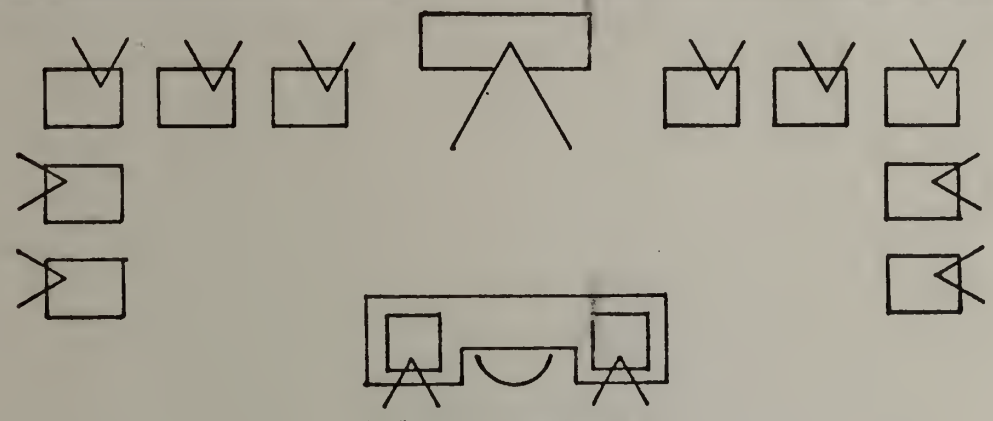
THE VISUAL RESPONSE SYSTEM CAN BE ARRANGED IN VARIOUS WAYS TO ADAPT TO EXISTING SPACE.



"V" CONFIGURATION



STRAIGHT LINE SET-UP



"U" CONFIGURATION

quation of all student responses was a highly desirable feature of the system. In addition, it was soon discovered that for the MIVR system to be utilized effectively, teachers had to prepare instructional materials in a manner requiring relatively high frequencies of student response and that teachers present the material in manageable amounts.

There have been a number of experimental assessments conducted to determine the effectiveness of the MIVR system. The first was performed by Eachus (1969) at the American School for the Deaf. This study produced evidence that the rate, accuracy and complexity of sentence writing by 10-12 year old deaf students could be modified by manipulation of the consequences for sentence writing. Electromechanical counters installed at each student's desk allowed the teacher to immediately award points, which were used in a token economy and traded in for balloons, dolls, books, model kits, etc., for correct sentences. Incorrect responses were immediately remediated by the teacher. The combination of reinforcement for correct sentences and remediation of incorrect sentences brought about a doubling of the number of sentences written per session (from a mean of 24 to a mean of 48-50), and an increase in accuracy from a baseline subject range of 27-63% of all sentences correct to 90-100% correct. This dramatic increase in performance was produced in most subjects by the tenth session. A final phase of this experiment added a concurrent contingency of reinforcement for higher order sentence writing. In addition to the usual one point for grammatically correct sentences (most sub-

jects quickly learned under this contingency to write short, simple sentences, thus reducing the probability of error), two points would be given for correct compound or complex sentences. The students, being provided with immediate feedback on their writing and taking advantage of the student-student visual interaction made possible by the MIVR system, began to compose compound and complex sentences with increasing degrees of accuracy during the remaining sessions of the experiment.

Piper (1970) conducted an experiment at the Tennessee School for the Deaf, in which social praise and teacher approval were used to reinforce correct question forms composed in the MIVR system. The subjects in this experiment were a group of nine year old deaf students described as underachievers. When social praise and teacher approval were administered contingent upon accurate question writing, a rapid increase in rate and accuracy was obtained.

The third experimental assessment of the MIVR system was conducted by Barrette (1971) in a hearing high school. A standard chemistry curriculum was presented to 13 students 15-17 years of age. Completion of workbook and laboratory assignments was reinforced by points which counted towards the grade for the course. The MIVR set-up was a straight line of all student projectors which did not facilitate student-student interaction. This arrangement did provide the chemistry teacher with immediate access to all student responses however, and points were delivered by means of electro-mechanical counters. With respect to the performance criteria in the curriculum, the class average

was 62% accuracy during baseline conditions. During the two experimental phases when reinforcement was available for correct student responses, the class averaged 94% and 98% correct for all items possible.

Gonzales (1971) studied the feasibility of using the MIVR system with preschool deaf children. This experiment was also conducted at the Tennessee School for the Deaf. Filmstrips developed by Project LIFE (National Foundation for the Improvement of Education, 1963+), a series designed to teach the pre-reading and writing skills necessary to adapt to the academic work that deaf children face in school, were presented via the MIVR system. A token economy was also operating in this experiment. Discrimination and association responses concerning the color and shape of various objects increased from a baseline level of 20-35% accuracy to more than 90% correct.

The MIVR systems described above generally made use of very simple arrangements of equipment and space. They consisted of standard student desks with overhead projectors placed beside them. These MIVR systems were often placed in the middle, or in one corner, of a conventional classroom usually of larger dimensions than would be desired for this type of instructional setting, which provided for much visual and auditory noise in competition with planned learning messages. Other forms of media, other than overhead projectors, for additional instructional input and devices for the monitoring and recording of performance criteria were generally nonexistent in these makeshift learning environments.

In 1972 the Northeast Regional Media Center for the Deaf constructed a more sophisticated version of the MIVR system at the Boston School for the Deaf in Randolph, Massachusetts. The Optimum Interaction Learning Laboratory (OILL) was designed to incorporate the tested features of earlier MIVR installations into a setting which would facilitate maximum student interaction with instructional materials, the teacher and other students (Wyman, 1973).

The OILL was constructed in a room remodeled exclusively for the purpose of eliminating extraneous visual and auditory stimuli. There are no windows, chalkboards, clocks, posters, bulletin boards, posters, or other common origins of interference with planned instruction. The OILL consists of 10 specially equipped student stations, each with a built-in overhead projector. At each student station is a response counter, a red and green light, and a call button which lights a numbered indicator on the teacher's console. The teacher can control each individual student overhead projector as well as deliver points to the response counters at the student stations from the console at the teacher's desk. A more detailed description of this visual response system is presented in Chapter II.

Design Considerations. The analysis of behavior is dependent upon the attainment of valid and reliable experimental control over the variables (behavior) under investigation. In this experiment, a teaching methodology was manipulated in an attempt to demonstrate control over the rate, accuracy and linguistic content of sentences composed

by deaf-aphasic children. In a discussion of experimental techniques, Sidman (1960) defines experimental control:

> ". . . experimental control refers to the investigator's ability to manipulate an individual subject's behavior in a precise and reliable fashion. To be able to turn some quantitative aspect of behavior on and off by manipulation of specifiable variables demonstrates a high order of control." (Sidman, 1960, p. 342)

In the analysis of behavior, experimental control is often demonstrated by the reversability of steady states of behavior (Skinner, 1938: Sidman, 1960). To accomplish this the behavior under investigation is recorded and allowed to stabilize (as evidenced by a fairly consistent rate) under baseline conditions, i.e., conditions identical to later experimental phases except that the independent variables under study have not yet been introduced. When a steady baseline rate is achieved, the independent variables are introduced and subsequent alterations in the subject's behavior are recorded. To insure that a behavior change isn't the result of some uncontrolled variable, the previous manipulation is reversed and baseline conditions are reestablished. If the behavior at that point then "reverses" and approaches baseline, further confidence can be put in the postulation that the independent variable manipulations are, in fact, controlling the behavior. Such experimental reversals are repeated with a single subject; and on each occasion that the subject's bahvior changes in the same manner, the reliability of the phenomenon under study is further enhanced.

In essence then, the experimental analysis of behavior rests its validity and reliability upon many highly controlled independent variable manipulations with a single subject. Reliability and generality are advanced by systematically replicating phenomena of interest in other subjects. With such an approach to data collection, the problem of ascertaining the statistical relevance of data and the role played by chance in the experiment's outcome is avoided. Skinner (1966) writes:

> ". . . in the experimental analysis of behavior, where experments are usually performed on a few subjects, curves representing behavioral processes are seldom averaged, the behavior attributed to complex mental activity is analyzed directly, and so on. The simpler procedure is possible because rate of responding and changes in rate can be directly observed. . . . Statistical methods are unnecessary. . . . The complex system we call an organism has an elaborate and largely unknown history which endows it with certain individuality. No two organisms embark upon an experiment in precisely the same condition nor are they affected in the same way by the contingencies in an experimental space. Statistical techniques cannot eliminate this kind of individuality; they can only obscure and falsify it. An averaged curve seldom correctly represents any of the cases contributing to it." (Skinner, 1966, pp. 20-21)

In the applied analysis of behavior, several factors often serve to mitigate against the successful and "clean" use of a straight reversal design. When the setting for an applied study is compared to the highly controlled experimental chambers and solid state programming and data recording devices that comprise the modern operant laboratory, it becomes evident that many variables, due to the nature of the environment where an applied analysis must take place, will go uncontrolled. One such uncontrollable variable is adventitious, or "bootleg" reinforcement. When attempting a reversal to baseline conditions in a situation where the subject is receiving reinforcement outside of that being delivered by the experimenter (e.g., a child who is learning math via reinforcement may also receive reinforcement for the newly acquired behavior from his/her parents at home, by making correct change at a store, etc.), experimental control will be hard to demonstrate. Baer, Wolf, and Risley (1968) contend that the discovery and refinement of procedures that will produce and foster socially relevant behaviors is a major goal of researchers conducting applied behavior analysis. By its very nature, that goal often impedes verification of experimental control by the reversal method, because society (especially the educational and theraputic institutions where much of this research is performed) often will not allow the continued manipulation of socially significant behaviors in order to satisfy scientific curiosity. (When a mute psychotic, who has not spoken in 30 years, begins to use coherent speech, it is easy to understand why

ward personnel and others concerned with the patient's welfare are not happy to see the suspected cause for such improvement discontinued.)

The multiple baseline approach to the analysis of behavior is often effective in producing evidence of experimental control in cases where a reversal technique is not appropriate and/or desired (Sidman, 1960; Ferster and Skinner, 1957; Baer, Wolf and Risley, 1968). In a multiple baseline design, data are collected on at least two dependent variables simultaneously. Independent variable manipulations are then performed on one of the dependent variables, and the fluctuations of that behavior are contrasted with the steady states of the other dependent variables. Another behavior is then selected as the target of the independent variable manipulation and its performance is measured. When each dependent variable changes maximally at the point when it became the target of the independent variable manipulation, then one may conclude that the independent variable is effective in controlling the behaviors under study. For a more detailed description of the multiple baseline design see Sidman (1960).

Experimental Objectives. The data reported by Eachus (1969) were highly inconsistent with the results usually reported in studies analyzing the ability of deaf children to learn and correctly use language. As noted above, the literature on the language ability of deaf students depicts extremely poor levels of performance and acquisition rates. Such data, as that reported by Eachus, require replication to test their reliability. The first objective of this experiment was to perform a systematic replication of the research conducted by Eachus

(1969) in an attempt to extend the reliability and generality of that body of data. Systematic replication differs from a direct replication in that it tests the phenomenon in question in conditions other than those operating in the original experiment. Sidman (1960) discusses the advantages and disadvantages of performing a systematic replication:

> "But this procedure (a systematic replication, ed.) is a gamble. If systematic replication fails, the original experiment will still have to be redone, else there is no way of determining whether the failure to replicate stemmed from the introduction of new variables in the second experiment, or whether the control of relevant factors was inadequate in the first one. On the other hand, if systematic replication succeeds, the payoff is handsome. Not only is the reliability of the original finding increased, but also its generality with respect to other organisms and to other experimental procedures is greatly enhanced." (Sidman, 1960, pp. 111-112)

The second objective of this experiment was to determine if the teaching methodology employed could be used to cause deaf-aphasic children to produce correct sentences containing new linguistic units that had rarely appeared in the subjects' writing beforehand. This was attempted successively with two different linguistic components.

A final experimental objective was to determine if the same procedures could be employed to cause the subjects to write correct sen-

tences that contained both of the newly acquired linguistic components simultaneously.

C H A P T E R II

METHOD

Subjects. Eight students from the Aphasic Department at the Boston School for the Deaf, Randolph, Massachusetts, served as subjects for this experiment. The subjects, four female and four male, ranged in age from 8 years, 10 months to 11 years, 4 months at the onset of the experiment. The subjects possessed various levels of hearing impairment (one subject displayed no hearing loss) and were diagnosed as aphasic. As a group, the subjects presented a variety of background profiles (see Table 1). Four of the subjects participated for the entire duration of the experiment, three subjects were present only for the Spring component of the experiment, and one subject was present only during the Fall segment.

The regular homeroom teacher of the subjects served as teacher in the experiment. At the onset of the experiment, it was the teacher's third year of teaching at a school for the deaf, and her second year of teaching students diagnosed as aphasic.

Apparatus. The experiment was conducted in the Optimum Interaction Learning Laboratory (OILL) at the Boston School for the Deaf, Randolph, Massachusetts. The OILL is a visual response system consisting of 10 specially constructed student stations, each with a built-in overhead projector. At each student station was a response counter, a red light, a green light, and a call button which lights a numbered indicator on the teacher's console. Each student station was also equipped

Table 1

Background Data on Subjects

Subject	Age	Mental Ability (BSD Evaluation From Assorted Test Instruments)	Aphasia Type	Etiology	Hearing Loss In Decibles Left/Right
*Gil (M)	10-4	Above Avg.	Receptive	Rubella	40/50
*Lee Anne (F)	8-10	High Avg.	Receptive/ Expressive	?	55/55
*Marie[1] (F)	10-1	Average	Expressive	?	None
*Susan (F)	10-3	Average	Receptive	?	40/50
[s]Brian (M)	10-1	Average	Receptive	Prenatal Medication	40/30
[s]Jacques (M)	9-6	High Avg.	Mixed	?	60/65
[s]Sandy (F)	10-3	Average	Receptive	Rubella	65/80
[f]Paul (M)	11-4	Above Avg.	Receptive/ Expressive	RH Incompatibility	90/80

*Participated in entire study

[s]Participated only in Spring

[f]Participated only in Fall

[1]Residential student (all other subjects were day students)

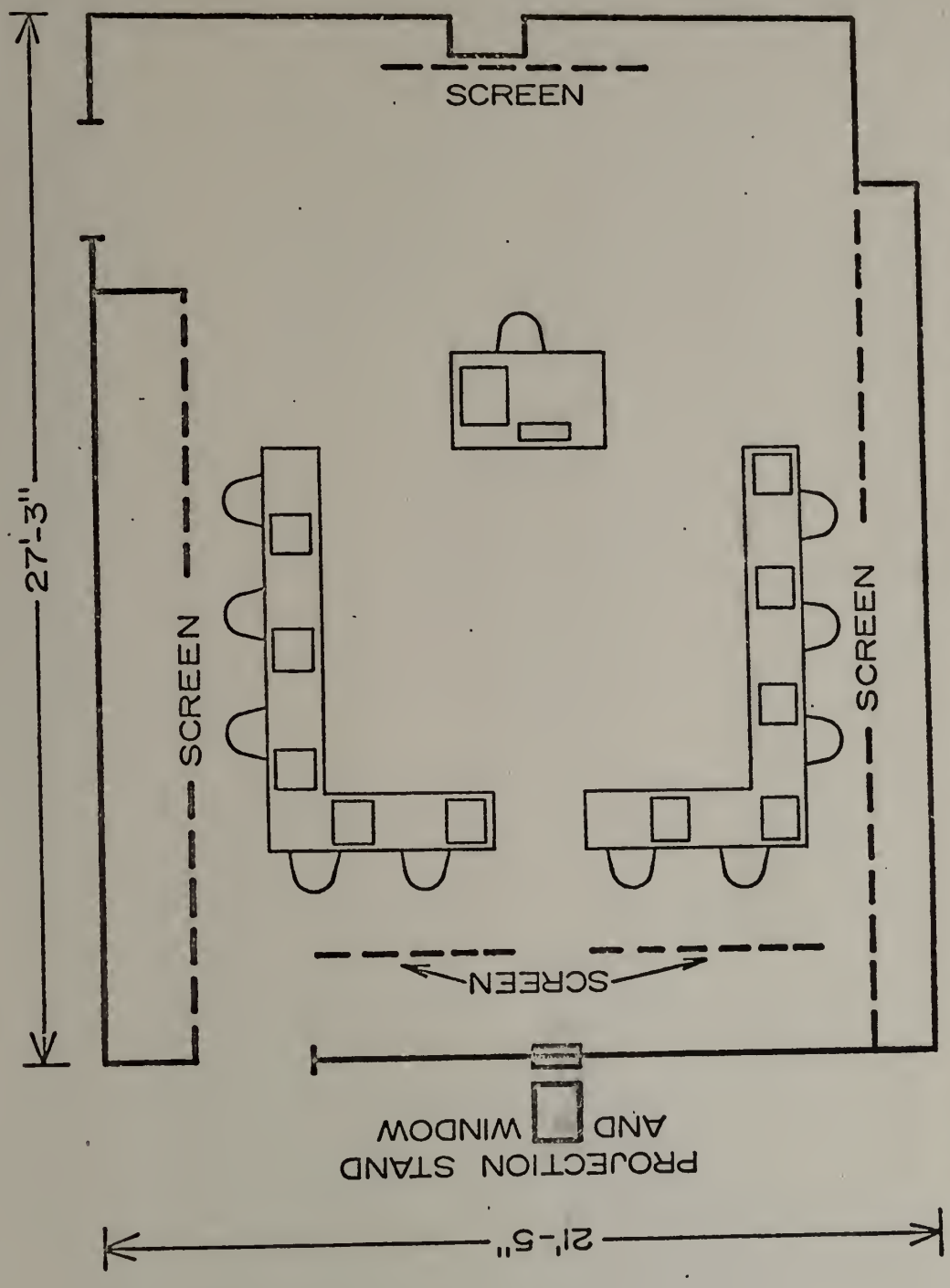
with a binaurally volume controlled headset with a lip microphone.

The teacher's console was equipped with an overhead projector and switches to operate the student response counters, red and green lights, individual overhead projectors, an integrated sound system, and a turntable. A filmstrip projector, slide projector, and movie projector, which were also teacher controlled from the console, were housed in a rear projection room.

The OILL was constructed in a room remodeled specifically for its use (see Illustration 2). The walls along the sides of the OILL were anti-keystoned and served as a projection screen for student projectors facing those walls. The teacher's overhead projector and those of students seated along the back wall projected on anti-keystoned screens secured to the floor and ceiling. The floor was completely carpeted with all wiring concealed underneath. There were no posters, bulletin boards, clocks, intercoms, lunch menus, etc. The OILL was designed to produce a very favorable signal-to-noise ratio both auditorily and visually.

The stimulus materials used in this experiment were a subset of overhead projector transparencies from the Northeast Regional Media Center for the Deaf Language Arts Series (Wyman and Tilley, 1968), a series developed to assist teachers in the instruction of elementary language principles to hearing impaired children. The transparencies chosen for this experiment all contained pictures of objects, people, and places and depicted some ongoing scene. Transparencies were presented in random order by trial, and most transparencies were presented three or four times during the course of the experiment.

The reinforcers which were available to the subjects through the



Optimum Interaction Learning Laboratory

exchange of points accumulated during the experimental sessions were determined by asking the subjects what candies, toys, games, and activities they enjoy the most. These items were then placed in a "store" set-up in the Boston School's Institutional Resource Center across the hall from the OILL and were made available to the subjects during the final period on the last day of each week. During the Fall portion of the experiment, the reinforcers were housed in the subjects' homeroom. The items named by the subjects as reinforcers covered a wide cost range from penny candies to record players and sport cars. The actual items that were acquired and used in the token economy and the number of points required to obtain them are listed in Table 2.

Procedure. Five dependent variables concerning the sentence writing behavior of the subjects were recorded for each subject during the experiment: 1) Rate, the total number of sentences written per session; 2) Accuracy, the percentage correct of the total sentences written per session; 3) The percentage of total correct sentences written per session containing a prenominal adjective (any word immediately preceeding a noun and modifying that noun); 4) The percentage of total correct sentences written per session containing an adverb (any word or phrase modifying a verb by adding information of How, When, Where, and Why); and 5) The percentage of total correct sentences written per session containing a prenominal adjective and an adverb. Judgment of accuracy and content were made by the subjects' teacher.

The subjects met once a day in the OILL system for 40 minute sessions. The actual time of the session varied depending upon the day of

TABLE II

Items Chosen by Subjects as Reinforcers and Their Point Value

Spring

Penny Candies	3	Crayons (small box)	35
Candy Bars	10	Pony Tail Holders	35
Gum (pkg.)	10	Fun Books Coloring Books	50
Memo Pads	15	Comb and Brush	100
Rulers	15	Model Airplane Kits	100
Boston Bruins Stickers	15		

Fall

- To Buy-		- To Rent for the Weekend -	
Penny Candies	10	Frisbees	25
Candy Bars	25	Pick-Up Sticks	25
Gum (pkg.)	25	Puzzles	35
Rubber Ball	150	Barrel of Monkeys (game)	35
Coloring Books	150	Building Blocks	35
Pot Holder Kits	150	Hands Down (game)	50
Jump Ropes	200	Viewmaster	50
Yo-Yos	200	Kerplunk (game)	75
		Fat Albert (game)	75

the week. The experiment consisted of 28 sessions conducted from 29 January 1973 to 15 March 1973 and 34 sessions held from 2 October 1973 to 30 November 1973. Nine weeks of school in the Spring of 1973, three months of summer vacation, and four weeks of school in the Fall of 1973 separated the two segments of the experiment. Easter and Thanksgiving vacations occurred during the periods that the experiment was conducted.

Each experimental session consisted of two five minute writing trials. Each trial was initiated by the teacher projecting a stimulus on her overhead projector to set the occasion for sentence writing. Subjects wrote sentences with water soluble pens on blank acetate sheets placed directly on the stage of their overhead projectors. All student projectors remained on during all writing trials throughout the experiment. Subjects were supplied with as many acetate sheets as their writing required. No verbalization on the part of the teacher or the subjects was required, but subjects were not prohibited from talking. The subjects' response sheets were collected at the end of each session and the experimental data obtained from them. Six experimental phases were conducted during the Spring (S-1 - S-6) and six during the Fall (F-1 - F-6).

The twelve phases of the experiment are described below:

S-1 Baseline. No direct consequence was delivered for sentence writing during this phase. The teacher instructed the subjects to "Write as many correct sentences describing this picture as you can

until I say, 'Stop.'" After a five minute writing period, the teacher turned off her projector and said, "Stop." The subjects response transparencies were immediately collected after each trial with no comment made regarding the writing.

S-2 Reinforcement and Remediation. During this phase, a point was awarded each subject for every correct sentence written. The teacher collected all response sheets after each trial and checked each subject's sentences on the teacher's overhead projector. Subjects had their response counters advanced for every correct sentence they had written. Sentences that were not correct were remediated by the insertion of appropriate changes directly upon the subject's response transparency by the teacher. Subjects were required to write both gramatically and conceptually correct sentences to receive a point (e.g., if a stimulus depicted a cat sitting on a chair, the sentence "The cat is sitting under the chair," was considered incorrect). This remediation was carried out in full view of all subjects.

S-3 Baseline Conditions. Reinforcement and remediation of sentence writing were terminated during this phase and phase S-1 conditions were in effect, except that the teacher orally instructed the subjects before the first session of this phase, "There won't be any points now, but do the best you can anyway."

S-4 Reinforcement and Remediation - Prenominal Adjectives. The procedures were the same as in phase S-2, except that correct sentences containing a prenominal adjective were consequated with two points. For

example, the sentence, "I see a man," was worth one point, but a subject writing, "I see a happy man," received two points. A vacant student overhead projector was used to project six correct sentences without prenominal adjectives and six correct sentences including prenominal adjectives (see Appendix 2). A bracket (⌜——⌝) was drawn under each prenominal adjective. These visual prompts were projected throughout each session of this phase and were the only experimental input regarding the use of prenominal adjectives.

S-5 Baseline Conditions. Phase S-3 conditions were reinstated.

S-6 Reinforcement and Remediation - Prenominal Adjectives. Phase S-4 procedures were reinstated. Beginning with the third session of this phase all visual prompts for sentence writing were terminated.

F-1 Baseline. Phase S-1 contingencies were in effect.

F-2 Reinforcement and Remediation - Prenominal Adjectives. During this phase, the teacher scanned the subjects' projected writing throughout all trials. When the teacher judged a sentence to be correct, one point was immediately added to the response counter of the subject who wrote the sentence. If a correct sentence contained a prenominal adjective, two points were administered. After each writing trial, the teacher collected all of the subjects response transparencies and remediated incorrect sentences in the same manner described in phase S-2. Before the first session of this phase, the teacher orally prompted the subjects to, "Try and write sentences with adjectives."

F-3 Reinforcement and Remediation - Adverbs. The same basic procedure employed in phase F-2 was in effect except that correct sentences containing an adverb were consequated with three points. All other correct sentences (including those with prenominal adjectives) were worth one point. A vacant student overhead projector was used to project this contingency throughout all sessions of this phase. A second vacant overhead projector was used to project 12 correct sentences, containing adverbs (adverbs underlined), each type of adverb appearing in three sentences (see Appendix 2). The sentence examples were projected only during the first five sessions of this phase.

F-4 Baseline Conditions. Phase F-3 conditions were reinstated.

F-5 Reinforcement and Remediation - Adverbs. Phase F-3 contingencies were reestablished; all visual cues for sentence writing were terminated.

F-6 Reinforcement and Remediation - Prenominal Adjectives and Adverbs. In this phase the procedure was the same as that used in phase F-2, except that each subject writing a correct sentnece containing both a prenominal adjective and an adverb received four points. All other correct sentences were consequated with one point. A vacant student overhead projector was used to project six correct sentences each including a prenominal adjective and an adverb. Prenominal adjectives and adverbs were notated in these examples in the same manner as earlier prompts. These examples were projected throughout each of the first four sessions of this phase.

Throughout all phases of contingent reinforcement of correct sentences, subjects were not delivered points for directly copying another subject's sentence or a projected example sentence. Nor could a subject write the same sentence more than once during any given trial. Such responses by a subject were considered an error.

No specific number of sessions was predetermined for the length of any given phase. The subjects' data were inspected daily and decisions to begin a new phase were based upon the general stability of that data for the majority of the subjects. Overall accuracy and the level of acquisition of prenominal adjectives and adverbs in the phases where they were being consequated served as the prime determiners for stability.

CHAPTER III

RESULTS

Results of this experiment are presented in three subsections; rate of response, accuracy of response, and topography of response. A final subsection will provide data concerning the various types of errors commiteed by each subject.

Rate of Response. The data on rate of response (see Figures 1-8[3]) indicate that the number of sentences written by the subjects was under the control of the experimental variables. All subjects displayed an

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[3]Special notations occur in each of the 24 figures: (a) On session nine, an additional male student joined the subjects and participated in the remaining experimental sessions of the Spring phases; data were not collected from this student; (b) During the first trial of session 20, Sandy wrote a large number of sentences using the form, "The boy's name is _____," "The girl's name is _____," etc. These sentences were consequated with two points, and on the second trial of that session five other subjects wrote the majority of their sentences in that form. Following session 20, a new contingency was instated that withheld reinforcement for sentences of that form exceeding the number of people portrayed by the projected stimulus; (c) Beginning with session 27, the examples of sentences containing prenominal adjectives were no longer projected on the screen; (d) During session 35, the teacher delivered verbal praise along with points to subjects who wrote sentences containing new words as prenominal adjectives; (e) Gil got into a fight (pushing and shouting) with Paul and Susan immediately before session 39; (f) Beginning with session 46, the examples of sentences containing adverbs were no longer projected on the screen; (g) During session 52, administrators from a local public school were present in the visual response system during the first writing trial; (h) During session 53, Susan's mother was present in the visual response system along with the chairperson of the Aphasic Department; (i) Beginning with session 61, the examples of sentences containing both a prenominal adjective and an adverb were no longer projected on the screen.

In addition to the five subjects two other male students participated in the Fall experimental phases. However, their writing skills were far below those of the original subjects, and the teacher set other contingencies for their writing behavior. Therefore, data of concern to the experiment were not tabulated from their sentences.

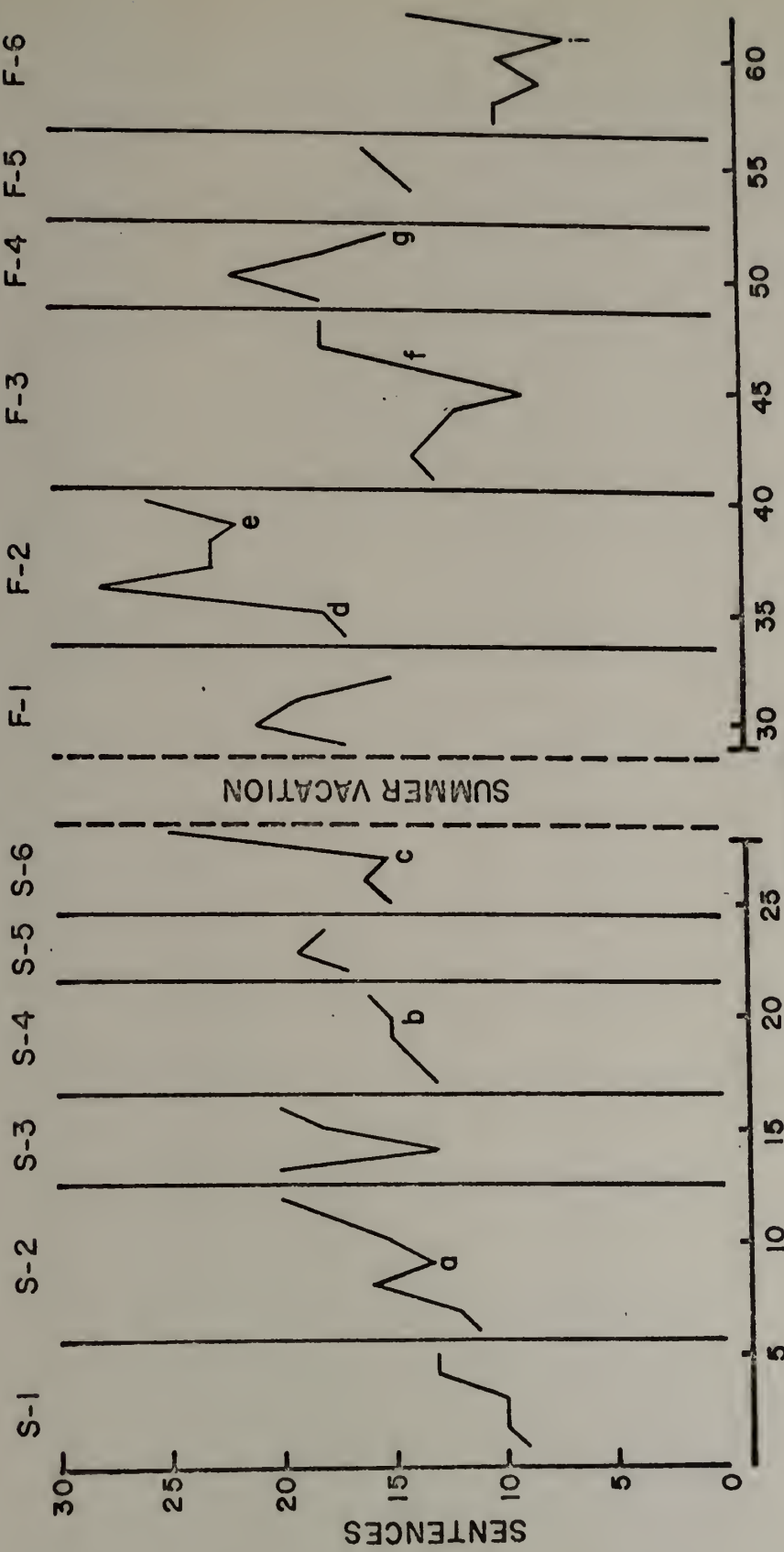

FIGURE 1 NUMBER OF SENTENCES WRITTEN PER SESSION - GIL

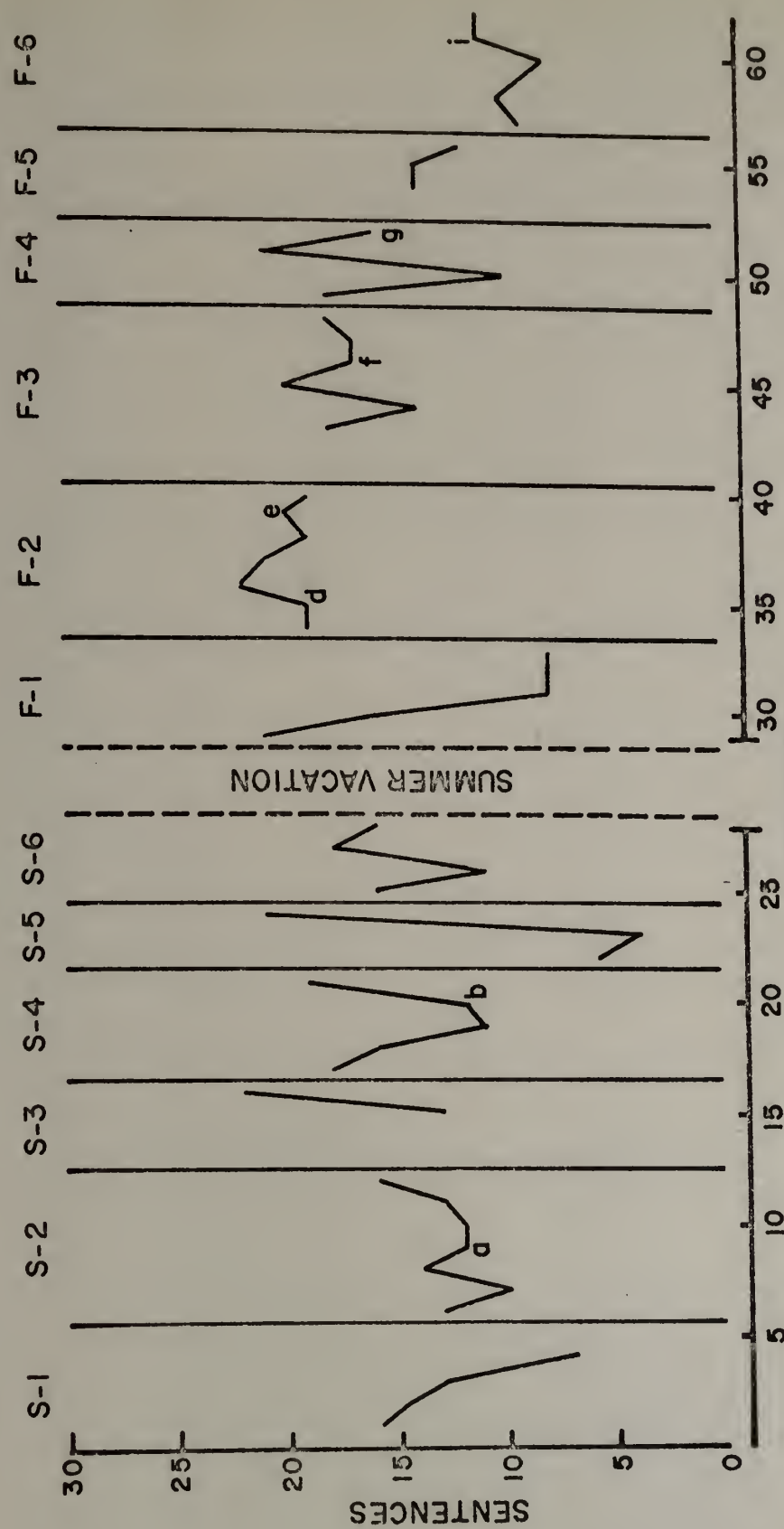

FIGURE 2 NUMBER OF SENTENCES WRITTEN PER SESSION - LEE ANNE

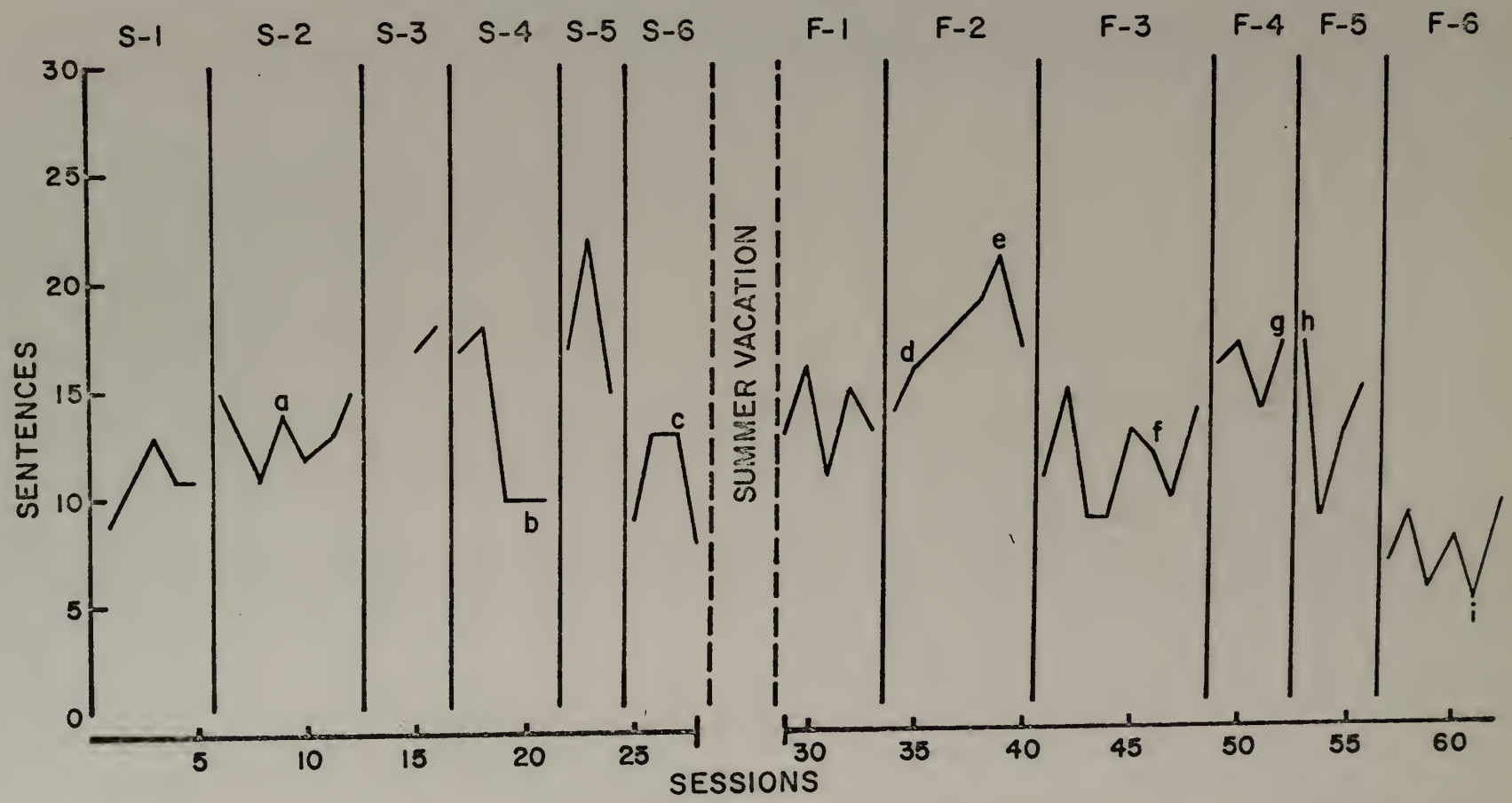

FIGURE 3 NUMBER OF SENTENCES WRITTEN PER SESSION - MARIE

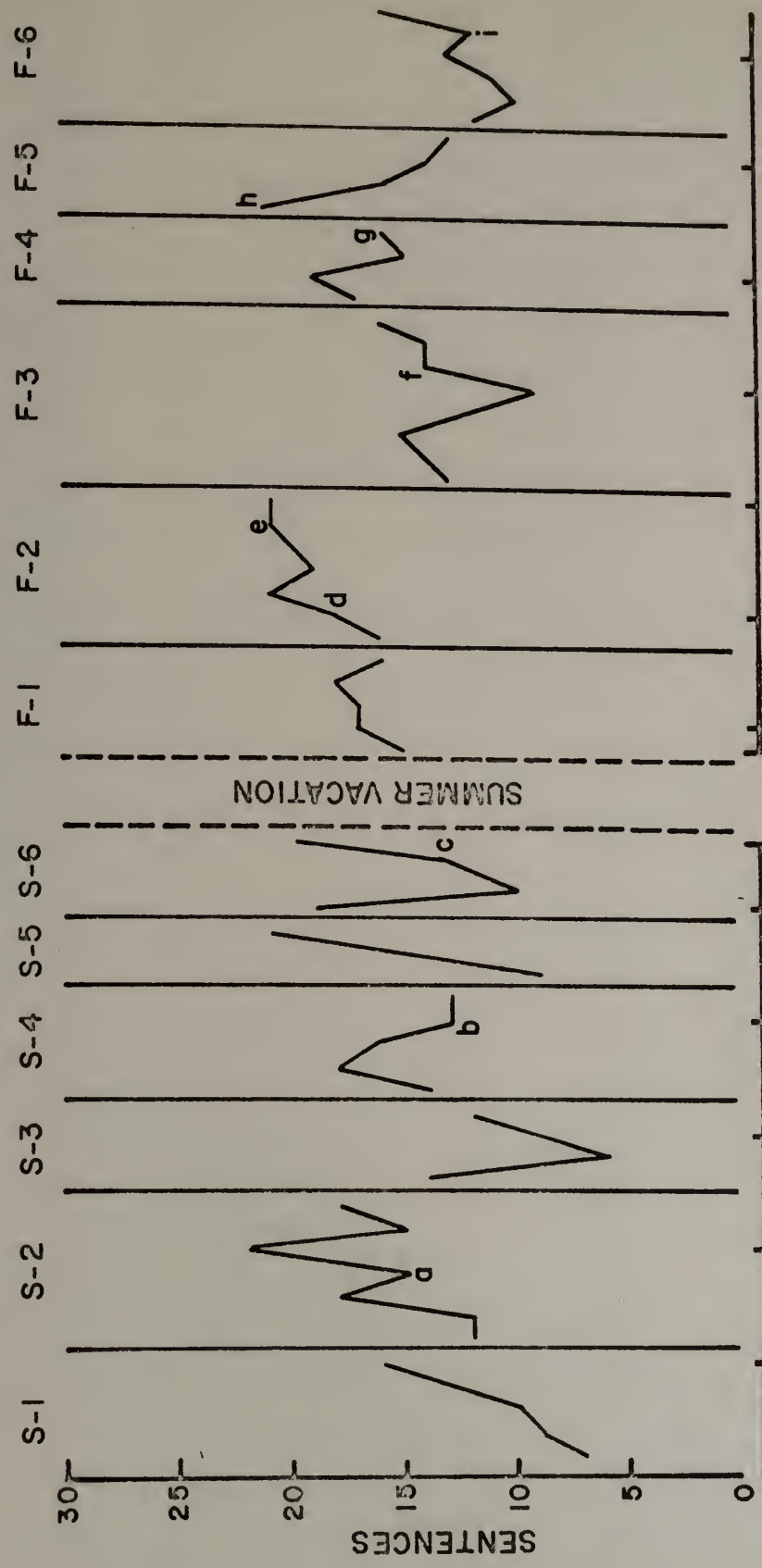

FIGURE 4 NUMBER OF SENTENCES WRITTEN PER SESSION - SUSAN

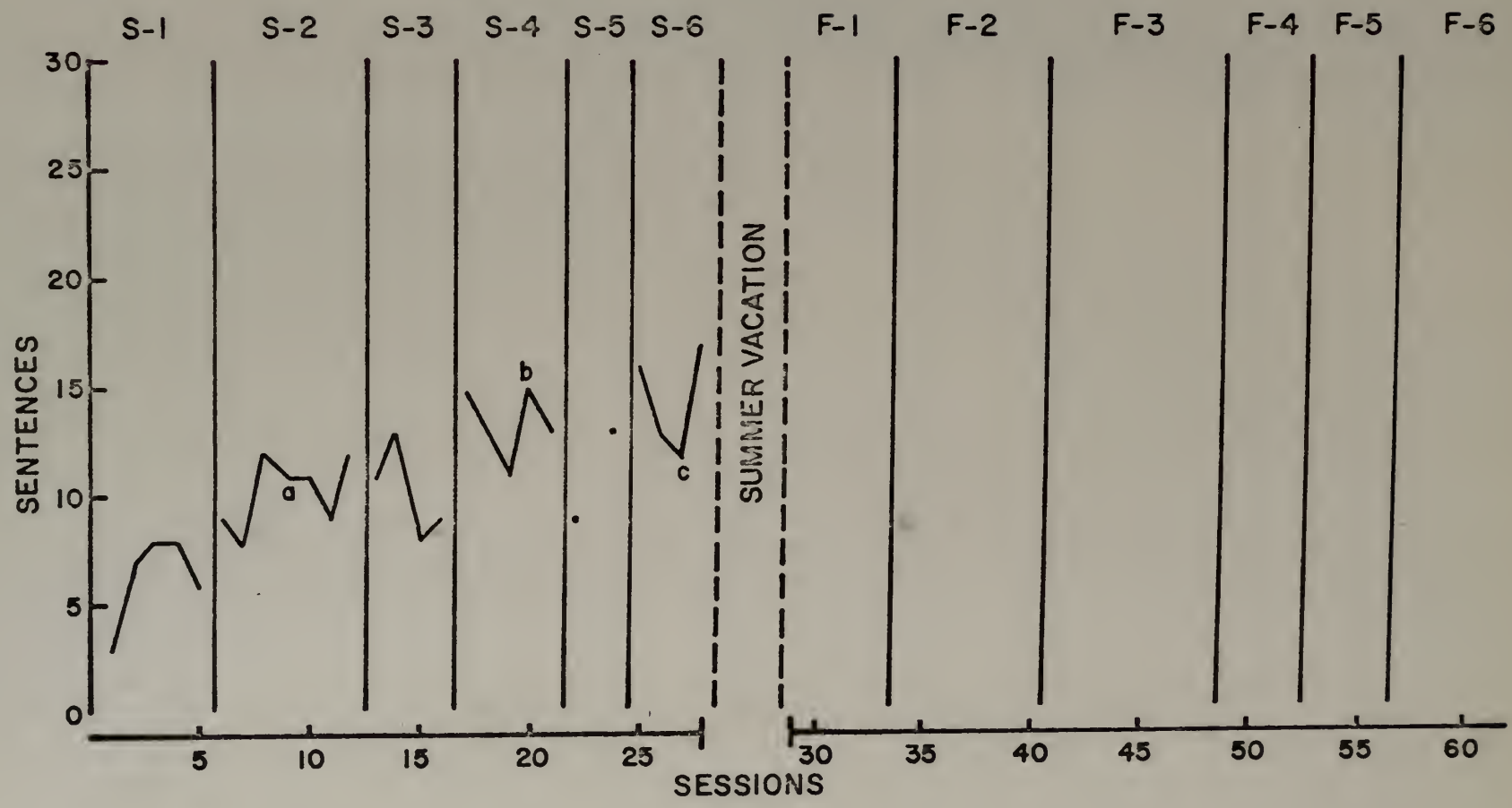

FIGURE 5 NUMBER OF SENTENCES WRITTEN PER SESSION - BRIAN

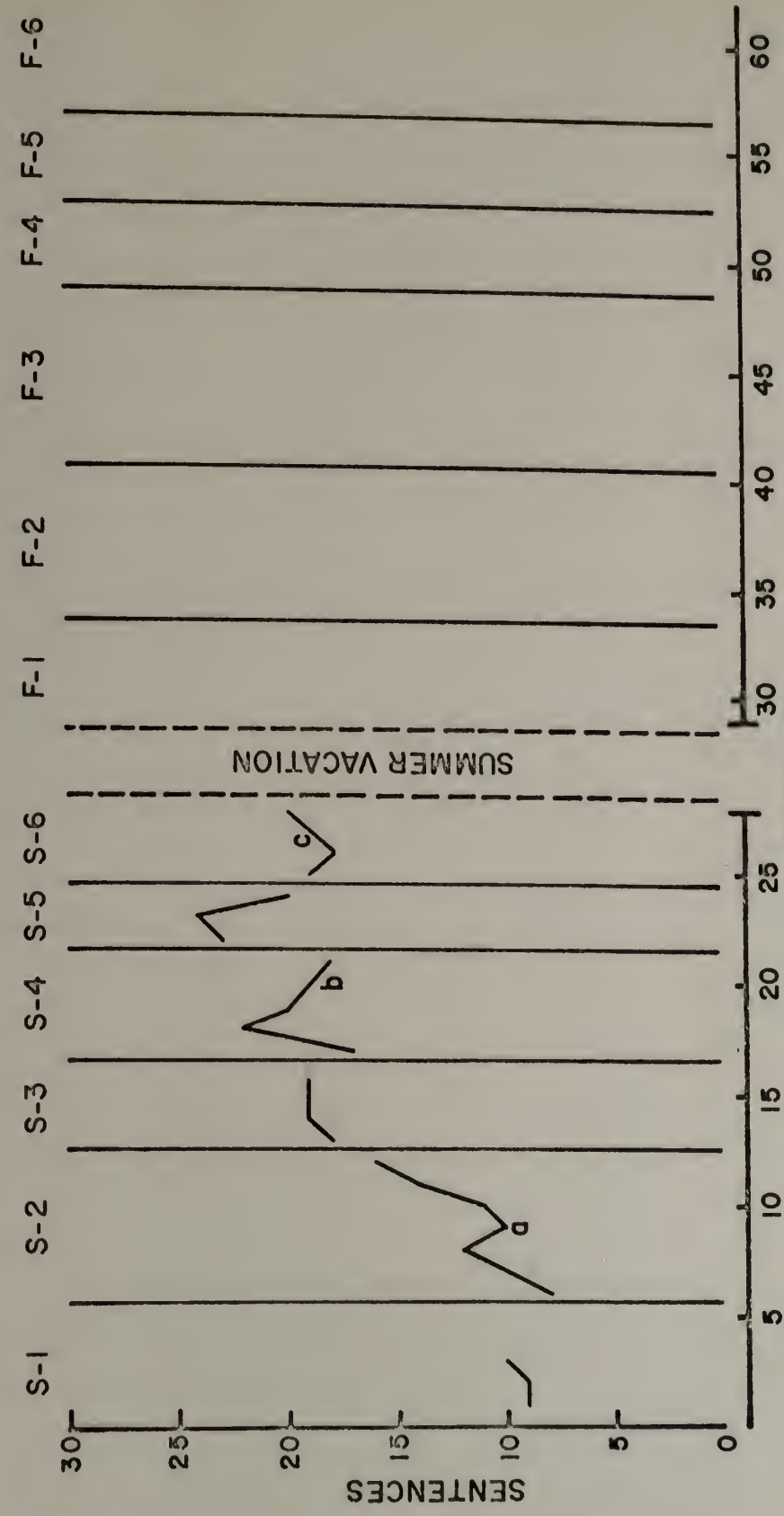

FIGURE 6 NUMBER OF SENTENCES WRITTEN PER SESSION - JACQUES

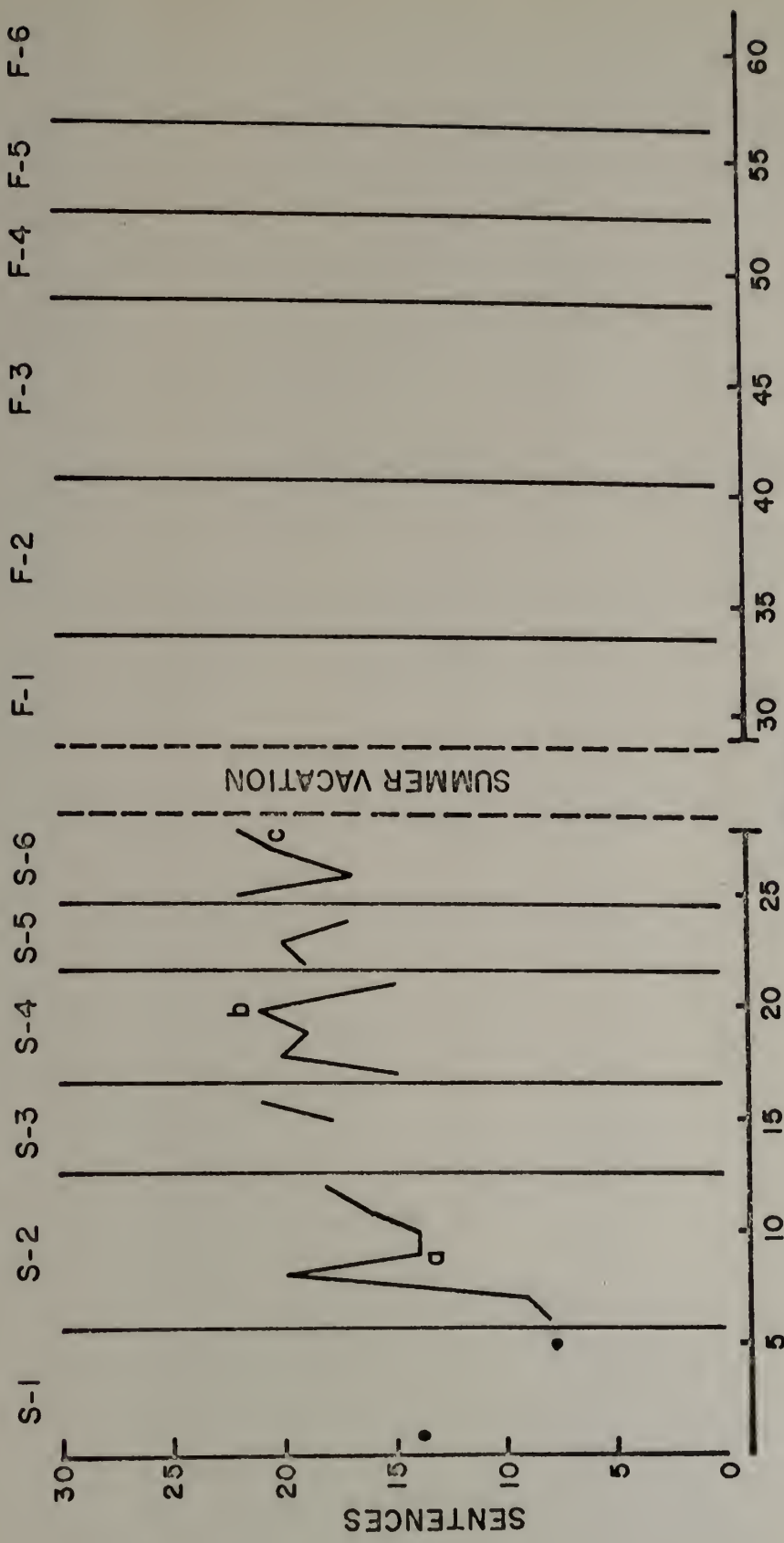

FIGURE 7 NUMBER OF SENTENCES WRITTEN PER SESSION - SANDY

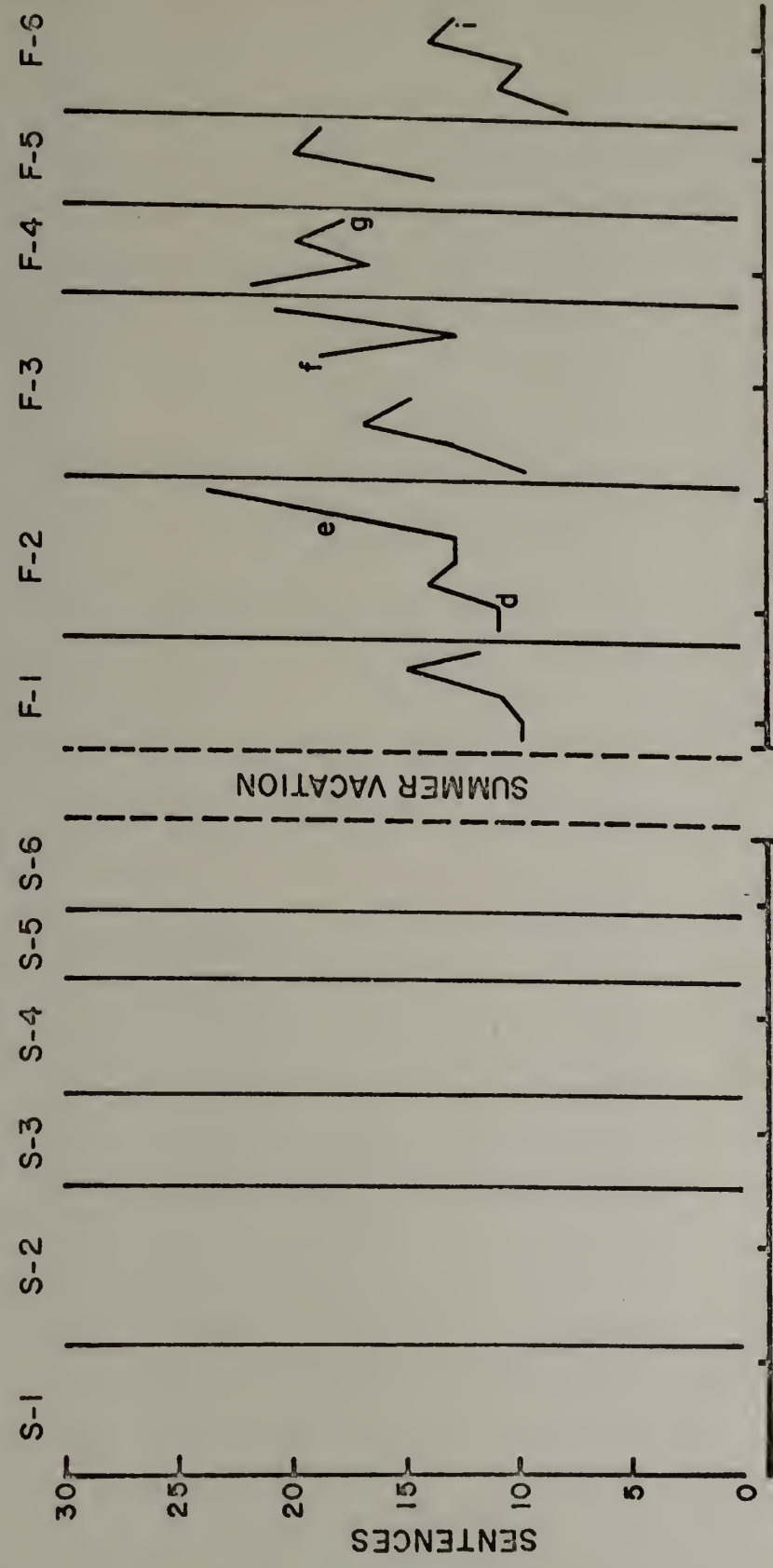

FIGURE 8 NUMBER OF SENTENCES WRITTEN PER SESSION - PAUL

increase in rate over baseline levels, when reinfrocement and remediation were made contingent upon writing correct sentences in phases S-2 and F-2. Increases in rate were disrupted by variable performance by most subjects, when reinforcement and remediation were discontinued during phases S-3, S-5, and F-4. When the inclusion of prenominal adjectives, adverbs, or both into the subjects' sentences was required for the first time in phases S-4, F-3, and F-6, all subjects displayed significant decreases or disruptions in rate.

Appendix 1 contains the number of sentences written per session by each subject. Because the subjects' changes in rate across phases were similar, these data are described as the subjects' range of change for each phase. Exceptions will be noted.

S-1 Baseline. The average number of sentences written per session during the five sessions of phase S-1 ranged across subjects from 6.4 for Brian to 12.8 for Lee Anne. Four of the subjects, Gil, Marie, Sandy, and Susan, average 11 sentences per session during this phase. Rate was fairly stable across the five sessions of this phase for Brian, Gil, Jacques, and Marie. Susan's rate increased steadily during baseline from seven sentences during session one to 16 on session five. Lee Anne wrote 16 sentences during the first session, then her rate decreased over the next three sessions to seven. She was absent during session five. Sandy was present only for sessions one and five writing 14 and eight sentences respectively.

S-2 Reinforcement and Remediation. All seven subjects displayed an increase in rate over phase S-1 during this phase. The average number of sentences written per session for the seven sessions of phase S-2 ranged from 12.9 for Lee Anne to 16 for Susan. Brian's overall rate increased the most from baseline, rising 61%; Lee Anne showed the smallest rise in rate, increasing only 8% over baseline.

S-3 Baseline Conditions. Susan's overall rate decreased to 10.3 during phase S-3, a drop of 36%. Five subjects, Gil, Jacques, Lee Anne, Marie, and Sandy continued to increase their response rates during phase S-3. Brian's average rate per session remained the same as during phase S-2. Marie and Sandy were absent on two of the four sessions, and Lee Anne was absent from session 14.

S-4 Reinforcement and Remediation - Prenominal Adjectives. All subjects, except Brian and Susan, showed a drop in rate from the previous session, when phase S-4 began on session 17. Brian, Susan, and Jacques showed overall increases in rate over phase S-3 of 30, 44 and 2% respectively. Gil, Lee Anne, Marie, and Sandy all displayed slight decreases in overall rate during phase S-4.

S-5 Baseline Conditions. Overall rate increased slightly for five of the subjects during phase S-5. Brian showed a slight decrease of 18% from phase S-4, and Lee Anne's rate dropped 32% over the same span.

S-6 Reinforcement and Remediation - Prenominal Adjectives. The response rate of all subjects, except Brian and Sandy, showed a decrease from the previous session when the contingency for prenominal

adjectives was reinstated on session 25. Overall rate during phase S-6, however, was higher than during phase S-4 for Brian, Gil, Sandy, and Susan. Jacques and Lee Anne wrote at the same rate as during phase S-4. Marie was the only subject to drop in rate from phase S-4 to S-6.

F-1 Baseline. Fall baseline levels for Gil, Marie, and Susan were higher than those they recorded in the Spring (S-1). Lee Anne wrote 21 sentences during the first session of phase F-1, but quickly dropped to eight by the third session of the phase and remained at that level for the remaining two sessions, making her overall rate during phase F-1 slightly lower than during phase S-1. Paul's average response rate was fairly stable at 11.6 sentences per session.

F-2 Reinforcement and Remediation - Prenominal Adjectives. When reinforcement and remediation were instated during session 34, all subjects showed a marked increase in response rate. The effects were similar to the increases in rate that occurred during phase S-2, except that overall rate was higher. All subjects produced their highest overall rate performance during this phase. A gradual positive acceleration was noted throughout the phase for all subjects, except Lee Anne who wrote approximately 20 sentences per session throughout the phase.

F-3 Reinforcement and Remediation - Adverbs. When the contingency for adverbs was put into effect in session 41, a drop in response rate was noted for all subjects. The effects were similar to those noted in phase S-4, when the contingency for prenominal adjectives was established. The subjects all showed a moderate increase in rate as phase F-3 progressed.

F-4 Baseline Conditions. Rate for all subjects was variable during this phase and approached baseline levels of phase F-1. In all cases, the rate was less than that produced during phase F-2.

F-5 Reinforcement and Remediation - Adverbs. Rate for all subjects was lower than that obtained during phase F-2, but overall rate was higher than phase F-3 for Marie, Paul, and Susan. Lee Anne's rate during phase F-5 was slightly lower than during phase F-3.

F-6 Reinforcement and Remediation - Prenominal Adjectives and Adverbs. When the contingency for sentences containing both a prenominal adjective and an adverb was instated on session 57, all subjects displayed a marked decrease in rate. Overall rate for all five subjects was lower than that during phase F-1, and approached the level obtained in phase S-1. A gradual increase in rate was exhibited by all subjects as phase F-6 progressed.

Accuracy of Response. Data representing the accuracy with which subjects composed sentences are presented in Figures 9-16. These data indicate that the percentage of total sentences each subject wrote correctly was under the control of the experimental variables. All subjects displayed a substantial increase in accuracy over baseline levels when reinforcement and remediation were made contingent upon writing correct sentences during phases S-2 and F-2. Gil, Lee Anne, and Susan showed decreases in accuracy when reinforcement and remediation were discontinued during phases S-3, S-5, and F-4. The other subjects either demonstrated a disruption in positively accelerating accuracy or variable performance during those phases when reinforce-

ment and remediation were terminated. In most cases, accuracy dropped slightly during phases S-4, F-3, and F-6, when maximum reinforcement was contingent upon writing correct sentences containing a prenominal adjective, adverb, or both, which were largely new behaviors for the subject.

The general results concerning the accuracy of sentence composition are drawn from all subjects. Description of accuracy data for each subject during the course of the experiment follows. Appendix 1 contains the number of correct sentences written per session by each subject.

Gil's baseline accuracy was zero for four of the five sessions of phase S-1 (Fig. 9). He wrote one correct sentence during session four, giving him an overall accuracy during baseline of 2%. Gil's accuracy steadily increased during phase S-2 from 9% on session six to a high of 65% on session 12. His accuracy continued to accelerate during phase S-3. Gil wrote 83% of his sentences correctly during phase S-4, dropped to 63% when reinforcement and remediation were terminated in phase S-5, and averaged 84% correct for the last three sessions of phase S-6. Gil's Fall baseline accuracy for four sessions of phase F-1 ranged from 74-88%. He maintained that same range of accuracy during phase F-2, except for sessions 35 and 36 when he dropped to 50 and 54%. Gil's accuracy was variable during the first six sessions of phase F-3, ranging between 54 and 86%, but he wrote 94% of his sentences from 83 to 47% in the fourth session of phase F-4, when reinforcement and remedia-

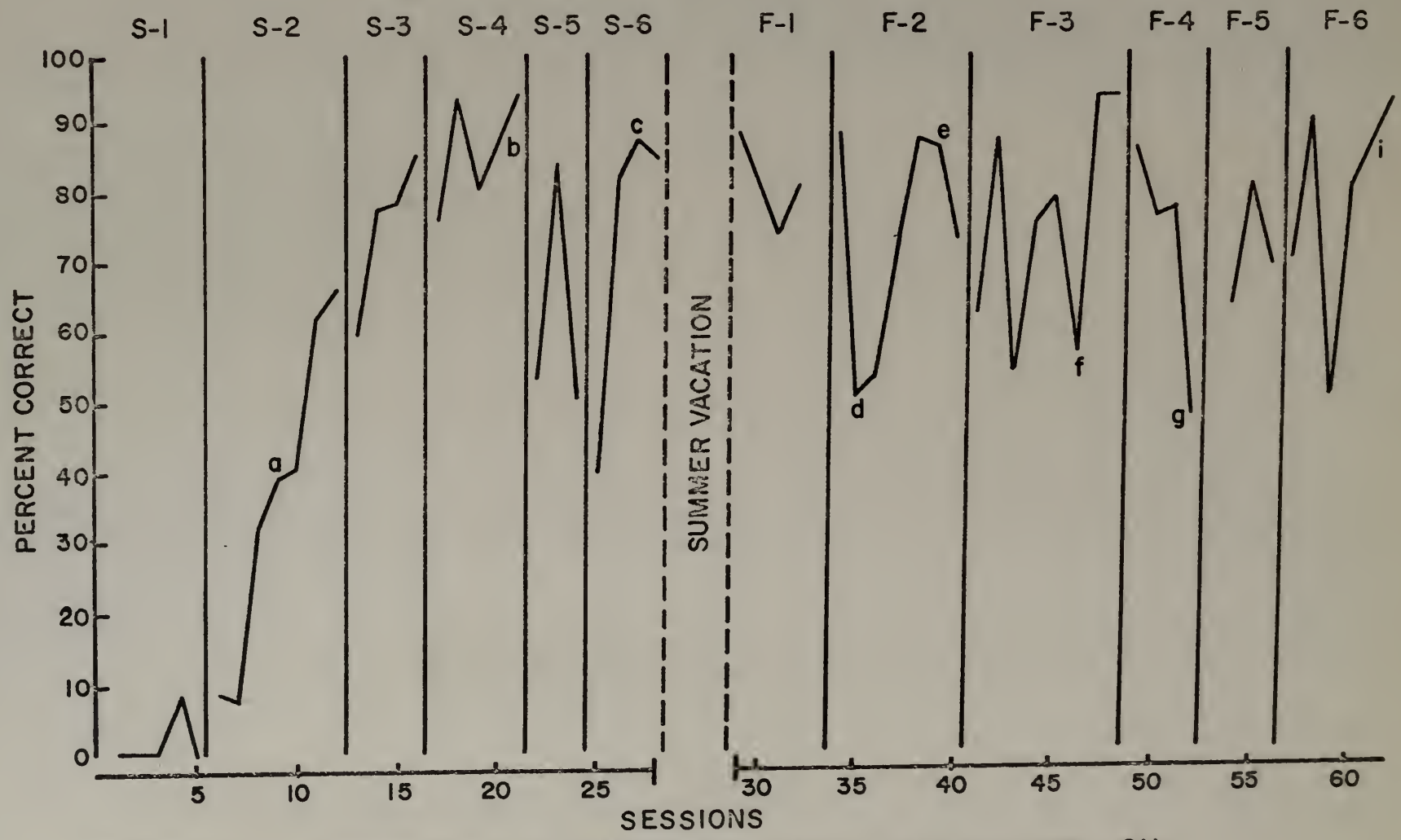

FIGURE 9 PERCENTAGE OF SENTENCES CORRECT PER SESSION - GIL

tion were terminated. With the reinstatement of reinforcement and remediation in phase F-5, his accuracy increased. Gil's level of accuracy was variable for the first three sessions of phase F-6 as he began to write more sophisticated sentences, then steadily increased to a high of 93% for the remainder of the phase.

Lee Anne wrote no correct sentences on three of the four sessions of phase S-1 that she attended (Fig. 10). Lee Anne demonstrated the most dramatic increase in accuracy of any subject, changing from an overall baseline level of 4% to 100% correct on the last session of phase S-2. Her accuracy fell to 73% in phase S-3, averaged 80% during phase S-4, and dropped steadily from 67 to 24% during the baseline conditions of phase S-5. She wrote 100% of her sentences correctly when reinforcement and remediation were reinstated during phase S-6 on session 25, then dropped to an average of 67% for the final three sessions of the last Spring phase. Lee Anne began phase F-1 by writing 97% of her sentences correctly in sessions 29 and 30, then dropped steadily to 38% correct by the last session of that phase. When reinforcement and remediation were contingent upon her writing behavior during phase F-2, her accuracy ranged from 73 to 89%. She dropped to 64% accuracy on the first session of phase F-3, then returned after a one day absence to write 83 to 100% of her sentences correctly for the final six sessions of that phase. Lee Anne's accuracy dropped considerably in phase F-4, reaching a low of 50% by session 59, throughout phase F-6. She averaged

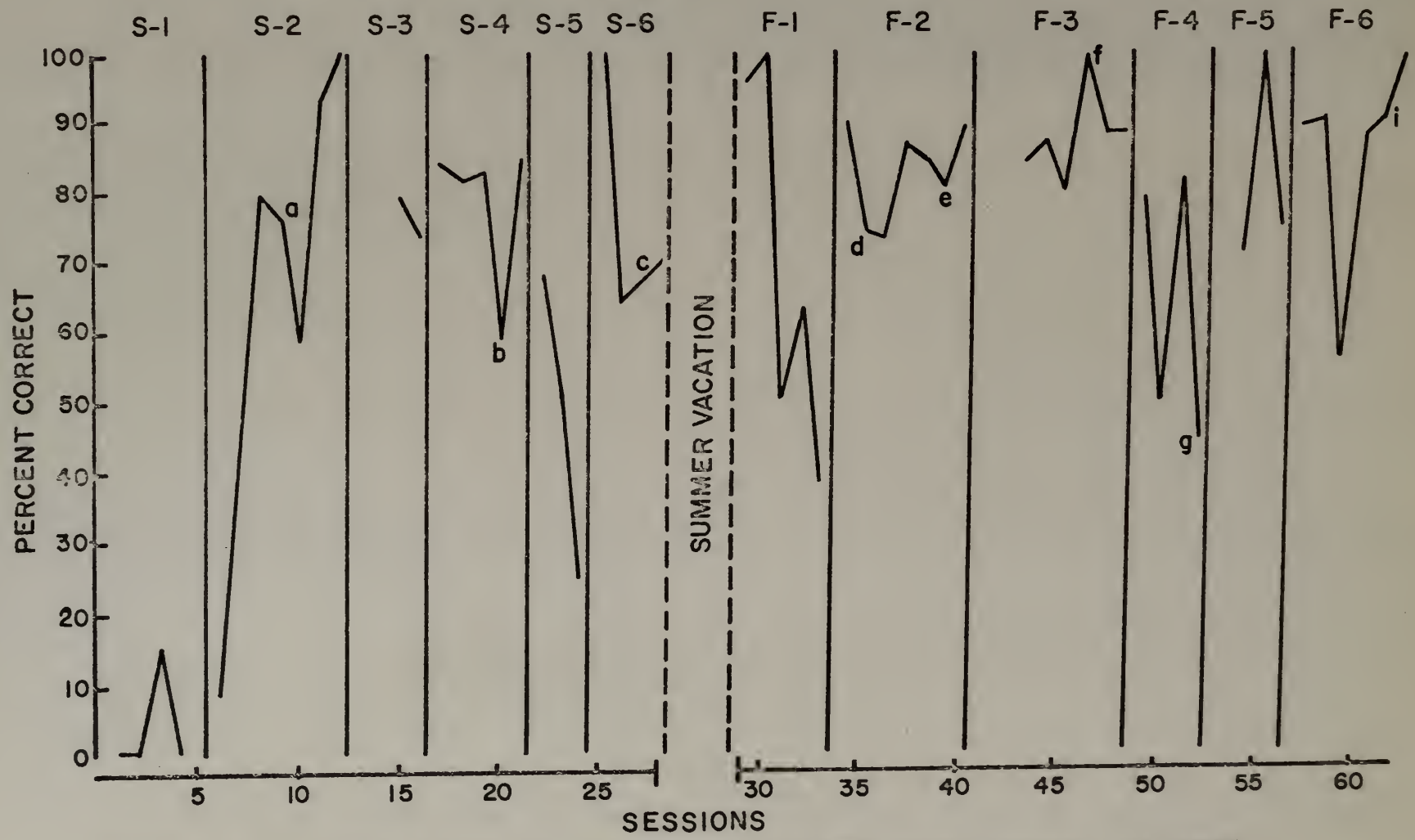

FIGURE 10 PERCENTAGE OF SENTENCES CORRECT PER SESSION - LEE ANNE

86% of her sentences correct during phase F-6 and displayed perfect accuracy on the last session of the experiment.

Marie entered the experiment with the highest level of sentence writing skills of any of the subjects (Fig. 11). Her baseline accuracy ranged from 44% to 91%, but she demonstrated an overall increase of accuracy from 69 to 81%, when Phase S-2 contingencies were in effect. Marie averaged 97% accuracy during the two sessions she attended of phase S-3, showed little change during phases S-4 and S-5, then dropped to 62% on session 27, before returning to 100% on the final session of phase S-6. Marie's F-1 baseline accuracy ranged from 75 to 100%, and she remained in that range through phase F-2, except for session 39 when her accuracy fell off to 57%. Marie's accuracy dropped to 45% during the first session of phase F-3, when the contingency for adverbs was established on session 41, then rose steadily to 100% by session 45. Her accuracy dropped to 58% on session 46, when the examples of sentences containing adverbs were withdrawn, but she averaged 92% of her sentences correct for the last two sessions of phase F-3. Marie's overall level of accuracy remained high, 89% during phase F-4, was 94% during phase F-5, and she wrote 100% of her sentences correctly on four of the six sessions of phase F-6.

Susan's baseline accuracy ranged from 11 to 22% (Fig. 12). Her accuracy increased rapidly during phase S-2, averaging 71% during the final three sessions of the phase. When reinforcement and remediation were discontinued in phase S-2, Susan's accuracy dropped to a low of

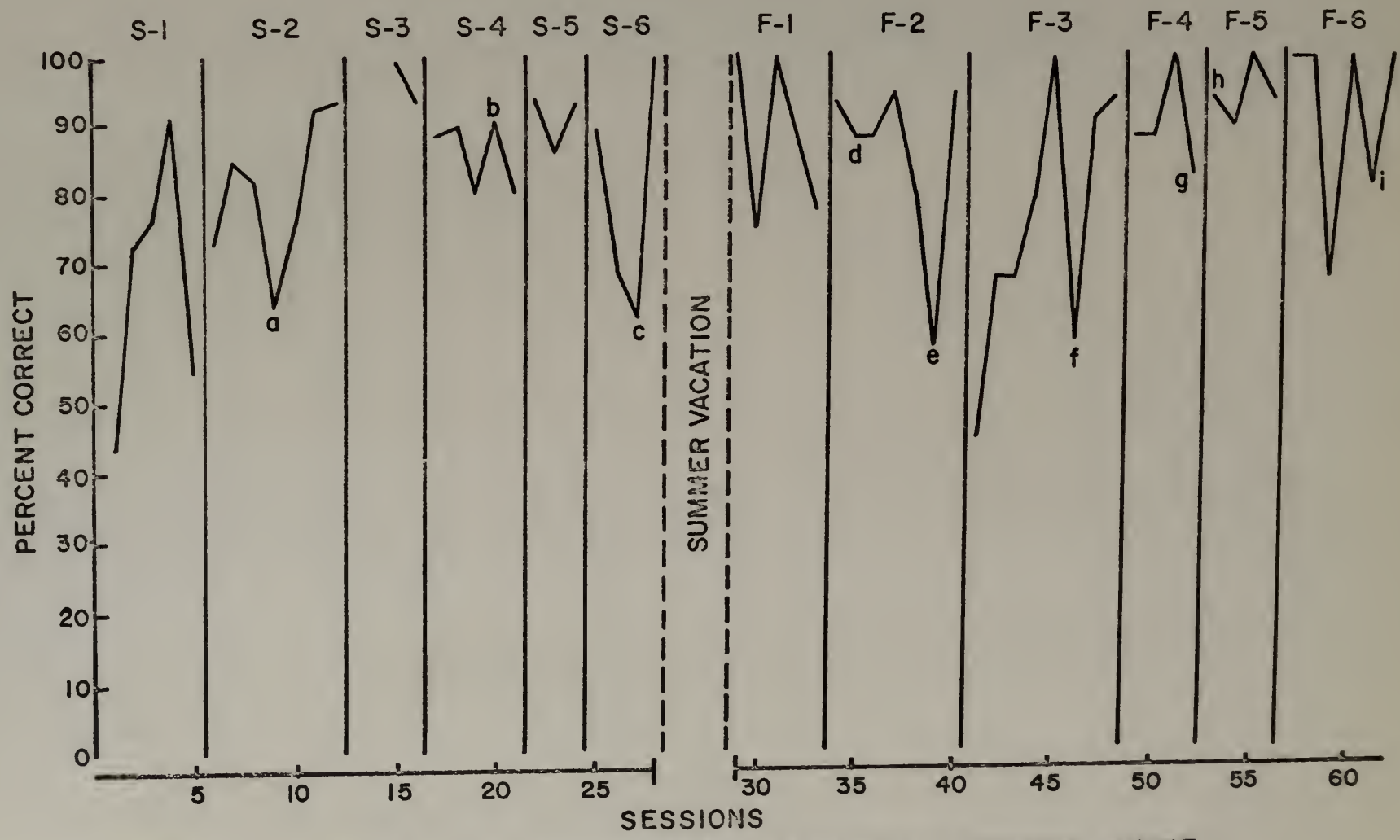

FIGURE 11 PERCENTAGE OF SENTENCES CORRECT PER SESSION - MARIE

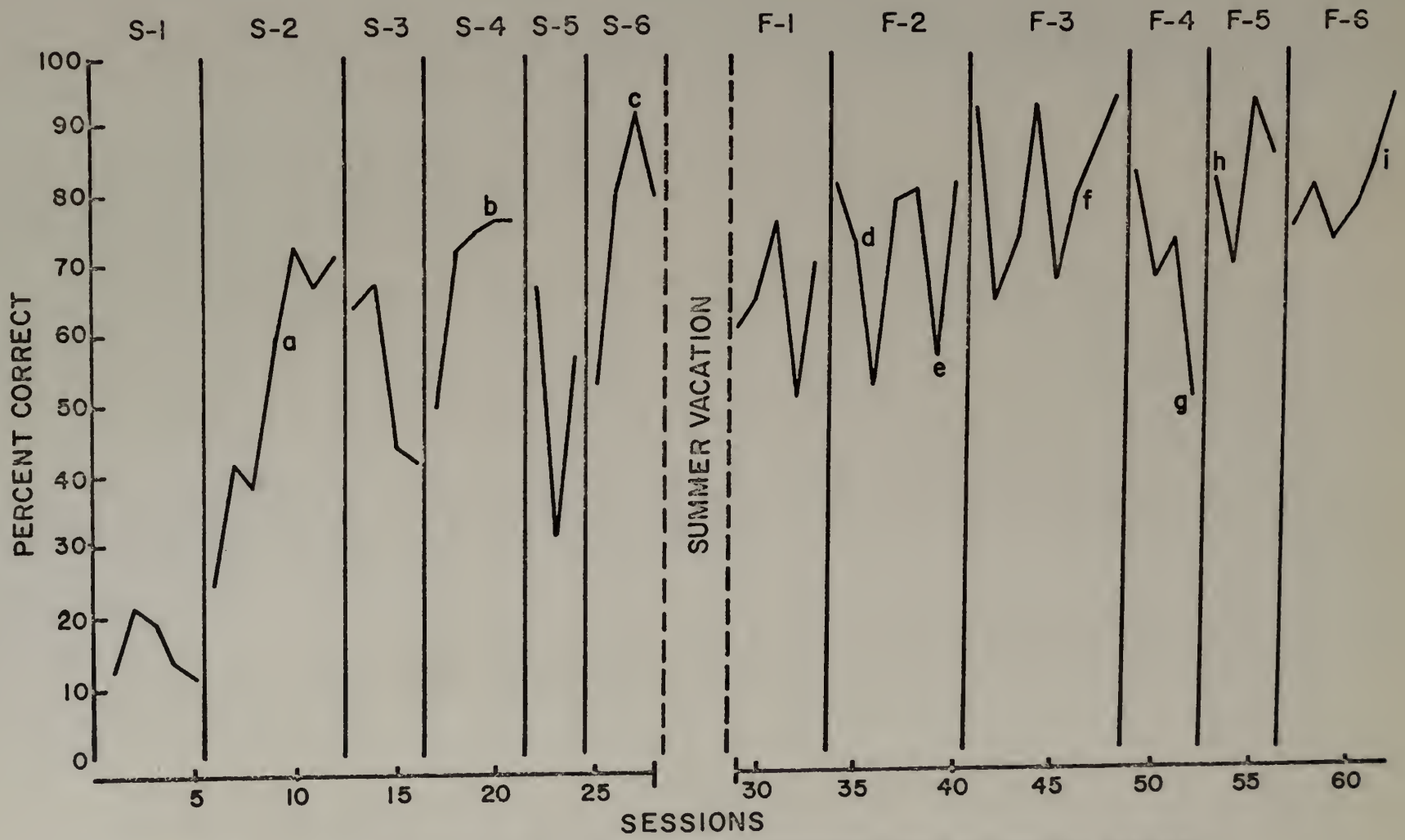

FIGURE 12 PERCENTAGE OF SENTENCES CORRECT PER SESSION - SUSAN

42%. She again showed an increase in accuracy when reinforcement and remediation were reinstated in phase S-4, writing a high of 77% of her sentences correctly on the last two sessions of that phase. Susan's accuracy again dropped when reinforcement and remediation were terminated in phase S-5, then rose to 92% when those consequences were made contingent upon writing correct sentences again during phase S-6. Susan's F-1 baseline accuracy ranged from 50 to 76%. Her overall accuracy was slightly higher during phase F-2. She wrote an average of 81% of her sentences correctly during phase F-3, dropping below 70% on only two sessions. Her accuracy decreased considerably during phase F-4, then increased again when reinforcement and remediation were re-established in phase F-5. Susan's accuracy increased steadily throughout phase F-6, reaching 94% on the final session of the experiment.

Brian's accuracy ranged from zero to 38% during baseline phase S-1 (Fig. 13). However, becuase his rate was so low, his baseline of 38% represents a total of only three correct sentences. His accuracy increased steadily over phase S-2 to 67% on sessions 11 and 12. Brian continued to write approximately 67% of his sentences correctly during three sessions of phase S-3, but rose to 85% correct on session 14. His accuracy was variable during phase S-4, ranging from 38 to 73%. Brian wrote 78% of his sentences correctly on the first session of phase S-5, was absent for the second session of that phase, then returned to write 38% correctly on the final session of phase S-5. Brian's accuracy was 50 and 38% for the first two sessions of phase

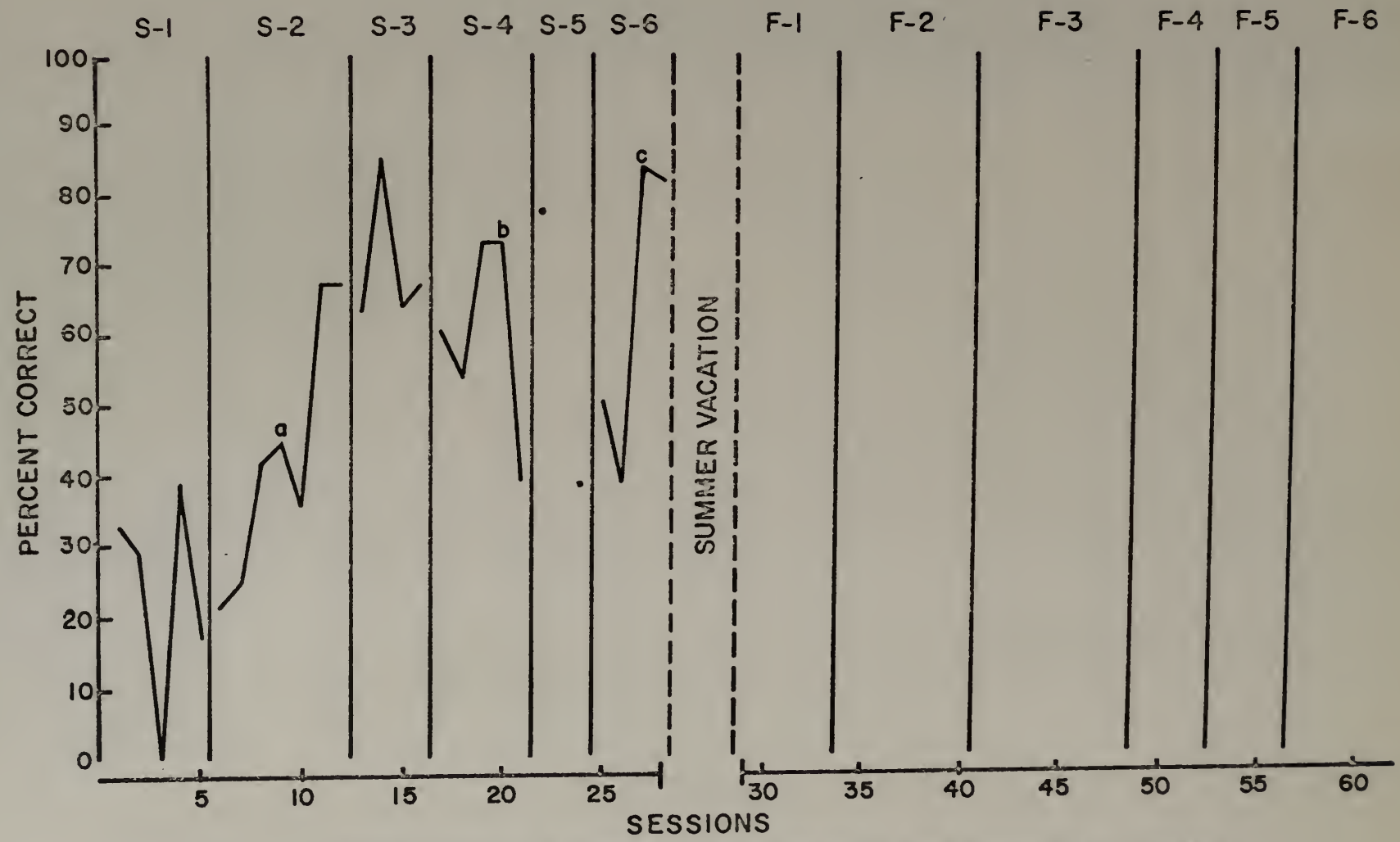

FIGURE 13 PERCENTAGE OF SENTENCES CORRECT PER SESSION - BRIAN

S-6, then increased to 83 and 82% for the last two sessions of that phase.

Jacques did not write any correct sentences during the three sessions of baseline phase S-1 that he attended (Fig. 14). His accuracy increased sharply during phase S-2, reaching 93% correct on session 11. Jacques' accuracy fell off slightly during the first two sessions of phase S-3, then returned to 89% for the last two sessions of that phase. Jacques wrote an average of 78% of his sentences correctly during phase S-4. His accuracy remained high during the first two sessions of phase S-5, then dropped off to 65% on session 24. Jacques averaged 91% accuracy during phase S-6, never dropping below 89%.

Sandy's 9% baseline accuracy during phase S-1 represents two correct sentences written over the two sessions of that phase that she attended (Fig. 15). She increased her accuracy from zero on the first session of phase S-2 to 65% on session eight, then dropped to an average of 35% for the last four sessions of that phase. She was absent for sessions 13 and 14, and wrote 17 and 67% of her sentences correctly on the final two sessions of phase S-3. Sandy's overall accuracy increased during phase S-4, and she wrote her experimental high of 90% of her sentences correctly on session 20. Her accuracy remained high for two of the sessions of phase S-5, but fell to 45% on session 23. Sandy's overall accuracy was 72% during phase S-6, even though she dropped to 47% on session 26.

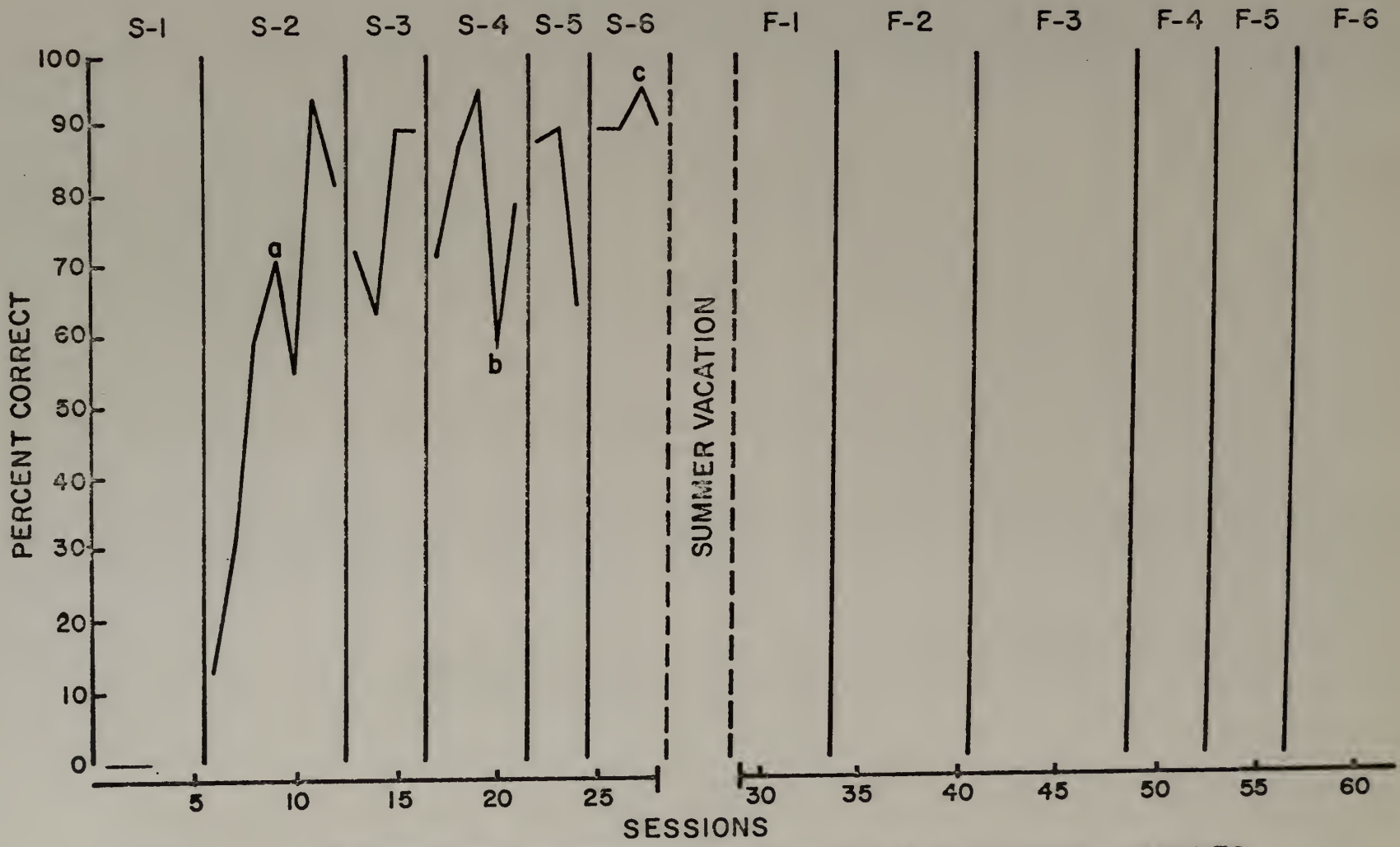

FIGURE 14 PERCENTAGE OF SENTENCES CORRECT PER SESSION - JACQUES

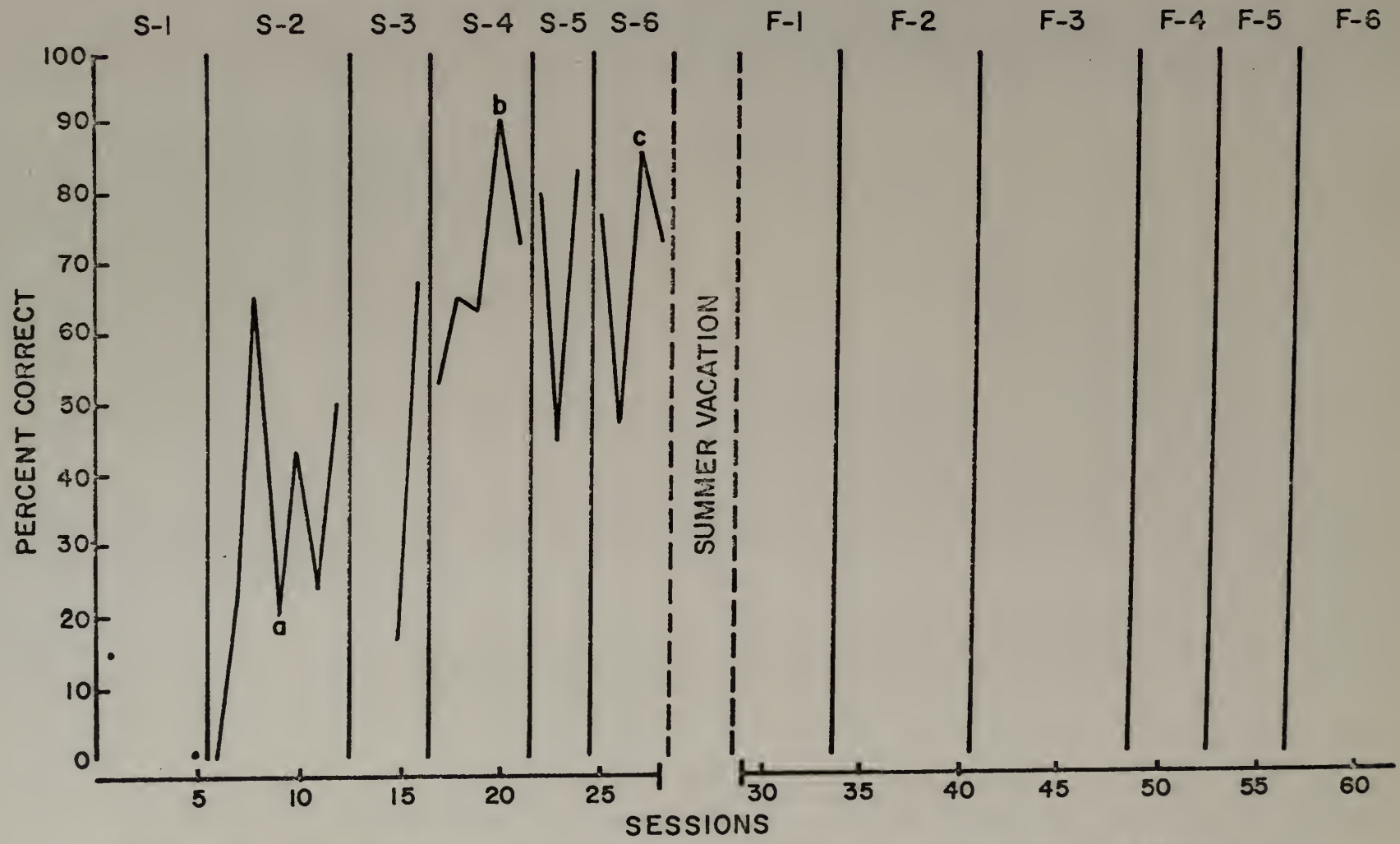

FIGURE 15 PERCENTAGE OF SENTENCES CORRECT PER SESSION - SANDY

Paul entered the experiment during the Fall, and his phase F-1 baseline accuracy ranged from 20 to 58% (Fig. 16). Paul dropped from 58% accuracy on the last session of phase F-1 to 36% for the first two sessions of phase F-2, before his accuracy began to steadily increase throughout the rest of that phase to a high of 83% on session 40. His accuracy ranged from 50 to 69% during phase F-3. Paul was absent from phase F-4. Paul was absent from session 53, then increased his accuracy during the final three sessions of phase F-5 to his experimental high of 89%. His accuracy fell to 50% on the first session of phase F-6, then increased steadily over the rest of that phase to 85% on session 61. Paul was absent from the final session of the experiment.

Topography of Response. The data on topography of response (see Figures 17-24) indicate that experimental control was established over the linguistic content of the sentences composed by the subjects. All subjects displayed sharp increases in the percentage of sentences containing prenominal adjectives and/or adverbs when the contingencies for such components were in effect. The high degree of experimental control over these variables is best evidenced in phases F-3 and F-6. Writing a correct sentence including only a prenominal adjective and writing a correct sentence with only an adverb are two incompatible operants. That is, they cannot be executed simultaneously. When the contingency for adverbs was introduced in phase F-3, the percentage of sentences containing prenominal adjectives, which had been high for all subjects during phase F-2, dropped sharply, while the percentage of correct

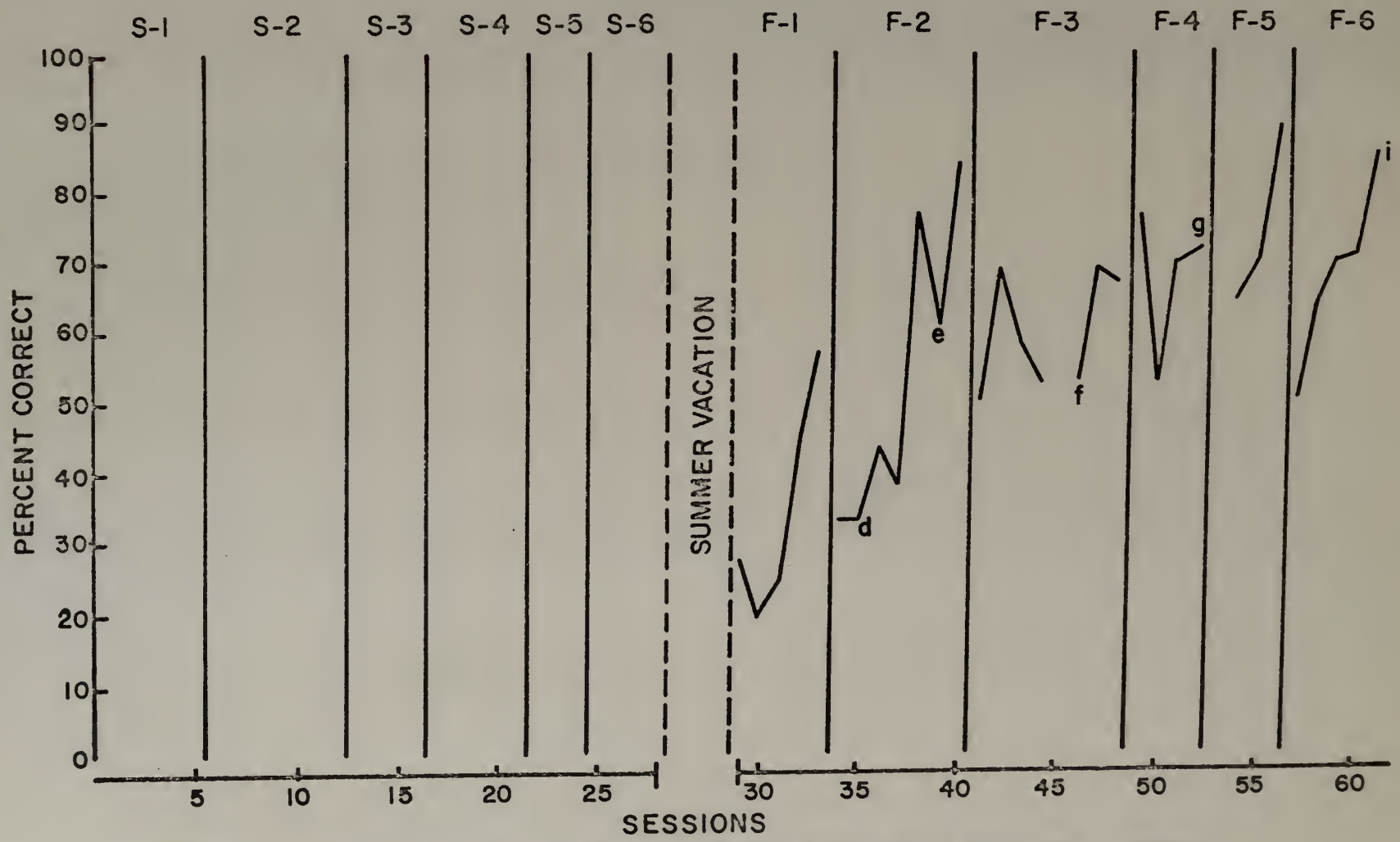

FIGURE 16 PERCENTAGE OF SENTENCES CORRECT PER SESSION - PAUL

sentences including adverbs increased. The two variables converged when no specific consequence was contingent for writing either one in phase F-4; then when the contingency for adverbs was reestablished in phase F-5, adverbs increased again and prenominal adjectives decreased. When maximum reinforcement was contingent upon writing correct sentences with both a prenominal adjective and an adverb in phase F-6, the percentage of such sentences increased for all subjects, while the incompatible operants of writing correct sentences including only a prenominal adjective or only an adverb decreased in frequency.

These findings concerning topography of response are further described for each subject. Appendix I contains the number of correct sentences including a prenominal adjective, adverb, or both written per session by each subject.

Gil did not write any correct sentences containing prenominal adjectives through the first nine sessions of the experiment (Fig. 17). He wrote a total of 5% of his correct sentences with prenominal adjectives during the 16 sessions comprising phases S-1, S-2, and S-3. When the contingency for prenominal adjectives was instated in phase S-4, Gil's percentage of correct sentences including that component increased dramatically. Gil included a prenominal adjective in 96% of his correct sentences during sessions 20 and 21. That figure dropped to a phase S-5 overall average of 59%. With the reinstatement of maximum reinforcement for writing correct sentences containing prenominal adjectives in phase S-6, Gil's per session percentage of sentences with that component

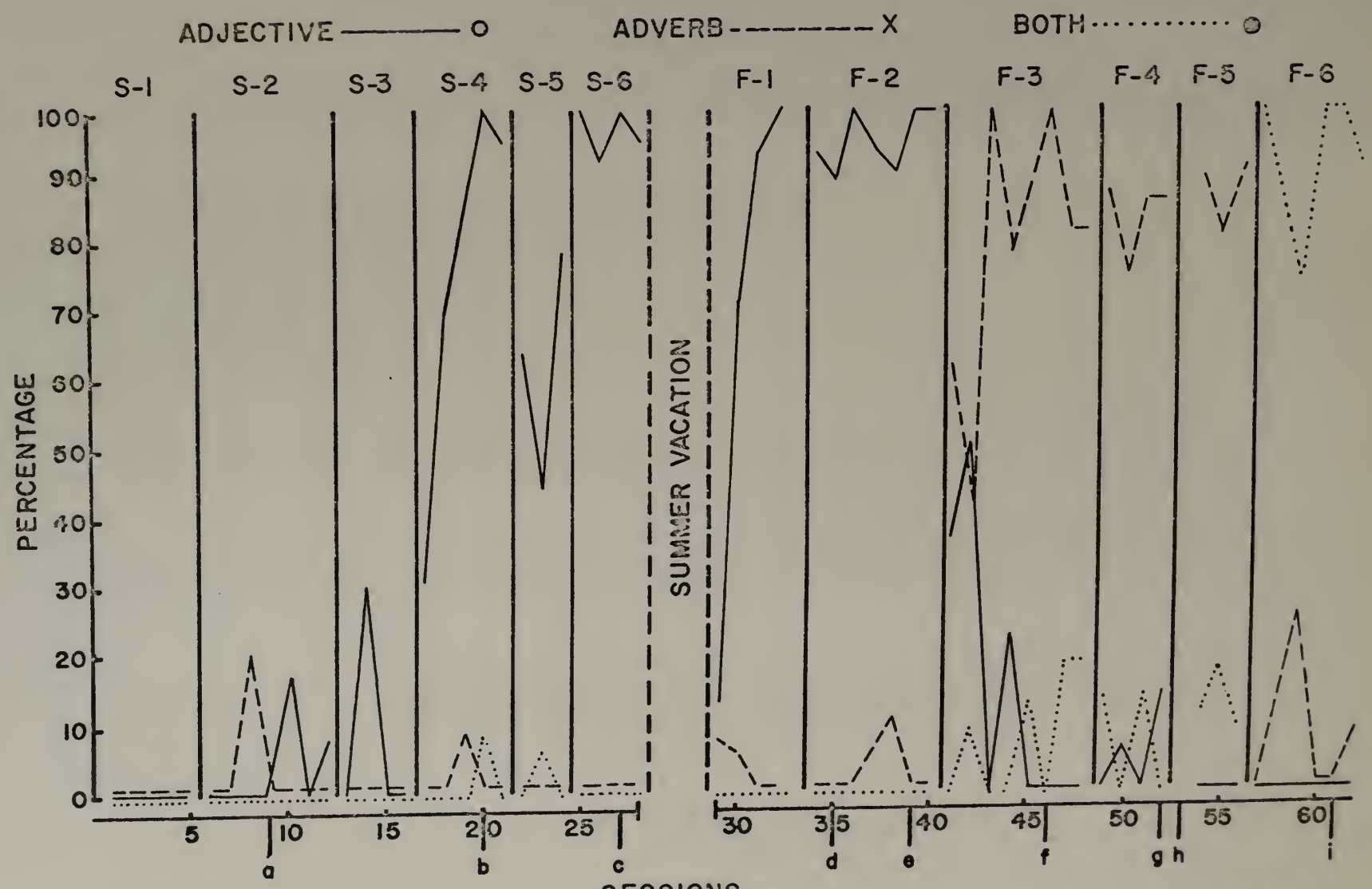

FIGURE 17 PERCENTAGE OF TOTAL CORRECT SENTENCES CONTAINING A PRENOMINAL ADJECTIVE, ADVERB OR BOTH PER SESSION - GIL

ranged from 92 to 100%. Gil's percentage of correct sentences including prenominal adjectives was 13% on the first session of phase F-1, but increased swiftly to 100% on the fourth session of that phase. That figure remained between 89 and 100% during phase F-2. Gil's percentage of correct sentences containing prenominal adjectives fell to 38% on the first session of phase F-3, when the contingency for adverbs was established, and dropped to zero for the remaining four sessions of that phase. He wrote only two correct sentences containing prenominal adjectives during the remaining sessions of the experiment and none during phases F-5 and F-6, when maximum reinforcement was contingent upon writing sentences containing other components.

Gil wrote only two correct sentences containing adverbs throughout the entire six phases of the Spring. He wrote a total of five such sentences during the 11 sessions he attended of phases F-1 and F-2. When the contingency for adverbs was established in phase F-3, Gil immediately began writing adverbs. By the third session of that phase, 100% of his correct sentences included adverbs. Figure 17 shows Gil as having written between 82 and 100% of his correct sentences with adverbs over the last four sessions of phase F-3. Actually all of his sentences contained adverbs during those sessions, but some also contained prenominal adjectives and are shown by the dotted line. Gil continued to write over 80% of his sentences with adverbs during phases F-4 and F-5, but dropped to an overall average of 6%, when the contingency for writing sentences containing just adverbs was terminated in phase F-6.

Lee Anne included a prenominal adjective in only 16% of the total correct sentences she wrote prior to phase S-4 (Fig. 18). Like Gil, Lee Anne immediately began to include prenominal adjectives in her sentences during phase S-4. She also included a prenominal adjective in 100% of her correct sentences on the fourth session of that phase. That figure dropped sharply during phase S-5, when baseline conditions were reestablished, and increased again during phase S-6. Lee Anne's percentage of correct sentences containing prenominal adjectives ranged from zero to 60% during phase F-1, then showed a general increase during phase F-2 to a high of 88% on session 40. When the contingency for adverbs was instated in phase F-3, Lee Anne's percentage of sentences including prenominal adjectives dropped quickly, and remained at zero for the final three sessions of that phase. That figure increased slightly during phase F-4. During the last two phases of the experiment, Lee Anne wrote only two sentences that contained a prenominal adjective.

Lee Anne included adverbs in only 4% of her correct sentences prior to phase F-3. When maximum reinforcement was contingent upon writing correct sentences with adverbs in phase F-3, she quickly began to include them in her sentences. Her percentage of correct sentences containing adverbs increased steadily throughout phase F-3 to 100% on the last session of that phase. When baseline conditions were reinstated in phase F-4, Lee Anne virtually stopped writing adverbs. When the contingency for adverbs was again put into effect in phase F-5, she wrote almost all of her correct sentences with adverbs. Lee Anne's percentage of correct sentences including adverbs dropped to a per session range of zero to 22%,

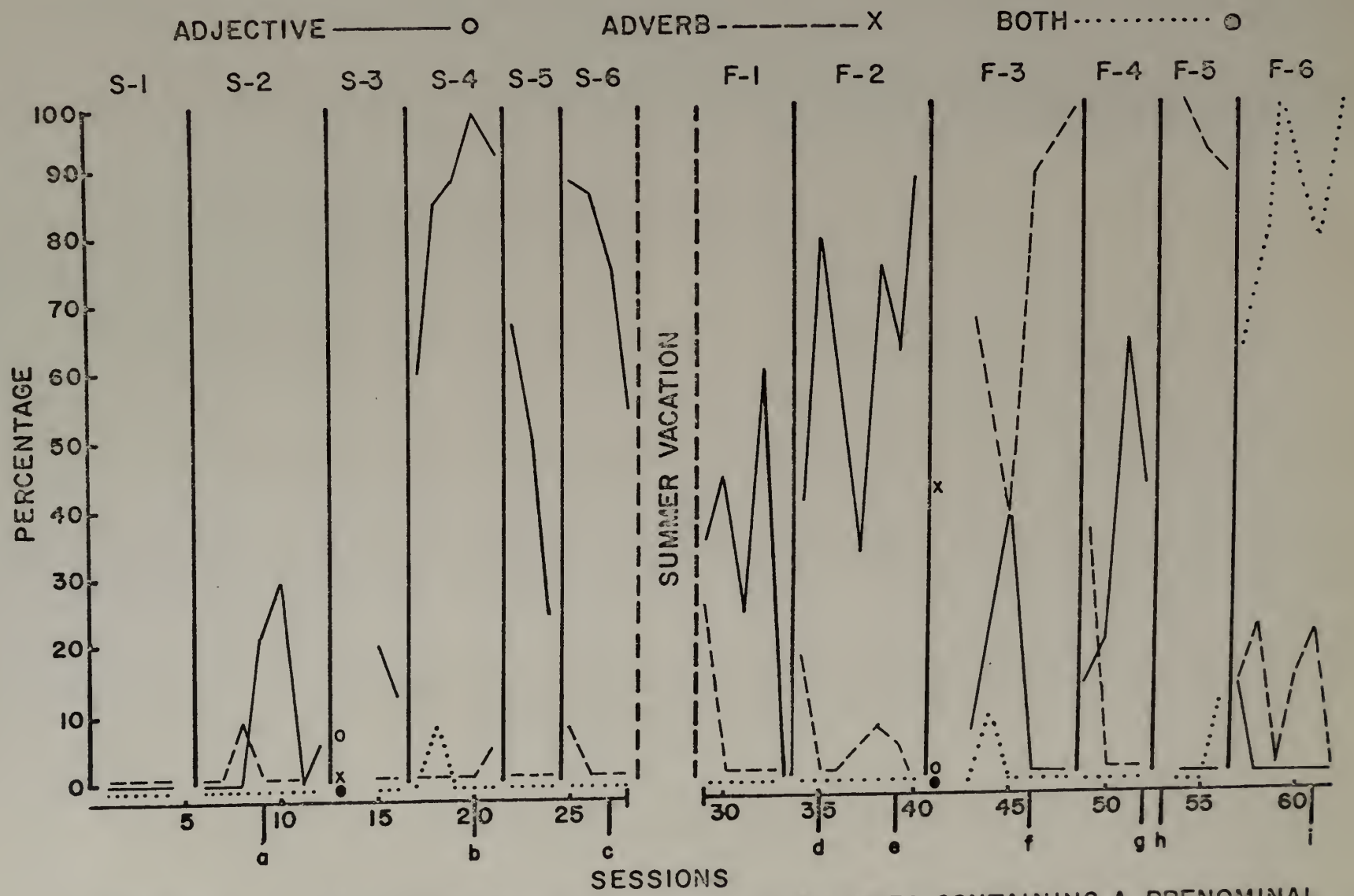

FIGURE 18 PERCENTAGE OF TOTAL CORRECT SENTENCES CONTAINING A PRENOMINAL ADJECTIVE, ADVERB OR BOTH PER SESSION - LEE ANNE

when the contingency for writing sentences with only adverbs was discontinued in phase F-6.

Lee Anne wrote three sentences prior to phase F-6 that contained both a prenominal adjective and an adverb. When the contingency for writing such sentences was instated in phase F-6, she immediately began to write a large number of sentences containing both components. Lee Anne wrote an average of 84% of her correct sentences containing a prenominal adjective and an adverb during phase F-6.

Marie entered the experiment writing more of her sentences correct than any of the other subjects, but she seldom included prenominal adjectives in her writing (Fig. 19). When the contingency for prenominal adjectives was established in phase S-4, Marie's percentage of correct sentences containing that component increased rapidly to a high of 88% on session 21. That figure decreased sharply on the last two sessions of phase S-5, and increased again when maximum reinforcement was again contingent upon including prenominal adjectives in phase S-6. Marie's correct sentences written during phase F-1 contained prenominal adjectives at a per session percentage range of 15 to 73%. An overall increase of sentences including prenominal adjectives occurred during phase F-2, when the contingency for writing that component was reinstated. That figure decreased from an overall average of 67% for the first three sessions of phase F-3, to 7% over the final three sessions of that phase. She included prenominal adjectives in 65% of her correct sentences when baseline conditions were reinstated in phase F-4. When the contingency for adverbs was established again in phase F-5, Marie wrote very few

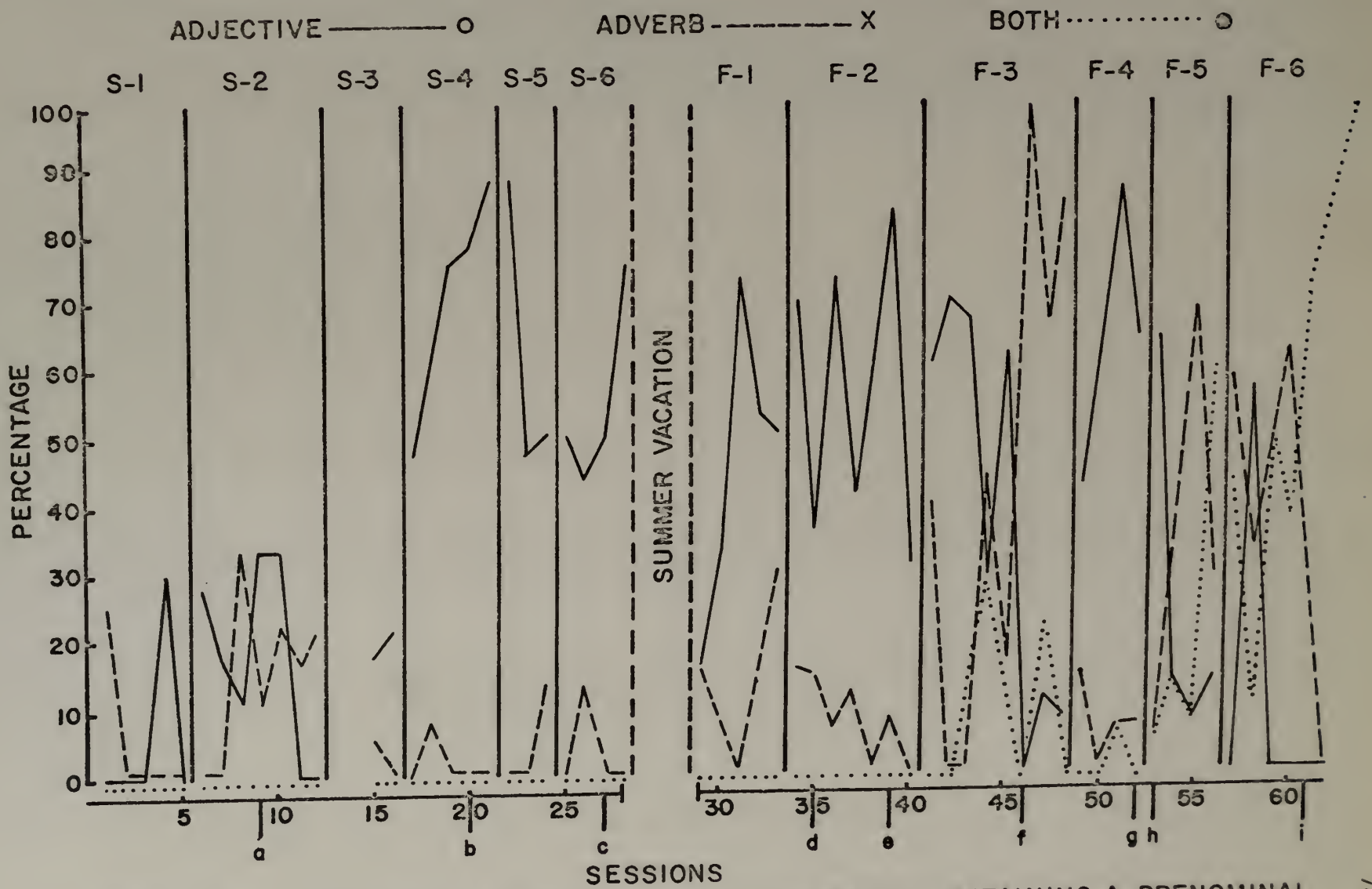

FIGURE 19 PERCENTAGE OF TOTAL CORRECT SENTENCES CONTAINING A PRENOMINAL ADJECTIVE, ADVERB OR BOTH PER SESSION - MARIE

sentences containing prenominal adjectives. That figure was zero for five of the six sessions of phase F-6.

Marie's maximum per session percentage of including adverbs in her correct sentences was 33% prior to phase F-3. On 17 of the 40 sessions before phase F-3, she wrote sentences containing an adverb. That figure increased steadily over phase F-3, when the contingency for adverbs was instated. She included adverbs in 90% of her correct sentences over the final three sessions of that phase. This figure dropped sharply throughout phase F-4 to near zero, and then increased again in phase F-5. Marie included adverbs in 50% of her correct sentences over the first four sessions of phases F-6, but as she began to write more sentences containing both a prenominal adjective and an adverb, her percentage of sentences containing just an adverb dropped to zero by the final session of the experiment.

Marie did not write any sentences containing both a prenominal adjecitve and an adverb prior to phase F-3. She wrote a small number of such sentences during phases F-3, F-4, and F-5. When maximum reinforcement was contingent upon writing sentences including both components during phase S-6, Marie began to write an increasing percentage of such sentences. On the final session of the experiment, she included both a prenominal adjective and an adverb in 100% of her correct sentences.

Susan, like the other subjects, also wrote very few sentences containing prenominal adjectives prior to phase S-4 (Fig. 20). When the contingency for prenominal adjectives was instated in phase S-4, she quickly began to include them in her sentences. Susan wrote 100% of

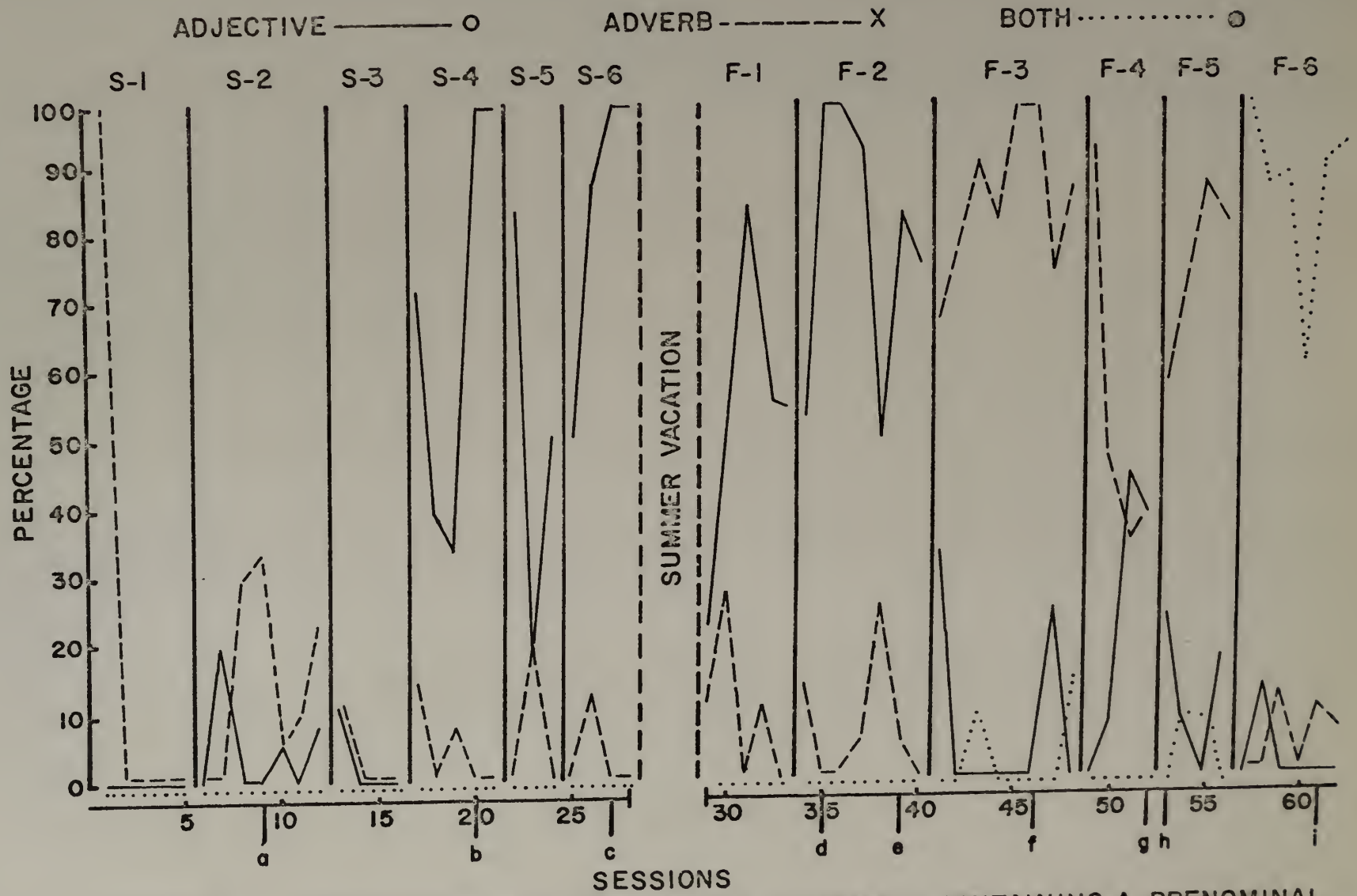

FIGURE 20 PERCENTAGE OF TOTAL CORRECT SENTENCES CONTAINING A PRENOMINAL ADJECTIVE, ADVERB OR BOTH PER SESSION - SUSAN

her correct sentences with prenominal adjectives over the last two sessions of phase S-4. That figure dropped significantly during phase S-5, when baseline conditions were reinstated and increased sharply again to 100% during phase S-6, when the contingency for prenominal adjectives was reestablished. Susan's per session percentage of correct sentences with prenominal adjectives ranged from 22 to 85% during baseline phase F-1. That range shifted upward during phase F-2 to 50 to 100%. When maximum reinforcement was contingent upon writing correct sentences with adverbs in phase F-3, Susan's percentage of sentences containing prenominal adjectives dropped sharply and was zero for six of the eight sessions comprising that phase. She wrote very few sentences containing prenominal adjectives for the remainder of the experiment.

Susan wrote very few sentences containing adverbs prior to phase F-3. The 100% data point shown in session one represents only one sentence. Susan jumped from writing no sentences containing adverbs on session 40 to including them in 67% of her sentences on session 41, when the contingency for adverbs was put into effect. She included adverbs in 93% of her sentences over the final four sessions of phase F-3. That figure dropped steadily throughout phase F-4, when baseline conditions were reinstated, and increased again, when reinforcement for writing adverbs was reinstated in phase F-5. Only 6% of Susan's correct sentences contained adverbs over the six sessions of phase F-6.

Susan, like Marie, did not write any correct sentences including both a prenominal adjective and an adverb during the 40 sessions prior

to phase F-3. She wrote a small number of such sentences with prenominal adjectives and adverbs, when the contingency for such sentences was instated on session 57. Her overall percentage for such sentences was 84% during phase F-6.

Brian wrote four sentences containing prenominal adjectives during the 16 sessions prior to phase S-4 (Fig. 21). He wrote a total of seven sentences with a prenominal adjective during the five sessions of phase S-4, representing a significant increase in percentage of correct sentences containing that component. That figure jumped to 78% on the first session of phase S-5, Brian was absent from the next session, and then his percentage of sentences containing prenominal adjectives fell to zero on the last session for that phase. Brian's percentage of sentences containing prenominal adjectives increased steadily during phase S-6, when the contingency for that component was reinstated, to a high of 57% on the last session of that phase.

Brian wrote a total of nine correct sentences including an adverb during the Spring segment of the experiment. He did not write any correct sentences containing both a prenominal adjective and an adverb. Brian did not take part in the Fall portion of the experiment.

Jacques wrote very few correct sentences containing prenominal adjectives during the 16 sessions prior to phase S-4 (Fig. 22). When the contingency for writing such sentences was instated in phase S-4, Jacques' percentage of correct sentences containing a prenominal adjective increased steadily from 33% on the first session of phase S-4 to 93% on the last session of that phase. That figure dropped considerably during phase S-5, and showed an overall increase when the contingency was

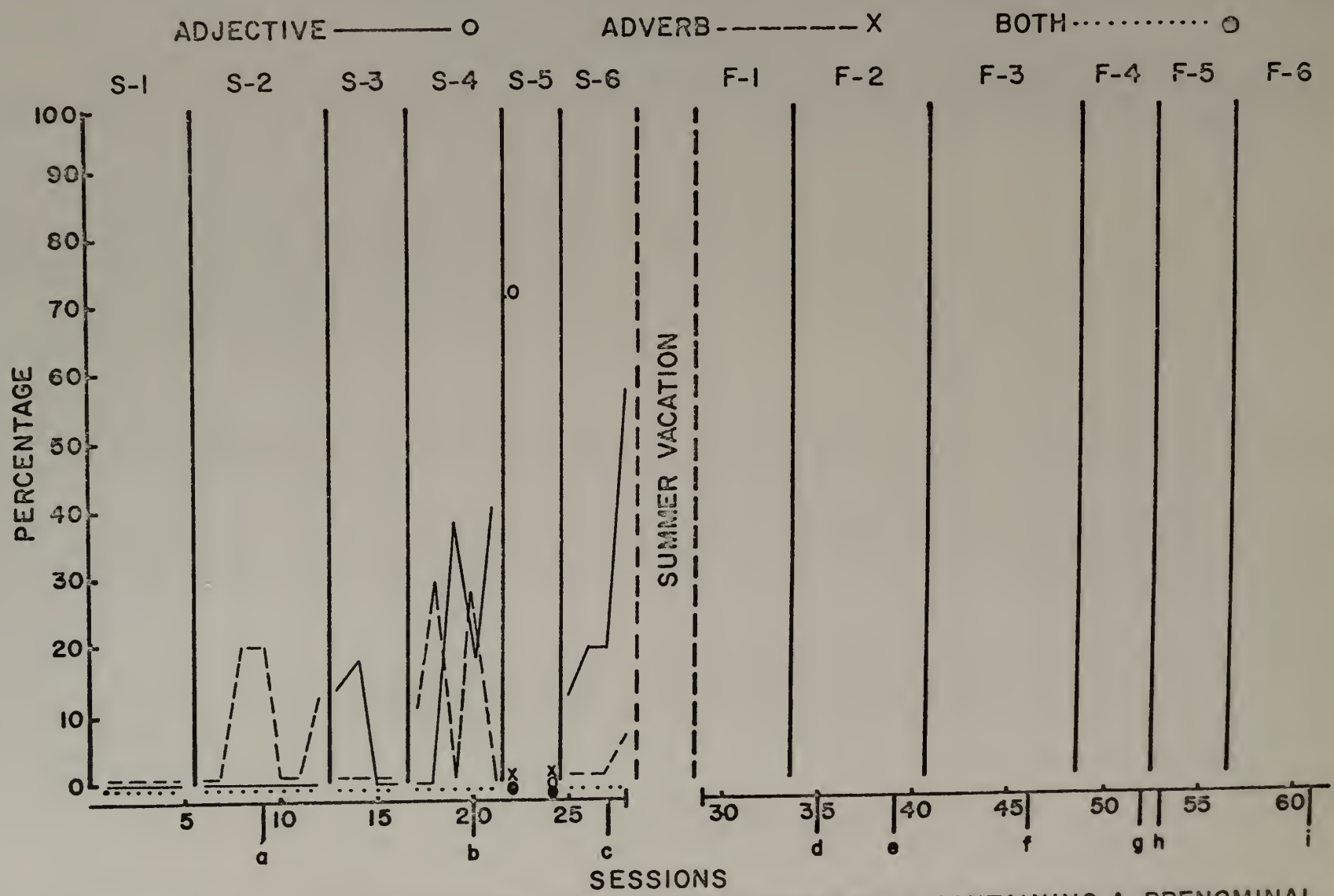

FIGURE 21 PERCENTAGE OF TOTAL CORRECT SENTENCES CONTAINING A PRENOMINAL ADJECTIVE, ADVERB OR BOTH PER SESSION - BRIAN

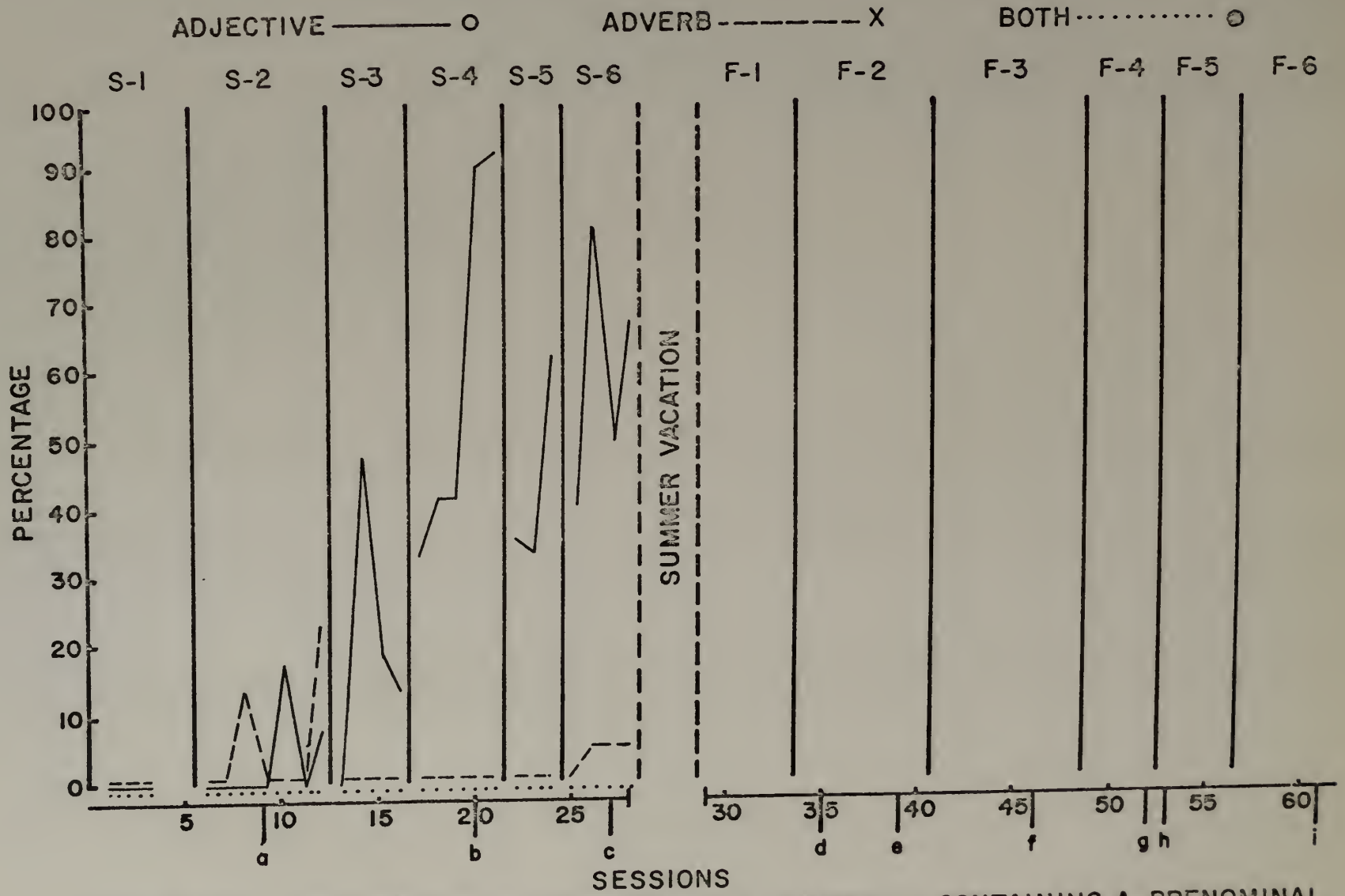

FIGURE 22 PERCENTAGE OF TOTAL CORRECT SENTENCES CONTAINING A PRENOMINAL ADJECTIVE, ADVERB OR BOTH PER SESSION - JACQUES

reestablished in phase S-6.

Jacques wrote a total of seven sentences containing an adverb during the Spring and none containing a prenominal adjective and an adverb. Jacques did not participate in the Fall portion of the experiment.

Sandy included a prenominal adjective in three of the 56 correct sentences she wrote prior to phase S-4 (Fig. 23). When the contingency for writing correct sentences containing prenominal adjectives was instated in phase S-4, Sandy quickly began to write such sentences. Her percentage of correct sentences containing prenominal adjectives rose to an average of 86% over the last two sessions of phase S-4. That figure dropped sharply when baseline conditions were reestablished in phase S-5, and showed a small increase when the contingency for prenominal adjectives was reinstated in phase S-6.

Sandy wrote three correct sentences with an adverb during the 23 sessions she participated in the experiment and no correct sentences containing both a prenominal adjective and an adverb. She did not take part in the Fall segment of the experiment.

Paul did not participate in the Spring phases of the experiment (Fig. 24). Paul wrote no correct sentences with a prenominal adjective during the five baseline sessions of phase F-1. When maximum reinforcement was made contingent upon writing correct sentences with prenominal adjectives in phase F-2, his percentage of such sentences increased to a high of 85% by the last session of that phase. That figure dropped during phase F-3, when the contingency for adverbs was established in phase F-4, and remained low throughout phases F-5 and F-6.

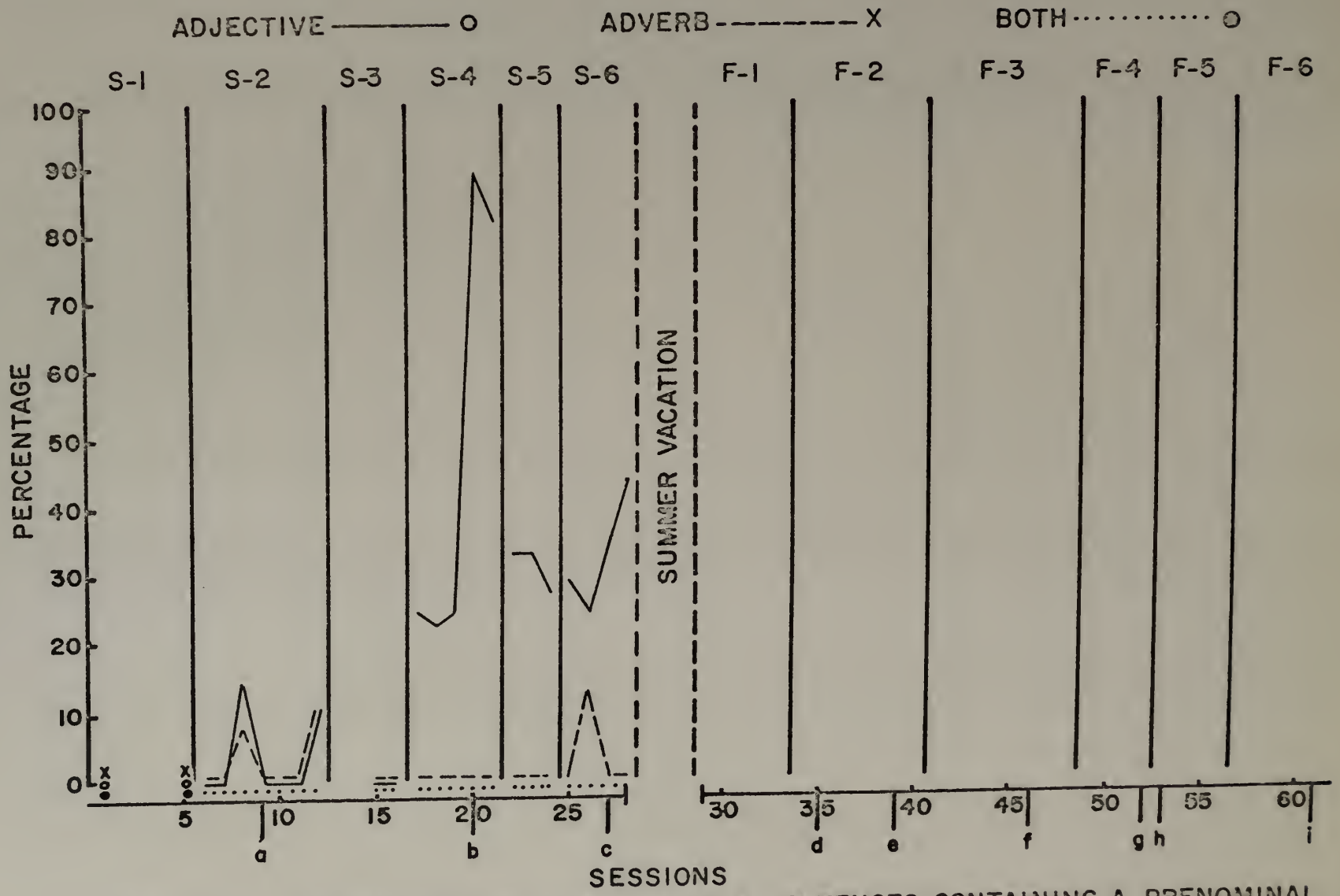

FIGURE 23 PERCENTAGE OF TOTAL CORRECT SENTENCES CONTAINING A PRENOMINAL ADJECTIVE, ADVERB OR BOTH PER SESSION - SANDY

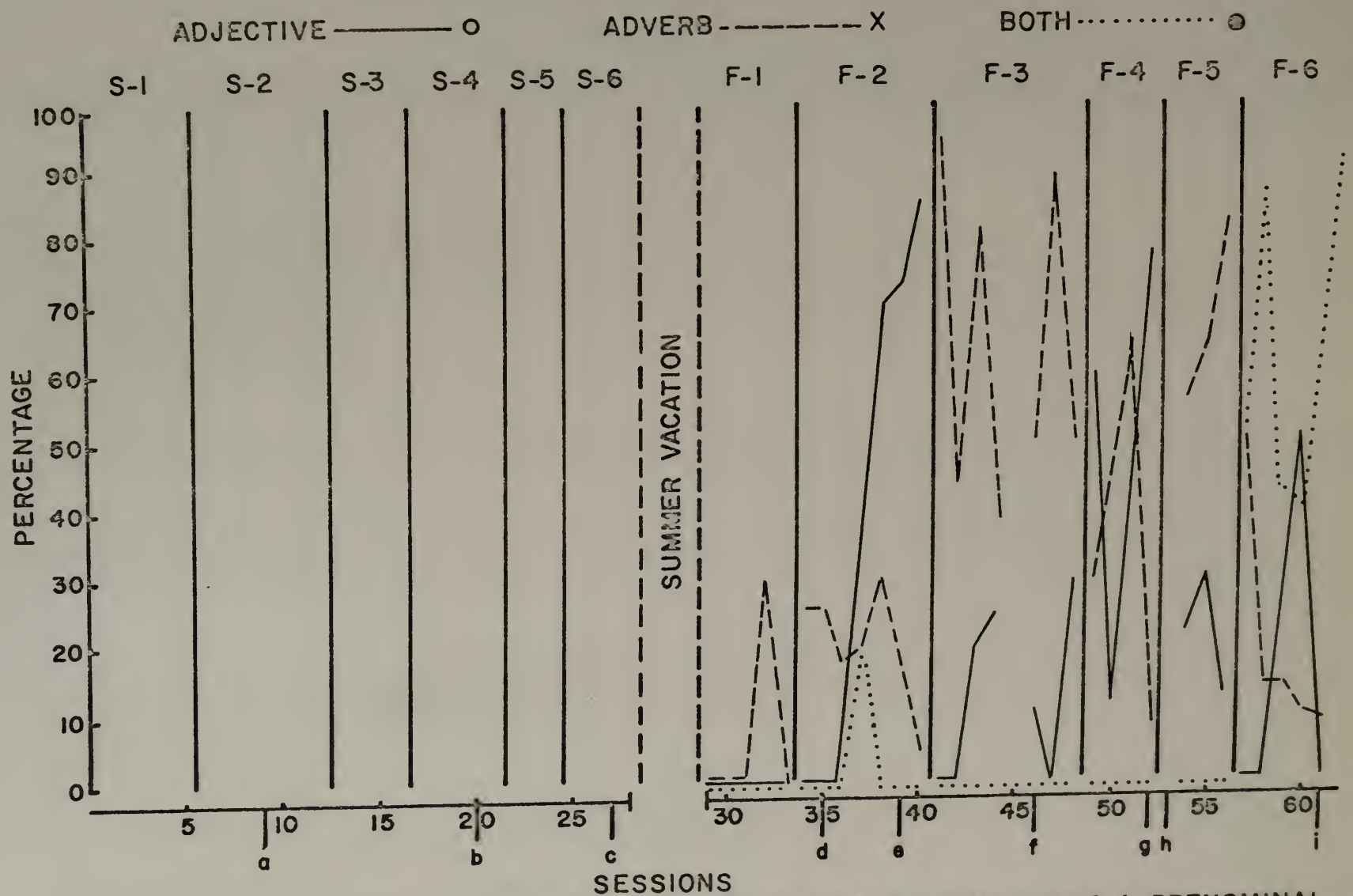

FIGURE 24 PERCENTAGE OF TOTAL CORRECT SENTENCES CONTAINING A PRENOMINAL ADJECTIVE, ADVERB OR BOTH PER SESSION - PAUL

Paul wrote one correct sentence with an adverb during phase F-1. He included adverbs in an average of 15% of his correct sentences written during phase F-2. This overall average increased to 77% in phase F-3, when the contingency for adverbs was instated. Paul's percentage of correct sentences including adverbs increased when baseline conditions were reinstated in phase F-4, then rose again in phase F-5, when the contingency for adverbs was reinstated. His percentage of correct sentences containing only adverbs dropped steadily throughout phase F-6.

Paul wrote only one sentence prior to phase F-6 containing both a prenominal adjective and an adverb. When the contingency for such sentences was established in phase F-6, his per session percentage ranged from 40 to 91% for an overall average of 64%.

Types of Errors. Because one of the major objectives of the experiment was to investigate the effects of teacher-student interaction during remediation on the accuracy of sentence writing, the types of errors committed by the subjects were categorized and tabulated. The effects of remediation are demonstrated by increases of accuracy, and specifically, reductions of the frequency with which subjects committed certain types of errors. In order to provide greater detail in such an analysis, the errors made by each of t he eight subjects were categorized and recorded for each session. The 1,955 errors committed by the subjects in 4,987 sentences written over all 62 sessions of the experiment were of 11 types. The categories were not developed on an a priori basis, but were formed at the conclusion of the experiment based upon the sentences

produced by the subjects. Any given sentence could contain more than one error. Appendix 3 contains samples of correct and incorrect sentences written by each of the subjects during each phase of the experiment.

The categories of errors and sentences written by the subjects during the experiment containing each type of error are listed below:

1. Concept Error: A grammatically correct sentence that does not make sense or represent what was depicted by the projected stimulus. e.g., The outside is on the rain. The house is a spring.
2. Spelling Error: Mispelled or incompletely written words. e.g., The kitten are all corlors. I see some citys.
3. Punctuation Error: Misuse of periods, commas, capitals, etc. e.g., The school is in new hampshire. I see a boy_
4. Wrong Word Order: Words written in wrong sequences. e.g., The grow woods. I see a shadow car.
5. Verb Error: Verb written in incorrect tense or case. e.g., Jane is jump rope. Gil teach him.
6. Word Omission: Sentence written with a missing word. e.g., I a dish. The farm had house.
7. Word Insertion: Extra word inserted causing sentence to be incorrect. e.g., The girl is walking at slow. The a bike is very fast.
8. Singular/Plural Error: Nonagreement of number. e.g., I see some boat. The car has four tire.
9. Wrong Word: Inappropriate use of a word. e.g., The children

are playing at Sunday. The men are big eyes.

10. Article Error: Inappropriate use of definite or indefinite article. e.g., I see a apple in the dish. She is having an coffee.

11. Possessive Error: Misuse of a possessive. e.g., The baby_ name is Tom. Bill_ last name is Johnson.

Data representing the types of errors are presented in Tables 3-10. Each subject is represented by a table which shows the number of each type of error committed by him/her per every 10 sentences written for each phase of the experiment. Error densities were calculated by multiplying by 10 the total number of each type of error made by a subject during a given phase and dividing by the total number of sentences written by that subject during that phase. The error densities are shown per 10 sentences, because as the experiment progressed and the subjects made fewer errors, the resulting numbers representing error densities per sentence would have been extremely small. A density of 1.00 in any given phase therefore indicates that one error of a given type was committed in every 10 sentences written during that phase. For example, Table 3 is read in the following manner: The error density of 1.45 in row one, column two means that Gil committed 1.45 spelling errors for every 10 sentences that he wrote in phase S-1. The error density of 0.73 in row two, column two means that Gil reduced his number of spelling errors by one-half when reinforcement and remediation were made contingent upon writing correct sentences in phase S-2.

TABLE 3

Error Density--Per 10 Sentences--By Type Per Phase--Gil

Phase	Error Type												
	Concept	Spelling	Punctuation	Word Order	Verb	Omission	Insertion	Singular/ Plural	Wrong Word	Article	Possessive	Total Errors	Total Errors Per 10 Sentences
S-1	2.18	1.45	14.55	0.77	2.36	1.82	1.64	0.00	1.27	0.00	0.73	147	26.73
S-2	0.52	0.73	3.13	0.42	0.63	0.42	2.40	0.10	0.52	0.21	0.10	88	9.17
S-3	0.14	0.14	1.13	0.42	0.56	0.00	0.99	0.70	0.28	0.14	0.00	32	4.51
S-4	0.14	0.14	0.41	0.00	0.41	0.41	0.00	0.00	0.41	0.00	0.00	14	1.92
S-5	0.37	0.19	0.56	0.19	0.31	3.33	0.00	0.37	0.93	0.00	0.00	34	6.30
S-6	0.00	0.42	0.42	0.14	0.28	0.42	0.42	0.42	0.56	0.00	0.00	22	3.10

TABLE 3 (cont.)

Error Density--Per 10 Sentences--By Type Per Phase--Gil

Phase	Error Type												
	Concept	Spelling	Punctuation	Word Order	Verb	Omission	Insertion	Singular/ Plural	Wrong Word	Article	Possessive	Total Errors	Total Errors Per 10 Sentences
F-1	0.00	0.28	0.56	0.00	0.56	0.42	0.14	0.56	0.69	0.14	0.00	24	3.33
F-2	0.00	0.26	0.58	0.00	0.32	0.52	0.52	0.26	0.06	0.06	0.00	40	2.58
F-3	0.27	0.36	0.09	0.00	0.54	0.54	0.09	0.00	0.09	0.00	0.00	21	1.88
F-4	1.11	0.14	0.14	0.14	0.56	0.56	0.00	0.14	0.56	0.00	0.00	24	3.33
F-5	0.22	0.89	0.00	0.00	0.22	0.22	0.00	0.22	0.44	0.00	0.00	10	2.22
F-6	0.41	0.20	0.00	0.00	0.41	0.00	0.61	0.00	0.00	0.00	0.00	8	1.63

TABLE 4

Error Density--Per 10 Sentences--By Type Per Phase--Lee Anne

Phase	Error Type												
	Concept	Spelling	Punctuation	Word Order	Verb	Omission	Insertion	Singular/ Plural	Wrong Word	Article	Possessive	Total Errors	Total Errors Per 10 Sentences
S-1	0.25	5.75	13.50	0.00	0.25	0.75	0.00	0.00	0.75	0.25	0.00	86	16.86
S-2	0.00	0.89	0.33	0.00	0.11	0.00	0.33	0.11	0.11	0.00	0.22	19	2.11
S-3	0.00	0.38	0.19	0.00	0.00	0.00	0.00	0.00	0.19	0.38	0.00	6	1.15
S-4	0.00	0.66	0.53	0.00	0.00	0.39	0.00	0.13	0.00	0.00	0.13	14	1.84
S-5	0.00	2.90	0.32	0.32	0.32	0.00	0.65	0.65	0.00	0.00	0.00	16	5.16
S-6	0.00	1.15	1.31	0.00	0.00	0.00	0.00	0.00	0.33	0.00	0.33	19	3.11

TABLE 4 (cont.)

Error Density--Per 10 Sentences--By Type Per Phase--Lee Anne

Phase	Error Type												
	Concept	Spelling	Punctuation	Word Order	Verb	Omission	Insertion	Singular/ Plural	Wrong Word	Article	Possessive	Total Errors	Total Errors Per 10 Sentences
F-1	0.00	1.15	1.15	0.00	0.00	0.33	0.16	0.00	0.00	0.00	0.00	17	2.79
F-2	0.00	0.94	0.29	0.00	0.14	0.07	0.14	0.14	0.00	0.00	0.14	26	1.87
F-3	0.00	0.88	0.35	0.00	0.09	0.00	0.09	0.00	0.00	0.00	0.00	16	1.40
F-4	0.00	1.54	0.77	0.00	0.00	0.15	0.00	0.31	0.00	0.15	0.00	19	2.92
F-5	0.00	1.00	0.00	0.00	0.50	0.00	0.00	0.00	0.25	0.00	0.00	7	1.75
F-6	0.00	1.03	0.00	0.00	0.00	0.52	0.00	0.00	0.00	0.00	0.00	9	1.55

TABLE 5

Error Density--Per 10 Sentences--By Type Per Phase--Marie

Phase	Error Type: Concept	Spelling	Punctuation	Word Order	Verb	Omission	Insertion	Singular/ Plural	Wrong Word	Article	Possessive	Total Errors	Total Errors Per 10 Sentences
S-1	0.36	2.91	2.00	0.00	0.18	0.18	0.00	0.18	0.18	0.00	0.18	42	7.64
S-2	0.00	0.54	0.43	0.00	0.00	0.22	0.00	0.00	0.00	0.00	0.11	12	1.29
S-3	0.00	0.29	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1	0.29
S-4	0.15	0.31	0.77	0.00	0.00	0.15	0.00	0.00	0.00	0.00	0.15	10	1.54
S-5	0.00	1.11	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	6	1.11
S-6	0.00	0.93	0.47	0.00	0.00	0.23	0.47	0.00	0.23	0.00	0.23	11	2.56

TABLE 5 (cont.)

Error Density--Per 10 Sentences--By Type Per Phase--Marie

Phase	Concept	Spelling	Punctuation	Word Order	Verb	Omission	Insertion	Singular/ Plural	Wrong Word	Article	Possessive	Total Errors	Total Errors Per 10 Sentences
F-1	0.00	0.59	0.29	0.00	0.00	0.15	0.00	0.00	0.29	0.29	0.00	11	1.62
F-2	0.00	0.44	0.26	0.00	0.00	0.26	0.00	0.00	0.00	0.00	0.00	10	0.88
F-3	0.00	0.18	0.65	0.00	0.11	0.00	0.11	0.00	0.00	0.00	0.00	19	2.04
F-4	0.00	0.78	0.63	0.00	0.00	0.00	0.00	0.16	0.00	0.00	0.00	10	1.56
F-5	0.00	0.37	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2	0.37
F-6	0.00	0.68	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	3	0.68

TABLE 6

Error Density--Per 10 Sentences--By Type Per Phase--Susan

Phase	Error Type												
	Concept	Spelling	Punctuation	Word Order	Verb	Omission	Insertion	Singular/ Plural	Wrong Word	Article	Possessive	Total Errors	Total Errors Per 10 Sentences
S-1	0.73	1.27	1.27	0.18	3.82	4.73	0.36	0.18	1.09	0.00	1.09	81	14.73
S-2	0.00	0.63	0.18	0.09	1.70	0.98	0.54	0.18	0.18	0.00	0.00	45	4.02
S-3	0.65	1.61	0.32	0.32	0.97	1.94	0.97	0.97	0.32	0.00	0.97	28	9.03
S-4	0.14	1.22	0.54	0.14	0.27	0.27	0.00	0.54	0.14	0.00	0.00	24	3.24
S-5	0.22	0.43	1.30	0.00	0.65	1.74	0.00	0.43	0.00	0.00	0.43	24	5.22
S-6	0.00	0.65	0.32	0.00	0.65	0.97	0.48	0.00	0.00	0.00	0.00	19	3.06

TABLE 6 (cont.)

Error Density--Per 10 Sentences--By Type Per Phase--Susan

Phase	Error Type												
	Concept	Spelling	Punctuation	Word Order	Verb	Omission	Insertion	Singular/ Plural	Wrong Word	Article	Possessive	Total Errors	Total Errors Per 10 Sentences
F-1	0.00	0.49	0.12	0.12	2.07	0.73	0.12	0.24	0.24	0.12	0.00	35	4.27
F-2	0.00	0.59	0.15	0.00	0.88	1.10	0.00	0.15	0.00	0.07	0.00	40	2.94
F-3	0.00	0.47	0.00	0.00	0.93	0.28	0.00	0.00	0.19	0.00	0.09	21	1.96
F-4	0.00	0.45	0.15	0.00	1.04	0.90	0.15	0.00	0.45	0.00	0.00	21	3.13
F-5	0.16	0.63	0.00	0.00	0.78	0.31	0.00	0.00	0.16	0.00	0.16	14	2.19
F-6	0.14	0.41	0.00	0.00	0.95	0.14	0.00	0.00	0.14	0.00	0.00	13	1.76

TABLE 7

Error Density--Per 10 Sentences--By Type Per Phase--Brian

Phase	Error Type												
	Concept	Spelling	Punctuation	Word Order	Verb	Omission	Insertion	Singular/ Plural	Wrong Word	Article	Possessive	Total Errors	Total Errors Per 10 Sentences
S-1	1.88	5.94	2.19	0.00	0.63	5.94	0.63	0.63	0.94	0.31	0.00	51	15.94
S-2	0.00	1.29	0.32	0.32	0.48	0.97	0.65	0.81	0.48	0.16	0.00	34	5.48
S-3	0.00	1.22	0.00	0.00	0.49	0.49	0.98	0.98	0.24	0.00	0.00	18	4.39
S-4	0.15	1.49	0.15	0.00	0.30	0.75	0.90	0.45	0.75	0.00	0.00	38	5.67
S-5	0.00	2.73	0.00	0.00	0.45	0.91	0.91	1.36	0.91	0.00	0.00	16	7.27
S-6	0.00	1.72	0.52	0.00	0.34	0.34	0.34	0.34	0.34	0.17	0.00	24	4.14

TABLE 8

Error Density--Per 10 Sentences--By Type Per Phase--Jacques

Phase	Error Type												
	Concept	Spelling	Punctuation	Word Order	Verb	Omission	Insertion	Singular/ Plural	Wrong Word	Article	Possessive	Total Errors	Total Errors Per 10 Sentences
S-1	5.71	4.64	4.64	0.00	1.79	1.79	1.07	0.00	0.71	1.07	0.00	61	5.71
S-2	0.00	0.62	0.37	0.00	0.25	0.25	0.37	0.00	0.49	0.12	0.00	20	2.47
S-3	0.00	0.40	0.53	0.00	0.00	0.13	0.40	0.27	0.00	0.40	0.00	16	2.13
S-4	0.10	0.63	0.31	0.00	0.00	0.31	0.31	0.42	0.31	0.31	0.00	25	2.60
S-5	0.00	0.75	0.00	0.00	0.60	0.15	0.15	0.45	0.15	0.30	0.00	17	2.54
S-6	0.00	0.53	0.13	0.00	0.26	0.00	0.00	0.26	0.00	0.00	0.00	9	1.18

TABLE 9

Error Density--Per 10 Sentences--By Type Per Phase--Sandy

Phase	Concept	Spelling	Punctuation	Word Order	Verb	Omission	Insertion	Singular/ Plural	Wrong Word	Article	Possessive	Total Errors	Total Errors Per 10 Sentences
S-1	0.45	4.55	4.55	0.00	2.27	2.27	0.45	0.00	1.36	0.91	0.45	38	17.27
S-2	0.00	1.52	2.42	0.00	0.40	0.81	0.00	0.00	0.20	0.10	0.51	59	5.96
S-3	0.00	2.58	1.29	0.00	0.42	0.97	0.00	0.00	0.65	0.00	0.32	31	7.95
S-4	0.10	1.11	1.01	0.00	0.30	0.30	0.20	0.20	0.00	0.00	0.00	32	3.23
S-5	0.00	1.93	0.00	0.00	1.23	0.00	0.18	0.35	0.18	0.00	0.35	24	4.21
S-6	0.00	1.11	0.00	0.00	0.99	0.25	0.00	0.25	0.37	0.00	0.74	30	3.70

TABLE 10

Error Density--Per 10 Sentences--By Type Per Phase--Paul

Phase	Error Type												
	Concept	Spelling	Punctuation	Word Order	Verb	Omission	Insertion	Singular/ Plural	Wrong Word	Article	Possessive	Total Errors	Total Errors Per 10 Sentences
F-1	0.69	1.38	0.52	0.17	1.03	1.21	0.52	0.00	0.17	0.69	0.00	37	6.38
F-2	0.19	0.77	0.48	0.38	1.06	0.19	1.25	0.00	0.19	0.10	0.00	48	4.62
F-3	0.83	0.37	0.19	0.00	1.11	0.74	0.19	0.37	0.46	0.09	0.00	47	4.35
F-4	0.39	0.65	0.00	0.26	0.65	0.65	0.00	0.65	0.52	0.00	0.00	27	3.51
F-5	0.00	0.38	0.00	0.00	0.19	0.57	0.00	0.19	0.00	0.94	0.00	14	2.64
F-6	0.18	0.71	0.00	0.00	0.71	0.18	0.54	0.36	0.54	0.00	0.18	19	3.39

Overall error density decreased for all subjects on 15 of the 19 occasions when a phase of reinforcement and remediation followed a phase of baseline conditions. The four times that overall error density increased all occurred when shifting to phase S-4 contingencies, which required the subjects to write prenominal adjectives for the first time. Overall error densities decreased seven of the 10 possible times when shifting from phase F-2 and F-5 contingencies to phase F-3 and F-6 conditions. Both of these contingency shifts required the subjects to produce sentences containing new components. Such a decrease in errors, despite a high frequency of writing new structures, demonstrates the effectiveness of the reinforcement and remediation in producing error free sentences.

Of the 69 types of errors committed by the eight subjects when they entered the experiment, 53 were completely eliminated during at least one phase of contingent reinforcement and remediation. This demonstrates that considerable control was established over the various types of errors committed by the subjects. Of the 38 total types of errors still remaining for the eight subjects when they finished the experiment, only three occurred as much as once in every 10 sentences, and 13 of those total error types appeared less than three times in every 100 sentences written by the subjects.

CHAPTER IV

DISCUSSION

The results of the experiment demonstrate that effective control was established over the sentence writing behavior of the subjects. Rate and accuracy were dependent upon the availability of reinforcement and remediation as consequences for writing correct sentences. New linguistic components, prenominal adjectives and adverbs, appeared in the subjects' sentences when maximum reinforcement was contingent upon writing correct sentences including those components.

Reinforcement of Written Language. Differential reinforcement for writing sentences of more complex topography enabled the subjects to produce quickly language components that had previously appeared rarely in their writing. Although the subjects began writing more correct sentences during phase S-2, when reinforcement and remediation were first made contingent upon writing correct sentences, those sentences were short subject-verb-object structures void of modifiers. For this reason, together with the fact that they had not yet been introduced in the subjects' regular language curriculum, prenominal adjectives were chosen as the first dependent variable in an attempt to change the language content of the sentences written by the subjects. The rate at which the subjects began producing many correct sentences with prenominal adjectives during phase S-4 far exceeded the expectations of the teaching staff at the Boston School for the Deaf. Prior to phase S-4, the teacher expressed doubt that the subjects would be able to use

correctly prenominal adjectives because they "hadn't had them yet." It is important to note that no instructional input regarding the proper usage of prenominal adjectives was given other than the projected sentence examples that contained prenominal adjectives, nor did the subjects receive any other formal written language training during the school day throughout the course of the experiment. The subjects demonstrated that they had learned the proper usage of the prenominal adjective when they continued to write many correct sentences including prenominal adjectives after the projected sentence examples were withdrawn on session 27.

Most subjects displayed a savings across tasks in the number of sessions required for them to incorporate effectively new components into their sentences. Subjects correctly included adverbs in a large percentage of their sentences during phase F-3 in fewer sessions than they had required to reach the same level of acquisition with prenominal adjectives in phase S-4. This rate of acquisition of a new component was subsequently surpassed in phase F-6, when most subjects began writing a large percentage of their correct sentences with both a prenominal adjective and an adverb on the first or second session of that phase. Whether this savings in time required to learn new language components is a function of: 1) strengthening the response class of learning new language via the technology and teaching methods employed in the experiment; 2) adaptation of the subjects to the visual response system; 3) the sequence in which the language components were introduced; or

4) the increasing magnitude of reinforcement used during phases S-4, F-3, and F-6, cannot be determined from the data and requires further experimental manipulation of those variables.

That the new language components were integrated into the subjects' repertoires in the order in which they were presented is suggested by the data from phases F-3, F-4, and F-5. Of the 24 correct sentences containing both a prenominal adjective and an adverb written by the subjects prior to phase F-6, when the contingency for such sentences was instated, 20 were written during phases F-3, F-4, and F-5. That is, subjects did not begin to write sentences including both a prenominal adjective and an adverb with any appreciable frequency until phase F-3, by which time both components had been experimentally introduced.

An important finding in the data is that the wide improvements in expressive language proficiency made by the subjects were independent of the type of aphasia each subject was reported to have by the school diagnostician. Although the verbal behavior studied in the experiment was expressive, no performance differentiation could be made among the subjects on the basis of whether they had been diagnosed as expressive, receptive, or receptive-expressive aphasic. This supports the notion that expressive and receptive language functions represent different response topographies within the larger response class of verbal behavior, rather than entirely different language processes or separate learning centers. It also suggests that specific language deficiencies

can be directly treated by strengthening those behaviors that are weak.

The consequences manipulated in the experiment were also effective in increasing the language performance of the subjects regardless of sex, reported mental ability, or degree of hearing loss. Differences in language ability have been noted on such dimensions (Myklebust, 1964). Although Marie, who has no hearing loss, displayed sentence writing skills significantly more advanced than the other subjects during baseline phase S-1, the direction and rates of improvement in accuracy and the acquisiton of prenominal adjectives and adverbs were similar for all subjects.

That the changes in language performance caused by the teaching methodology used in the experiment are relatively permanent, at least in the environment in which the experiment took place, is evidenced in the data of Gil, Lee Anne, Marie, and Susan, the four subjects who participated in the entire 12 phases of the experiment. Phase F-1 levels of accuracy for these subjects compared favorably to the high levels of accuracy obtained by them during phase S-6. Such long term maintenance of performance suggests that the sentence writing behavior of the subjects established during the Spring phases of the experiment was: 1) emitted by the subjects during the interim between phases S-6 and F-1 and maintained by natural reinforcers; or 2) those language skills were well established in the repertoires of the subjects during the Spring and the stimulus control exerted by the visual response system

was sufficient to set the occasion for their reappearance during phase F-1. The relative importance of either of those two variables in the maintenance of the subjects' language skills cannot be determined from the data. However, the notion that the new sentence writing behaviors were integrated into the subjects' repertoires, and that the visual response system served as a discriminative stimulus for their occurrence is supported by the data. The subjects all wrote a higher percentage of sentences containing prenominal adjectives during baseline phase F-1 than during all Spring phases prior to S-4, when the contingency for prenominal adjectives was first put into effect. Gil and Marie included prenominal adjectives in the same percentage of their sentences during phase F-1 than they had six months before in phase S-6.

The data from phase F-4 also suggest that the language components acquired during the experiment were integrated into the subjects' repertoires in a fairly permanent manner. When the contingency for adverbs was in effect during phase F-3, the subjects wrote very few sentences containing prenominal adjectives. However, when baseline conditions were reinstated in phase F-4, all subjects included prenominal adjectives in a percentage of their correct sentences far exceeding levels obtained during baseline phases prior to phase S-4, when the contingency for prenominal adjectives was first introduced.

The saliency of the reinforcers used in the experiment and the notion that the visual response system acquired discriminative stimulus properties indicating the delivery of those reinforcers was further

supported by anecdotal information. After the subjects had been given writing instructions on the first session of phase F-1, Susan motioned to her response counter, then pointed to a hair barrette she had acquired with points earned during the Spring phases of the experiment, and said to Paul, "Points." Another incident involving Susan took place prior to session 54. Just before entering the visual response system, Susan vomited and was told by the teacher to go see the school nurse. Susan refused, insisting that she did not want to miss earning more points.

Visual Interaction. An important feature of the experiment was that the visual response system allowed the teacher ongoing access to the subjects' sentence writing behavior as it was being emitted. This enables a teacher to exert control over the verbal behavior of students as precise as that performed by teaching machines, while at the same time allows for human interaction and determination of contingencies of reinforcement, which are necessary for the variety and spontaneity desired in expressive language. In a typical classroom of hearing students, a verbally rich environment prevails. When a teacher orally consequates one student's response, other students have the opportunity to use that information. This is not the case in classrooms of hearing impaired students where that information is muffled or garbled at best. Sign language, fingerspelling, and speechreading are often used in classrooms for the deaf in order to transmit verbal information visually. However, the typical classroom offers much visual competition for

the teacher's planned message. Another difficulty hampering the completion of successful learning trials in classrooms for the deaf is the low language level of most deaf students. Teacher-delivered consequences are sometimes misunderstood, especially remediation instructing the student to modify his/her response in a particular manner. The visual response system overcomes these problems by providing an environment where all teacher initiated instructions, prompts, and presentations can be projected with few distractions. The technology provided by the visual response system enables a teacher to deliver immediately salient reinforcers to students for correctly completing a response, giving each student much needed feedback on the quality of his/her responses. Remediation can be as precise as desired by modeling the correct response on the teacher's overhead projector for all students to see. This type of remediation proved very effective in decreasing the frequency of all types of writing errors committed by the subjects in the experiment.

In the usual classroom situation, regardless of whether the students are hearing or deaf, a common procedure is for students to take turns responding to a question or problem that the teacher has posed, while the others follow along or mark time until they are called upon to respond. When a class of students does work on a unit of instructional material simultaneously, such as completing a section of a workbook or computing a list of math problems, the consequation for those behaviors is delayed, often by as much as several days. The importance

of immediacy of consequences is well documented (Skinner, 1938; Honig, 1966). The delay between a subject completing a correct sentence and the delivery of reinforcement during phases F-2, F-3, F-5 and F-6 averaged only three seconds with very few delays of as much as five seconds. There is no taking turns in the visual response system. All students respond to all stimulus presentations. This greatly increases the total number of individual learning trials that can be completed in a given class period. For example, during phase F-2 an average of 94 individual learning trials took place during each of the seven sessions of that phase. This is an average of almost 20 trials per student over a time span of only 10 minutes. The total number of trials capable of being executed during a given session would undoubtedly be much higher for responses requiring less time to complete than that of writing sentences.

In addition to the teacher-student interaction which took place during the processes of reinforcement and remediation, visual interaction between subjects increased as the experiment progressed. Student-student interaction was minimal during phase S-1, as some of the subjects covered their transparency sheets with their hands in attempting to hide their sentences from the other subjects. On session five, the teacher reported that Gil and Brian regularly began looking across the room at each other's projected writing. An incident that occurred on session 20 lends support to the notion that the subjects were attending to one another's responses and the consequences those responses

precipitated. During the first trial of that session, Sandy wrote a large number of sentences using the form "The boy's name is Joe," "The girl's name is Sue." The words "boy's" and "girl's" fit the experimental definition of a prenominal adjective, and Sandy received two points for each of the sentences, which amounted to the largest number of points earned by any subject during one trial up to that point. On the second trial of session 20, every subject but Brian wrote virtually every sentence in the form "The boy's name is _____" "The girl's name is _____." Student-student interaction was also demonstrated by the fact that new words and phrases that were reinforced when included in the correct sentences written by one subject would soon appear in the writing of other subjects. The subjects were given no experimental input suggesting words or phrases that commonly serve as prenominal adjectives or adverbs, however, the majority of words and phrases used to modify nouns and verbs in the subjects' sentences were ones other than those included in the projected sentence examples. The number of words and phrases that served as prenominal adjectives and adverbs in the subjects' sentences increased as the experiment progressed.

Generalization and Maintenance of Newly Acquired Behavior. A major concern in education is whether or not a new skill acquired in an instructional setting will appear in the student's everyday environment where that particular behavior is functional and desirable. Generalization of a behavior to environments other than the one in which

the behavior was conditioned is a technological problem (Whaley and Malott, 1971). In other words, generalization, in most cases, will not happen automatically but can be achieved by properly arranging environmental events. Two techniques for increasing the probability that a behavior will generalize from an instructional setting to another environment are: 1) to generate high rates of behavior in the instructional setting that are resistant to extinction; and 2) arranging for the reinforcers that would normally maintain the behavior in the everyday environment to follow the behavior when it appears in the new environment.

The teaching methodology employed in the experiment and the technology provided by the visual response system enabled the teacher to generate high and stable rates of performance by the subjects. That those levels of performance were maintained when reinforcement and remediation were terminated during phase F-4 suggests that the procedures used in the experiment produced behavior resistant to extinction.

In a school for the deaf, proper use of language and correct grammatical expression by students are highly regarded. The Boston School for the Deaf is no exception. It is feasible that the subjects began writing more accurate and sophisticated sentences in other settings within the school and were reinforced with praise and approval for doing so. Although arrangement for such events to take place was not within the scope of this experiment, the fact that the subjects'

high level of performance did not deteriorate over the six months between phases S-6 and F-1 suggests that such extra-experimental reinforcement may have been occurring. Anecdotal information supplied by the subjects' teacher indicated that the sentences written by the subjects in their homeroom four months after the conclusion of the experiment were significantly more accurate and contained more modifiers than the sentences they composed prior to the experiment.

Implications for Further Research. The results of the experiment suggest further research and development of the teaching methodology employed in the experiment be undertaken (this implies the procedures used in the experiment in concert with the visual response system).

Of the 11 error types, spelling errors were not affected by remediation in the same manner as the errors of syntax or concept. For instance, when a verb error was made by a subject, remediation usually resulted in decreasing the relative frequency of such an error. However, when new words were attempted and misspelled, the subjects would avoid using the misspelled word in future sentences. While the absolute frequency of spelling errors decreased over the course of the experiment, very few new words were attempted during the later phases. The response class of including new words in a sentence (a response not mandatory for obtaining maximum reinforcement) underwent extinction over the course of the experiment. Other types of errors, such as an error in verb tense, had to be corrected by the subjects in order to construct a complete sentence. It would be interesting to conduct a

similar experiment incorporating error-specific contingencies. Such a contingency for spelling errors could administer points for trying new words, and make even more points contingent upon a new word appearing correctly in a subject's sentence. Lists of new words to be learned could be distributed to the subjects as prompts similar to the prompts used in the experiment, and the effectiveness of the teaching methodology in teaching new vocabulary could be studied.

Prenominal adjectives and adverbs were the only language components to serve as dependent variables in the experiment. The procedure must be tried with other linguistic units to test its generality and usefulness as a method for teaching language.

Student-student visual interaction, which took place with an increasing frequency as the experiment progressed, warrants further investigation to identify the relationships, if any, of students having access to each others responses to the learning evidenced in the experiment. Perhaps there are a set of behaviors that students must learn in order to take best advantage of the interaction made possible by the visual response system.

Procedures to insure the generalization of new language skills acquired by the teaching methodology employed in the experiment must be developed and investigated to increase the practicality of the methodology.

The effects of the teaching methodology could be studied with subjects of ages different from those used in the present experiment, and

subjects possessing handicaps other than hearing impairment and aphasia such as the mentally retarded.

It would be worthwhile to investigate the feasibility of developing an entire language curriculum based upon the procedures found successful in the experiment. Such a curriculum could conceivably begin with children able to sit at an overhead projector and produce marks on an acetate sheet. Experiments could be conducted to discover if the basic teaching methodology used in the experiment can be employed to teach young children to form letters, write words, combine words into phrases, produce simple sentences, and finally to compose complex, sophisticated language structures. Other forms of verbal behavior, such as the receptive language skills of responding to printed and spoken or signed language, could become dependent variables in experiments analyzing this teaching methodology. Other academic subjects could also come under the scrutiny of the procedures employed in the experiment.

Sufficient evidence was produced by the experiment to generate an extensive series of related investigations into a large number of issues and areas of concern effecting the education of deaf and aphasic children.

Relationship to the Education of Deaf-Aphasic Children. The performance gains attained by the subjects during the course of the experiment far surpassed the rate of achievement normally realized by deaf students the age of the subjects. Silverman & Lane (1970) report that:

> "The rate of progress for deaf children varies from the norms of hearing children. For example, it takes a deaf child approximately two years to complete the second grade and one and a half years to cover third grade material." (p. 427)

Contingencies to modify the subjects' sentence writing behavior were in effect for 41 sessions. When the 21 sessions of baseline conditions, when no reinforcement or remediation were contingent upon sentence writing, are subtracted from the number of class periods devoted to the experiment, the improvements made by the subjects are even more impressive.

The handicapping effects of hearing impairment are studied in depth during the initial year of teacher training programs (Calhoun, 1973). Student teachers are repeatedly provided with information concerning the slow learning rates and poor academic performance of deaf students such as those reported by Davis and Silverman (1970), Fusfield (1955), and Myklebust (1960). It is not surprising that many teachers of the deaf do not expect high rates of progress from their students and are often satisfied by mediocre or even poor performance that they would not consider acceptable for hearing students of the same age. As a result, many teachers do not arrange contingencies which set the occasion for and reinforce measurable improvements in performance, but accept whatever a student is producing as the best he/she can do. The results of the experiment show that when language behaviors of the subjects were consequated in a performance based situation, improvements were rapid. Dissemination of such findings may help to raise the

expectations of teachers of deaf and aphasic children.

Judging a student's abilities by what he/she does, rather than by what he/she should or shouldn't be capable of doing, enables a teacher to concentrate on building upon those behaviors that the student exhibits. Training teachers in the principles of behavior from which the methods and technology employed in the experiment are based could be one way in which to equip teachers with the skills necessary to shape and strenghten the behaviors of deaf and aphasic children.

It is important to note that the results obtained in the experiment were produced by the subjects' regular homeroom and language teacher. Teachers are sometimes distrustful of experimental results reported by professional researchers. They often feel that researchers make use of some "trick" or device which is either unknown or unobtainable to the teacher in the classroom. The teacher in the experiment was inexperienced with the procedures and the principles of behavior from which they were derived prior to the beginning of the experiment. That no special training was required for the teacher to effectively use the procedures employed in the experiment, indicates the ease with which such teaching behaviors can be integrated into the repertoires of practicing teachers.

The decisions of what specific language components to introduce to the subjects in the experiment were not made on an a priori basis. Prenominal adjectives were choosen because they were to be taught to the subjects via their regular language curriculum several months hence.

Adverbs were then picked because of the rarity with which verb modifiers appeared in the subjects' writing. Strauss and McCarus (1958) contend that the teaching of language to language deficient children can be directed and enhanced by applying what linguists know about the structure of language to the process of teaching language. The procedures employed in the experiment could seemingly be used with any sequence of language components and series of relationships among those components. One advantage of the teaching methodology used in the experiment over the use of symbol systems to teach language is that it appears to lend itself to the production of functional language by students rather than emphasizing a structural analysis. The stilted sentence structure so often witnessed in the writing of deaf and aphasic children, who have been taught language via a symbol system, can be eliminated with the procedures used in the experiment by simply instating a contingency for variety in sentence structure in a manner similar to the way in which the contingencies for prenominal adjectives and adverbs were introduced in the experiment.

In summary, while the range of variables manipulated in the experiment was limited, the effects upon behavior were marked. The approach to improving the level of verbal behavior utilized in this experiment can give teachers a means by which to build selectively upon the language skills of their students.

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APPENDIX I

Number of Sentences--Total/Correct/Correct with Prenominal Adjective/ Correct with Adverb/Correct with Prenominal Adjective and Adverb-- Written per Session by Each Subject

Session	Gil	Lee Anne	Marie	Susan
1	9/ 0/ 0/ 0/ 0	16/ 0/ 0/ 0/ 0	9/ 4/ 0/ 1/ 0	7/ 1/ 0/ 1/ 0
2	10/ 0/ 0/ 0/ 0	15/ 0/ 0/ 0/ 0	11/ 8/ 0/ 0/ 0	9/ 2/ 0/ 0/ 0
3	10/ 0/ 0/ 0/ 0	13/ 2/ 0/ 0/ 0	13/10/ 0/ 0/ 0	10/ 2/ 0/ 0/ 0
4	13/ 1/ 0/ 0/ 0	7/ 0/ 0/ 0/ 0	11/10/ 3/ 0/ 0	13/ 2/ 0/ 0/ 0
5	13/ 0/ 0/ 0/ 0	Absent	11/ 6/ 0/ 0/ 0	16/ 2/ 0/ 0/ 0
6	11/ 1/ 0/ 0/ 0	13/ 1/ 0/ 0/ 0	15/11/ 3/ 0/ 0	12/ 3/ 0/ 0/ 0
7	12/ 1/ 0/ 0/ 0	10/ 4/ 0/ 0/ 0	13/11/ 2/ 0/ 0	12/ 5/ 2/ 0/ 0
8	16/ 5/ 0/ 1/ 0	14/11/ 0/ 1/ 0	11/ 9/ 1/ 3/ 0	18/ 7/ 0/ 2/ 0
9	13/ 5/ 0/ 1/ 0	12/ 9/ 2/ 0/ 0	14/ 9/ 3/ 1/ 0	15/ 9/ 0/ 3/ 0
10	15/ 6/ 1/ 0/ 0	12/ 7/ 2/ 0/ 0	12/ 9/ 3/ 2/ 0	22/16/ 1/ 1/ 0
11	18/11/ 0/ 0/ 0	13/12/ 0/ 0/ 0	13/12/ 0/ 2/ 0	15/10/ 0/ 1/ 0
12	20/13/ 0/ 0/ 0	16/16/ 1/ 2/ 0	15/14/ 0/ 3/ 0	18/13/ 1/ 3/ 0
13	20/12/ 0/ 0/ 0	17/15/ 1/ 0/ 0	Absent	14/ 9/ 1/ 1/ 0
14	13/10/ 3/ 0/ 0	Absent	Absent	6/ 4/ 0/ 0/ 0
15	18/14/ 0/ 0/ 0	13/10/ 2/ 0/ 0	17/17/ 2/ 0/ 0	9/ 4/ 0/ 0/ 0
16	20/17/ 0/ 0/ 0	22/16/ 2/ 0/ 0	18/14/ 3/ 1/ 0	12/ 5/ 1/ 0/ 0

APPENDIX I (cont.)

Session	Gil	Lee Anne	Marie	Susan
17	13/10/ 3/ 0/ 0	18/15/ 9/ 0/ 0	17/15/ 7/ 0/ 0	14/ 7/ 5/ 1/ 0
18	14/13/ 9/ 0/ 0	16/13/11/ 0/ 1	18/16/10/ 1/ 0	18/13/ 5/ 0/ 0
19	15/12/10/ 1/ 0	11/ 9/ 8/ 0/ 0	10/ 8/ 6/ 0/ 0	16/12/ 4/ 1/ 0
20	15/13/13/ 0/ 0	12/ 7/ 7/ 0/ 0	10/ 9/ 7/ 0/ 0	13/10/10/ 0/ 0
21	16/15/14/ 0/ 0	19/16/15/ 1/ 0	10/ 8/ 7/ 0/ 0	13/10/10/ 0/ 0
22	17/ 9/ 6/ 0/ 0	6/ 4/ 3/ 0/ 0	17/16/14/ 0/ 0	9/ 6/ 5/ 0/ 0
23	19/16/ 7/ 0/ 1	4/ 2/ 1/ 0/ 0	22/19/ 9/ 0/ 0	16/ 5/ 1/ 1/ 0
24	18/ 9/ 7/ 0/ 0	21/ 5/ 0/ 0/ 0	15/14/ 7/ 2/ 0	21/12/ 6/ 0/ 0
25	15/ 6/ 6/ 0/ 0	16/16/14/ 1/ 1	9/ 8/ 4/ 0/ 0	19/10/ 5/ 0/ 0
26	16/13/12/ 0/ 0	11/ 7/ 6/ 0/ 0	13/ 9/ 4/ 1/ 0	10/ 8/ 7/ 1/ 0
27	15/13/13/ 0/ 0	18/12/ 9/ 0/ 0	13/ 8/ 4/ 0/ 0	13/12/12/ 0/ 0
28	25/21/20/ 0/ 0	16/11/ 6/ 0/ 0	8/ 8/ 6/ 1/ 0	20/16/16/ 0/ 0
29	17/15/ 2/ 1/ 0	21/20/ 7/ 5/ 0	13/13/ 2/ 2/ 0	15/ 9/ 2/ 1/ 0
30	21/17/12/ 1/ 0	16/16/ 7/ 0/ 0	16/12/ 4/ 1/ 0	17/11/ 5/ 3/ 0
31	19/14/13/ 0/ 0	8/ 4/ 1/ 0/ 0	11/11/ 8/ 0/ 0	17/13/11/ 0/ 0
32	15/12/12/ 0/ 0	8/ 5/ 3/ 0/ 0	15/13/ 7/ 2/ 0	18/ 9/ 5/ 1/ 0
33	Absent	8/ 3/ 0/ 0/ 0	13/10/ 5/ 3/ 0	16/11/ 6/ 0/ 0
34	17/15/14/ 0/ 0	19/17/ 7/ 3/ 0	14/13/ 9/ 2/ 0	16/13/ 7/ 2/ 0

APPENDIX I (cont.)

Session	Gil	Lee Anne	Marie	Susan
35	17/15/14/ 0/ 0	19/14/11/ 0/ 0	14/13/ 9/ 2/ 0	16/13/ 7/ 2/ 0
36	28/14/14/ 0/ 0	22/16/ 9/ 0/ 0	17/15/11/ 1/ 0	21/11/11/ 0/ 0
37	23/17/16/ 1/ 0	21/18/ 6/ 1/ 0	18/17/ 7/ 2/ 0	19/15/14/ 1/ 0
38	23/20/18/ 2/ 0	19/16/12/ 1/ 0	19/15/ 9/ 0/ 0	20/16/ 8/ 4/ 0
39	22/19/19/ 0/ 0	20/16/10/ 1/ 0	21/12/10/ 1/ 0	21/12/10/ 1/ 0
40	26/19/19/ 0/ 0	19/17/15/ 0/ 0	17/16/ 5/ 0/ 0	21/17/13/ 0/ 0
41	13/ 8/ 3/ 5/ 0	11/ 7/ 0/ 3/ 0	11/ 5/ 3/ 2/ 0	13/12/ 4/ 8/ 0
42	14/12/ 6/ 6/ 0	Absent	15/10/ 7/ 0/ 0	14/ 9/ 0/ 7/ 0
43	13/ 7/ 0/ 7/ 0	18/15/ 1/10/ 0	9/ 6/ 4/ 0/ 1	15/11/ 0/10/ 1
44	12/ 9/ 2/ 7/ 0	14/12/ 3/ 6/ 1	9/ 7/ 2/ 3/ 2	12/11/ 0/ 9/ 0
45	9/ 7/ 0/ 6/ 1	20/16/ 6/ 6/ 0	13/13/ 8/ 2/ 1	9/ 6/ 0/ 6/ 0
46	14/ 8/ 0/ 8/ 0	17/17/ 0/15/ 0	12/ 7/ 0/ 7/ 0	14/11/ 0/11/ 0
47	18/17/ 0/14/ 3	17/15/ 0/14/ 0	10/ 9/ 1/ 6/ 2	14/12/ 3/ 9/ 0
48	18/17/ 0/14/ 3	18/15/ 0/15/ 0	14/13/ 1/11/ 0	16/15/ 0/13/ 0
49	18/15/ 0/13/ 2	18/14/ 2/ 5/ 0	16/14/ 6/ 2/ 0	17/14/ 0/13/ 0
50	22/17/ 1/13/ 0	10/ 5/ 1/ 0/ 0	17/15/10/ 0/ 0	19/13/ 1/ 6/ 0
51	18/14/ 0/12/ 2	21/17/11/ 0/ 0	14/14/12/ 1/ 1	15/11/ 5/ 4/ 0
52	15/ 7/ 1/ 6/ 0	16/ 7/ 3/ 0/ 0	17/14/ 9/ 1/ 0	16/ 8/ 3/ 3/ 0
53	Absent	Absent	17/16/10/ 1/ 1	21/17/ 4/10/ 0
54	14/ 9/ 0/ 8/ 1	14/10/ 0/10/ 0	9/ 8/ 1/ 3/ 1	16/11/ 1/ 8/ 1

APPENDIX I (cont.)

Session	Gil	Lee Anne	Marie	Susan
55	15/12/ 0/10/ 2	14/14/ 0/13/ 0	13/13/ 1/ 9/ 1	14/13/ 0/11/ 1
56	16/11/ 0/10/ 1	12/ 9/ 0/ 8/ 1	15/14/ 2/ 4/ 8	13/11/ 2/ 9/ 0
57	10/ 7/ 0/ 0/ 7	9/ 8/ 1/ 1/ 5	7/ 7/ 0/ 4/ 3	12/ 9/ 0/ 0/ 9
58	10/ 9/ 0/ 1/ 8	10/ 9/ 0/ 2/ 7	9/ 9/ 5/ 3/ 1	10/ 8/ 1/ 0/ 7
59	8/ 4/ 0/ 1/ 3	9/ 5/ 0/ 0/ 5	6/ 4/ 0/ 2/ 2	11/ 8/ 0/ 1/ 7
60	10/ 8/ 0/ 2/ 6	8/ 7/ 0/ 1/ 6	8/ 8/ 0/ 5/ 3	13/10/ 0/ 0/10
61	7/ 6/ 0/ 0/ 6	11/10/ 0/ 2/ 8	5/ 4/ 0/ 1/ 3	12/10/ 0/ 1/ 9
62	14/13/ 0/ 1/12	11/11/ 0/ 0/11	9/ 9/ 0/ 0/ 9	16/15/ 0/ 1/14

APPENDIX I (cont.)

Session	Brian	Jacques	Sandy	Paul
1	3/ 2/ 0/ 0/ 0	9/ 0/ 0/ 0/ 0	14/ 2/ 0/ 0/ 0	--
2	7/ 2/ 0/ 0/ 0	9/ 0/ 0/ 0/ 0	Absent	--
3	8/ 0/ 0/ 0/ 0	10/ 0/ 0/ 0/ 0	Absent	--
4	8/ 3/ 0/ 0/ 0	Absent	Absent	--
5	6/ 1/ 0/ 0/ 0	Absent	8/ 0/ 0/ 0/ 0	--
6	9/ 2/ 0/ 0/ 0	8/ 1/ 0/ 0/ 0	8/ 0/ 0/ 0/ 0	--
7	8/ 2/ 0/ 0/ 0	10/ 3/ 0/ 0/ 0	9/ 2/ 0/ 0/ 0	--
8	12/ 5/ 1/ 0/ 0	12/ 7/ 0/ 1/ 0	20/13/ 2/ 1/ 0	--
9	11/ 5/ 0/ 1/ 0	10/ 7/ 0/ 0/ 0	14/ 3/ 0/ 0/ 0	--
10	11/ 4/ 1/ 0/ 0	11/ 6/ 1/ 0/ 0	14/ 6/ 0/ 0/ 0	--
11	9/ 6/ 0/ 0/ 0	14/13/ 0/ 0/ 0	16/ 4/ 0/ 0/ 0	--
12	12/ 8/ 0/ 1/ 0	16/13/ 1/ 3/ 0	18/ 9/ 1/ 1/ 0	--
13	11/ 7/ 1/ 0/ 0	18/13/ 0/ 0/ 0	Absent	--
14	13/11/ 2/ 0/ 0	19/12/ 6/ 0/ 0	Absent	--
15	8/ 5/ 0/ 0/ 0	19/17/ 3/ 0/ 0	18/ 3/ 0/ 0/ 0	--
16	9/ 6/ 0/ 0/ 0	19/17/ 2/ 0/ 0	21/14/ 0/ 0/ 0	--
17	15/ 9/ 0/ 1/ 0	17/12/ 4/ 0/ 0	15/ 8/ 2/ 0/ 0	--
18	13/ 7/ 0/ 2/ 0	22/19/ 8/ 0/ 0	20/13/ 3/ 0/ 0	--
19	18/ 8/ 3/ 0/ 0	20/19/ 8/ 0/ 0	19/12/ 3/ 0/ 0	--
20	15/11/ 2/ 3/ 0	19/11/10/ 0/ 0	21/19/17/ 0/ 0	--

APPENDIX I (cont.)

Session	Brian	Jacques	Sandy	Paul
21	13/ 5/ 2/ 0/ 0	18/14/13/ 0/ 0	15/11/ 9/ 0/ 0	--
22	9/ 7/ 5/ 0/ 0	23/20/ 7/ 0/ 0	19/15/ 5/ 0/ 0	--
23	Absent	24/21/ 7/ 0/ 0	20/ 9/ 3/ 0/ 0	--
24	13/ 5/ 0/ 0/ 0	20/13/ 8/ 0/ 0	18/15/ 4/ 0/ 0	--
25	16/ 8/ 1/ 0/ 0	19/17/ 7/ 0/ 0	22/17/ 5/ 0/ 0	--
26	13/ 5/ 1/ 0/ 0	18/16/13/ 1/ 0	17/ 8/ 2/ 1/ 0	--
27	12/10/ 2/ 0/ 0	19/18/ 9/ 1/ 0	20/17/ 6/ 0/ 0	--
28	17/14/ 8/ 1/ 0	20/18/12/ 1/ 0	22/16/ 7/ 0/ 0	--
29	--	--	--	10/ 3/ 0/ 0/ 0
30	--	--	--	10/ 2/ 0/ 0/ 0
31	--	--	--	11/ 3/ 0/ 0/ 0
32	--	--	--	15/ 7/ 0/ 2/ 0
33	--	--	--	12/ 7/ 0/ 0/ 0
34	--	--	--	11/ 4/ 0/ 1/ 0
35	--	--	--	11/ 4/ 0/ 1/ 0
36	--	--	--	14/ 6/ 0/ 1/ 0
37	--	--	--	13/ 5/ 1/ 1/ 1
38	--	--	--	13/10/ 7/ 2/ 0
39	--	--	--	18/11/ 8/ 2/ 0

APPENDIX I (cont.)

Session	Brian	Jacques	Sandy	Paul
40	--	--	--	24/20/17/ 1/ 0
41	--	--	--	10/ 5/ 0/ 5/ 0
42	--	--	--	13/ 9/ 0/ 4/ 0
43	--	--	--	17/10/ 2/ 8/ 0
44	--	--	--	15/ 8/ 2/ 3/ 0
45	--	--	--	Absent
46	--	--	--	19/10/ 1/ 5/ 0
47	--	--	--	13/ 9/ 0/ 8/ 0
48	--	--	--	21/14/ 4/ 7/ 0
49	--	--	--	22/17/10/ 5/ 0
50	--	--	--	17/ 9/ 1/ 4/ 0
51	--	--	--	20/14/ 5/ 9/ 0
52	--	--	--	18/13/10/ 1/ 0
53	--	--	--	Absent
54	--	--	--	14/ 9/ 2/ 5/ 0
55	--	--	--	20/14/ 4/ 9/ 0
56	--	--	--	19/17/ 2/14/ 0
57	--	--	--	8/ 4/ 0/ 2/ 2

APPENDIX I (cont.)

Session	Brian	Jacques	Sandy	Paul
58	--	--	--	11/ 7/ 0/ 1/ 6
59	--	--	--	10/ 7/ 2/ 1/ 3
60	--	--	--	14/10/ 5/ 1/ 4
61	--	--	--	13/11/ 0/ 1/10
62	--	--	--	Absent

APPENDIX II

Information Projected Throughout Certain Sessions of the Experiment as Prompts for Sentence Writing

The following twelve sentences were projected during sessions 17-21 and 25-26. The sentences were handwritten on a single acetate sheet in the order below:

The car is red. 1 point.

The girl has brown hair. 2 points.

The day is snowy. 1 point.

The summer day is warm. 1 point.

The dress is pretty. 1 point.

Larry is a fat boy. 1 point.

The teacher is mad. 1 point.

The happy baby laughs. 2 points.

I see a girl. 1 point.

John has three pencils. 2 points.

The dog is small. 1 point.

The happy girl is playing. 2 points.

Two separate transparencies were projected throughout sessions 41-45 as prompts for adverbs. The first contained information regarding the reinforcement contingency in effect along with the definition of an adverb. The second prompt transparency listed 12 correct sentences, three each including one of the four types of adverbs.

(Adverb Prompt Transparency #1)

Correct Sentence = 1 point

APPENDIX II (cont.)

Correct Sentence with an Adverbial Phrase = 3 points

An Adverb Answers These Questions:

Where?

When?

How?

Why?

(Adverb Prompt Transparency #2)

Where?

1. The boy walked to the store.
2. Mary is in school.
3. The ball is under the table.

When?

1. John played football on Saturday.
2. We eat lunch at 12 o'clock.
3. I watch T.V. every afternoon.

How?

1. I go to school by car.
2. The boy runs fast.
3. The bird sings loudly.

Why?

1. I am happy because it is my birthday.
2. He is going to the store to buy a ball.
3. Mary is laughing because John is funny.

APPENDIX II (cont.)

The following reinforcement contingency and six example sentences were projected during sessions 57-60 as prompts for writing sentences containing both a prenominal adjective and an adverb:

Correct Sentence = 1 point

Correct Sentence with an Adjective and an Adverb = 4 points

The happy boy plays at 3 o'clock.

The two birds are flying fast.

Mary is walking to the hockey game.

John is going home to get his winter coat.

The boy hits the big ball with the bat.

The girl sees a brown dog on the grass.

APPENDIX III

Samples of Correct and Incorrect Sentences Written by Subjects

Two correct (C) and two incorrect (I) sentences written during each experimental phase are listed for each subject. These examples were randomly drawn from the raw data and reflect the changes which occurred in the writing of the subjects over the course of the experiment. Examples were taken from the last session of each phase whenever possible. Since the number of incorrect sentences decreased significantly in phases where reinforcement and remediation were available, the samples are weighted incorrectly. However, the types of errors committed are interesting, and incorrect sentences are presented in equal numbers to correct sentences.

Correct and Incorrect Sentences - Gil

S-1

(c) I will not drink.

(Only one correct sentence)

(I) Sandy is give Cat in the bootpack

Brain is a alive fool a sharkfish

S-2

(C) This is a car.

This is a big school.

(I) She writing on the her book.

The water wash on the car.

S-3

(C) This is a cookie.

APPENDIX III (cont.)

Correct and Incorrect Sentences - Gil

(C) The boys are happy.

(I) This is a apple.

ted is helped will Frank.

S-4

(C) This is a happy girl.

I see green leaves.

(I) All The Children is very happy.

The happy children is Friending.

S-5

(C) The girl's name is Mary.

I see more books.

(I) I see yellow book.

The happy book is storying.

S-6

(C) I see a black hair.

This is a happy boy.

(I) I see a two eyes.

This is a mad women.

F-1

(C) The girl's suit is pink.

The boy's name is John.

(I) Sunday is hot day.

The leave is very old.

APPENDIX III (cont.)

Correct and Incorrect Sentences - Gil

F-2

(C) I see a very big pipe.

I see a white floor.

(I) I see a small nose.

I see a big leave.

F-3

(C) The map is on the floor.

The man is working at 11:00.

(I) The girl is sitting on chair.

The children is in the school.

F-4

(C) The rake is on the grass.

The man runs fast.

(I) The man ask the boy if he can rake some.

I see sone boy on the bat.

F-5

(C) I see some boats in the water.

The cookies are on the table.

(I) The airport runs fast.

I see some citys on the grass.

F-6

(C) I see a small room in the school.

I see a small tent in the park.

APPENDIX III (cont.)

Correct and Incorrect Sentences - Gil

F-6

(I) I see a 5 cups on table.

The big pimkin is on the table.

Correct and Incorrect Sentences - Lee Anne

S-1

(C) The girl's name is Mary.

This is March.

(I) That is Dr Johns room

I see a picher

S-2

(C) The girl has a book.

This is Mother.

(I) It sady's bithday.

Thier is 100 people.

S-3

(C) I see a happy man.

I see a hat.

(I) I see a milk.

I see a apple.

S-4

(C) The boy's name is Joe.

Three boys walked home.

APPENDIX III (cont.)

Correct and Incorrect Sentences - Lee Anne

S-4

(I) I see girls room.

A toy airplane can'tnot fly.

S-5

(C) I see a bat.

I see Scott.

(I) I see a feid.

I see two shue.

S-6

(C) I see a red desk.

The girl is getting lunch.

(I) Who gives the lunch.

I see a red rug

F-1

(C) Lee is happy.

I see three boys.

(I) Gil is a montser.

I se a pool.

F-2

(C) I see a brown table.

I see a person eating a hotdog.

(I) I see a chich..

I see town St.

APPENDIX III (cont.)

Correct and Incorrect Sentences - Lee Anne

F-3

(C) The water is in a pail.

The dog is standing on the floor.

(I) The blackbord is on the wall.

The hair are on Joe and Sue.

F-4

(C) I see a boy.

The boy is sad.

(I) I see a dumb fat mens.

the home is red.

F-5

(C) The snow is on the hill because it is very cold up there.

I see seven children in room 7.

(I) The forks and nife are on the desks.

The hills are on the groud.

F-6

(C) The big shoes are on the fat lady.

The mad lady is beside the desk.

(I) The boy gone home to get his warm coat.

The scary maskes are on the kids.

APPENDIX III (cont.)

Correct and Incorrect Sentences - Marie

S-1

(C) The day is hot.

The boy is not happy.

(I) The boy is playing a trik on the boy who is summing

Mary is a good girl al the time.

S-2

(C) The boy's name is Jack.

The girl is in school.

(I) I see a boy

Mother is mad at the boy

S-3

(C) I see a hat.

The boy has hair.

(I) The man is halfering the little boy.

(Only one incorrect sentence)

S-4

(C) The girl's name is Lee Anne.

I see a mad boy.

(I) The girls name is Marie.

The boy is running

S-5

(C) Jimmy is in school.

The boy has long hair.

APPENDIX III (cont.)

Correct and Incorrect Sentences - Marie

S-5

(I) The girl has two legss.

I see a funny howse.

S-6

(C) Lee Anne is mad with the boy.

The girl's name is Kathy.

(I) The baby is in a crab.

Jack has brown, white pants.

F-1

(C) Mary is a nice girl.

The girl has a beach ball.

(I) I see a apple in the dish.

The red has a green leave.

F-2

(C) Snoopy is a very good dog.

The red church is big.

(I) The leavs are big.

The kinfe is big.

F-3

(C) They will go home at 2:30.

The girl is sitting in a room.

(I) The man's name is Mr. J

The pencil and the pen is on top of the desk.

APPENDIX III (cont.)

Correct and Incorrect Sentences - Marie

F-4

(C) They are good boys.

The little boy has a bat.

(I) I see a basekit.

I see some bracks.

F-5

(C) The boat is in the water because the men want to go for a boat ride.

I see a number four.

(I) The are happy because they are having anice party.

I see three apples on the talble.

F-6

(C) I see a smart boy in the room.

There are many books in the room.

(I) The big talbe cloth is on the talbe.

There are 50 caps on the talbe.

Correct and Incorrect Sentences - Susan

S-1

(C) She saw the water.

She ran out.

(I) The boy name is Gil.

Brian are Trik.

APPENDIX III (cont.)

Correct and Incorrect Sentences - Susan

S-2

(C) The boy's name is Gil.

He is washing the car.

(I) His family go someplace.

He be along.

S-3

(C) The girls are happy.

The boy's name is Ted.

(I) The lady are happy to spe for the children.

These are 6 mild of glass.

S-4

(C) I see six girls.

The happy girls are nice.

(I) The sad girl is cry.

I see two boys nice.

S-5

(C) This is a big wall.

These are ears.

(I) Bill not know how to play.

Mary wears pretty dress.

S-6

(C) I see a small frog.

I see a big window.

APPENDIX III (cont.)

Correct and Incorrect Sentences - Susan

S-6

(I) I see big table.

I see mad girl.

F-1

(C) It is Sunday.

She is 5 years old.

(I) Lee went to swimming.

The apple is very shines and red.

F-2

(C) I see a big dog.

Gil's nose is black.

(I) That he thoght.

I see may house.

F-3

(C) The water is on the floor.

The hat is on his head.

(I) He kneel on the floor.

She is working a 6 A.M.

F-4

(C) The leaves are on the grass.

I see a big gate.

(I) He like to play baseball.

The books are on his hand.

APPENDIX III (cont.)

Correct and Incorrect Sentences - Susan

F-5

(C) The cars are on the parking lot.

The children are in the big room.

(I) I see many cities in the town.

The airplane is land.

F-6

(C) Some books are missing in the room.

I see the big boy is missing because he is sick.

(I) The pretty glasse is on the lady's face.

I see a jack-o-laton.

Correct and Incorrect Sentences - Brian

S-1

(C) The boy is happy.

This is a girl.

(I) Father is the in house.

The cat is the boby.

S-2

(C) This is a mother.

This is a school.

(I) This is a water.

The car is bown.

APPENDIX III (cont.)

Correct and Incorrect Sentences - Brian

S-3

(C) This is a boy.

This is a man.

(I) I see two girls and boys.

This is a girls.

S-4

(C) These are happy boys.

This is a boy.

(I) The boy is the woked.

The boy is the fat.

S-5

(C) I see one book.

This is Gil.

(I) This is an eyes.

The boy is a happy.

S-6

(C) The boy is happy.

I see a big box.

(I) I see a apple.

The boy is vinng the doll.

APPENDIX III (cont.)

Correct and Incorrect Sentences - Jacques

S-1

(C) (No Correct Sentences)

(I) The boy is the look.

The talbet is the spoon.

S-2

(C) The girl is happy all the time.

This is a boy.

(I) I see a happy.

This is a water.

S-3

(C) This is a school.

This is an eye.

(I) I see two boy.

This is an nose.

S-4

(C) I see a happy man.

The boy's name is Jack.

(I) The boy is the fat.

The girl's name is sus.

S-5

(C) I see two shoes.

This is a hat.

APPENDIX III (cont.)

Correct and Incorrect Sentences - Jacques

S-5

(I) This is some haar.

I see orange book.

S-6

(C) The boy is in the school.

I see a big desk.

(I) I see a sad womam.

The woman's name is Gial.

Correct and Incorrect Sentences - Sandy

S-1

(C) The boy is looking.

The boy is happy.

(I) The chair is for the mane

The chair is going aroud a aroud

S-2

(C) The book is for Polly.

This is a red car.

(I) girl's name is Polly.

The weels is black.

S-3

(C) John's hat is red.

John is happy.

APPENDIX III (cont.)

Correct and Incorrect Sentences - Sandy

S-3

(I) Joe is hlep will John.

John have a apple and orange.

S-4

(C) Bobby is happy.

The boy's name is Bobby.

(I) Bobby is walked.

I See a boy.

S-5

(C) John is sad.

The books are red.

(I) This is a hats.

Brain licke John.

S-6

(C) Jack is happy.

Billy's hair is white.

(I) The books is on the table.

Mary happy.

Correct and Incorrect Sentences - Paul

F-1

(C) The girl is happy.

The girl is catching a ball.

APPENDIX III (cont.)

Correct and Incorrect Sentences - Paul

F-1

(I) The trees is falling a leaves.

The leaves biggern

F-2

(C) I see a white church.

I see a small house.

(I) I see a happy people.

I see a orange table.

F-3

(C) The girl is in the house.

I see a black dog.

(I) The girl is sitting down the chair.

The dog is eating a ice cream.

F-4

(C) I see some brown leaves.

The man is happy.

(I) The house is under the ground.

I see a four boys.

F-5

(C) The children are playing at 11:40.

I see some blue water.

(I) The cloud is about the water.

The children are school at every day.

APPENDIX III (cont.)

Correct and Incorrect Sentences - Paul

F-6

(C) The girl sees a gold tent on the ground.

The big pie is on the table.

(I) The happy children plays at 4:45.

The boy sees a brown football on the hold hand.