

THE UNIVERSITY OF MANITOBA

Effects of Sequential and Non-Sequential
Conditioned Reinforcers in a Picture -
Naming Task With Retarded Children

by
Carl E. Stephens

A Dissertation
Submitted to the Faculty of Graduate Studies
In Partial Fulfillment of the Requirements
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ABSTRACT

Picture - naming behavior of three retarded children was compared in two experimental conditions which were identical except that sequentially illuminated lights (which accumulated) were contingent upon correct responses in one experimental condition, whereas light-flashes which did not accumulate were contingent upon correct responses in the other experimental condition. Each child served in both experimental conditions. In Phase 1, primary reinforcers were delivered immediately after the fifth correct verbal response. During this phase, the performance of one subject was consistently superior in the light-flash condition. There was no difference in the performance of the other two subjects in either experimental condition. During Phase 2, subsequent to emitting five correct verbal responses a lever-press response in the presence of five illuminated lights was required to produce primary reinforcers in both experimental conditions, to increase the likelihood that the children attended to the lights. The performance of all subjects was consistently superior in the light-flash condition during this phase. In addition, the performance of the two subjects who did not show any difference between the two conditions in Phase 1 improved considerably in both experimental conditions as a result of requiring a lever-press response. Phase 3 was a reversal to the conditions of Phase 1, in that a lever-press response was no longer required to produce primary reinforcers. The performance of all subjects deteriorated in both experimental conditions. The subject who showed superior picture-naming performance in the light-flash condition of Phase 1 continued to do so in Phase 3 while the two conditions produced no differential effects for the other two subjects. The lever-press requirement was reintroduced in Phase 4 and the results of Phase 2 were

replicated in that the performance of all subjects was superior in the light-flash condition and the performance of the two subjects who showed no differences between the two conditions in Phase 1 and 3, improved considerably in both experimental conditions. During Phase 5 the schedule of primary reinforcement was increased from FR 5 to FR 10. The picture-naming behavior of two children remained superior across a number of dependent measures in the light-flash condition while the third subject's behavior deteriorated in both experimental conditions. In Phase 6 the schedule of primary reinforcement was reversed to FR 5 and the performance of all subjects was superior in the light-flash condition. The subject's behavior which deteriorated during Phase 5, recovered during Phase 6. During Phase 7 the light-flashes which followed fifth correct responses and were associated with primary reinforcers were different from the light-flashes which followed all but fifth correct responses. The two subjects exposed to this condition continued to emit superior picture-naming behavior in the light-flash condition. Performance in the sequential light condition seemed to be inferior to performance in the light-flash condition as a result of sequential lights discriminatively controlling low response rates when the probability of delivery primary reinforcers was low. Also, for two subjects the lights in either condition seemed to function as conditioned reinforcers only when a specific attending response was required to produce primary reinforcement, indicating that the simple pairing of stimuli and reinforcers is not always a sufficient procedure for establishing stimuli as conditioned reinforcers.

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CHAPTER I
INTRODUCTION

Basic Research on Conditioned Reinforcers

Events or stimuli which increase the future likelihood of behavior which they follow are called reinforcers (Ferster and Skinner, 1957). Some reinforcers, such as food and water, are able to strengthen (i.e., increase the probability of) behavior without having to be associated with other reinforcers. These are called primary reinforcers. Other reinforcers, such as money or praise, are formerly neutral events which acquire their reinforcing status by being appropriately associated with other reinforcers. These are called conditioned reinforcers. It is with conditioned reinforcers that this research is primarily concerned.

Despite the extensive basic research on conditioned reinforcement (discussed extensively by Hendry, 1969; Kelleher, 1966; and Kelleher and Gollub, 1962), disagreement remains with respect to the precise conditions necessary for creating conditioned reinforcers. One view maintains that when a stimulus is temporally paired with a reinforcer, the stimulus acquires reinforcing value. According to this theory, a stimulus such as the sound produced by the operation of a food dispenser in an experimental chamber, acquires reinforcing value simply as a result of being paired with food. An alternative view maintains that a stimulus acquires reinforcing value as a result of becoming a discriminative stimulus (a stimulus in the presence of

which a response is reinforced and in the absence of which the same response is not reinforced) for a subsequent response. According to this second theory, a stimulus such as the sound produced by the operation of a food dispenser, acquires reinforcing value as a result of functioning as a discriminative stimulus in the presence of which approaching the food tray is reinforced.

Early research on conditioned reinforcers revolved around this issue and evidence was produced for both positions. For example, in a study with rats, Schoenfeld, Antonitis and Bersh (1950) paired a stimulus light with the ingestion of food rather than with food delivery. They were unable to demonstrate that the light had acquired conditioned reinforcing value and concluded that simple pairing of a stimulus and reinforcer was not sufficient for creating a conditioned reinforcer. In contrast, Stein (1958) found that pairing a tone with the non-contingent delivery of reinforcing intra-cranial stimulation was sufficient to establish the tone as a conditioned reinforcer. This indicates that it is not necessary to establish a stimulus as a discriminative stimulus in order to establish it as a conditioned reinforcer. However, in studies such as Stein's it is possible that the stimulus which preceded reinforcer delivery discriminatively controlled an operant response which was unidentified by the experimenter. In short, the repeated pairing of a stimulus and a primary reinforcer, with the stimulus briefly preceding the primary reinforcer, is a sufficient procedure for establishing the stimulus as a conditioned reinforcer. Whether a stimulus must be a discriminative stimulus in order to function as a conditioned reinforcer is not known. Since this issue apparently cannot be resolved with current experimental techniques, it seems to have been temporarily set aside.

One of the problems with earlier research was that the effects of conditioned reinforcers were demonstrated during experimental extinction in

which primary reinforcement was withheld. Since conditioned reinforcers quickly lose their effectiveness as reinforcers when delivered in the absence of primary reinforcers, this approach prevented a thorough analysis of the effects of conditioned reinforcers. It now seems more promising to study conditioned reinforcers while the behavior of interest is being maintained by some schedule of primary reinforcement.

A schedule of reinforcement is a prescription for initiating and terminating reinforcing stimuli in relation to some behavior (Morse, 1966). In other words, a schedule of reinforcement specifies which instance of a behavior will be reinforced. Two general types of schedules are those that reinforce a response on the basis of time since the previously reinforced response (interval schedules) and those that reinforce a response on the basis of number of responses since the previously reinforced response (ratio schedules). Both interval and ratio schedules fall into two basic classes: fixed and variable. In a fixed-interval (FI) schedule of reinforcement, reinforcement is delivered to the first response that occurs after a fixed period of time following the previous reinforced response. In a variable interval (VI) schedule of reinforcement, reinforcement is delivered to the first response after a varying period of time following the previous reinforced response. In a fixed-ratio (FR) schedule of reinforcement, reinforcement occurs after a fixed number of responses since the previous reinforced response. Each of these four schedules generates a characteristic type of performance. Ferster and Skinner (1957) have described in detail the typical performance of rats and pigeons under different values of these schedules, and under a number of other complex schedules which are essentially variations and combinations of these simple schedules.

Two complex schedules whose effects have been extensively described

in the basic literature are chained and tandem schedules. These two types of schedules are similar in that primary reinforcers are delivered contingent upon the completion of a number of simple schedule components. For example, one type of chained or tandem schedule might specify that the first response after each successive one-minute interval completes a FI component, and that a primary reinforcer is delivered after every third fixed-interval component completion. Chained and tandem schedules differ only in that chained schedules have a different exteroceptive stimulus associated with each component, whereas no exteroceptive stimulus changes occur in a tandem schedule. Some of the most interesting recent research on conditioned reinforcement involves comparisons of chained and tandem schedules in which tandem schedules are used as control procedures for evaluating the effects of the exteroceptive stimuli in chained schedules. Research has demonstrated that the exteroceptive stimulus associated with each component of a chained schedule is a conditioned reinforcer (reviewed by Hendry, 1969; Kelleher, 1966).

A number of studies have compared the effects of chained and tandem FI schedules on the key-pecking of pigeons. For example, Gollub (1958) showed that in chained schedules, long pauses in responding occur in the FI component farthest from primary reinforcement, while typical FI scallops (a positively accelerating rate of response with the lowest rate occurring following reinforcer delivery and the highest rate occurring just prior to reinforcer delivery) occur in the other FI components. Neither pauses or scallops occur in the FI components of comparable tandem schedules. As a result tandem schedules typically maintain much more responding than comparable chained schedules. Gollub's study suggests that the component stimuli closest to primary reinforcement in two or three component chained schedules are discriminative stimuli controlling moderate response rates in their respective

components, but are not powerful conditioned reinforcers for responding in a preceding component.

The exteroceptive component stimuli farthest from the primary reinforcer are never associated with reinforcers in chained schedules. This probably accounts for some of the differences in performance generated by chained and tandem schedules. This conclusion seems to be supported in a study by Kelleher and Fry (1962). They examined three-component FI schedules in which the stimuli associated with each FI component were manipulated. They found that if the same stimulus was present in each component (i.e., a tandem schedule), response rate was positively accelerated throughout the entire schedule. If a different stimulus was correlated with each component (i.e., a chained schedule), pauses and low response rates were apparent in the two components farthest from primary reinforcement. If a different stimulus was correlated with each component but the order of the stimuli was varied so that primary reinforcers were delivered equally often in the presence of each, the pattern of responding was positively accelerated within each component. This study emphasizes the fact that component stimuli have discriminative as well as reinforcing properties. In a chained schedule the component stimuli farthest from the primary reinforcer are never associated with the reinforcer and may discriminatively come to control low response rates. As a result, a stimulus may be a conditioned reinforcer for responding in the preceding component but response rate in that component may be low as a result of the discriminative properties of the stimulus correlated with that component.

An interesting study by Byrd (1971) examined performance on chained FI schedules when the stimulus appearing in the terminal component (the component associated with the primary reinforcer) also appeared in other components. He found that when as many as eight components comprised a

chained schedule and the stimulus appearing in the terminal component also appeared in alternate components, moderate response rates were maintained in all components in which the stimulus was present, except in the initial component in which response rate was low. He felt that this was largely due to the discriminative effects of the terminal stimulus. His results indicate that low response rates in the initial components cannot be accounted for solely in terms of the reinforcing effect of component stimuli. Response rates during the third component increased more than eight times when the schedule was increased from three to five components; and fifth component performance increased when the schedule was changed from five to seven components. Byrd concluded that response rates in a chained schedule are low in the first component regardless of the number of components, whether or not the stimulus present in the subsequent component is a conditioned reinforcer, and whether or not the stimulus present during the initial component discriminatively controls high rates in other components. This is the case provided that the number of components and order of component stimuli remain constant during successive sequences.

In general, then, it seems that response rates in chained schedules are low in the components farthest from the reinforcer as a result of stimuli not associated with the delivery of reinforcers controlling low response rates, rather than a result of component stimuli functioning as weak reinforcers. While in some chained schedules it seems to be the stimulus associated with the initial component which controls low response rates, this does not always seem to be the only stimulus involved.

Other research has examined the effects of conditioned reinforcers such as tokens and brief light illuminations in chained schedules and other complex schedules of reinforcement in which conditioned reinforcers are

contingent upon completion of schedule components and are only intermittently accompanied by primary reinforcers. The performance characteristically generated by chained schedules is similar to the performance generated by schedules in which tokens are contingent upon completion of schedule components. For example, Kelleher (1957) described performance of chimpanzees under a chained FI 5-min. schedule in which the number of FI 5-min. components required was increased from one to eight. A token was delivered contingent upon the first response after the passage of a five-minute time interval, measured from the preceding token delivery. Primary reinforcers accompanied the exchange of a fixed number of tokens (i.e., primary reinforcers were contingent upon completing a fixed number of FI 5-min. components). Kelleher found that as the number of FI 5-min. components was increased, response rate in the initial component decreased. When the schedule consisted of eight FI 5-min. components, responding in the initial component ceased entirely.

In a similar study with chimpanzees Kelleher (1958) examined the effects of a chained schedule which consisted of fifty FR 125 components. A token was delivered contingent upon each subsequent one hundred and twenty-fifth response and primary reinforcement occurred after the exchange of fifty tokens. Kelleher found that responding was sporadic with frequent pausing until a number of tokens had been obtained. This initial pausing could be eliminated by giving the chimpanzee fifty free tokens (which were later exchanged for primary reinforcers) at the start of the schedule. In general, the performance generated by these token schedules is similar to the performance generated by other chained schedules. In token schedules, however, it is the accumulation of tokens which provide the stimulus change defining a chained schedule, and for token trained organisms the number of tokens in possession is a powerful controlling stimulus. The conditions which exist

prior to the delivery of the first few tokens are conditions which immediately follow the consumption of reinforcers and are quite dissimilar from the conditions associated with the delivery of primary reinforcers. As a result, these conditions seem to control low response rates discriminatively.

The typical performance generated by token schedules is not apparent in similar schedules when conditioned reinforcers which do not accumulate, as do tokens, are used. Several studies have utilized a brief change in some exteroceptive stimulus as a conditioned reinforcer. Stimuli such as these (e.g., the brief illumination of a light), because of their transient nature, are less likely than tokens to acquire discriminative functions. There is considerable evidence that when brief conditioned reinforcers are made contingent upon the completion of FI and FR schedule components, rate of responding is increased. Such conditioned reinforcers maintain what otherwise is often weak behavior without the pausing and low rates that typify token-schedule performances. For example, Findley and Brady (1965) examined the effects of brief conditioned reinforcers in an FR 4000 schedule with chimpanzees. In one condition the hopper-light which illuminated the food tray was illuminated only when reinforcers were delivered (i.e., after 4000 responses) while in a second condition a brief hopper-light illumination was contingent upon every four-hundredth response as well as when primary reinforcers were delivered. They found that post-reinforcement pauses were shorter and less time was taken to complete the ratio in the condition in which the hopper-light occurred after every four-hundredth response. In short, performance was enhanced in the condition in which brief conditioned reinforcers were periodically contingent upon correct responses.

In a similar study, Kelleher (1963) described the effects of a chained FI 4-min. schedule which consisted of fifteen FI 4-min. components.

A light-flash was contingent upon the completion of each FI 4-min. component and primary reinforcement accompanied every fifteenth component completion. He found that when the light-flash also accompanied primary reinforcement, the scalloped pattern of responding in each FI 4-min. component resembled food-reinforced FI responding. If the light flash did not accompany primary reinforcement, response rates were lower in all components and the typical FI patterning was no longer apparent. Thus it seems that brief conditioned reinforcers can often result in enhanced performance in chained FR and FI schedules. Similar effects are not evident in comparable schedules when conditioned reinforcers seem discriminatively to control low response rates when the likelihood of primary reinforcement is low. Brief conditioned reinforcers on the other hand, produce patterns of responding like those maintained by similarly scheduled primary reinforcers. This often results in chained schedule performance which is superior to that produced by chained schedules in which no conditioned reinforcers are utilized or in which conditioned reinforcers which accumulate are utilized.

Another type of enhancing effect of brief conditioned reinforcers is demonstrated in a study involving a more complex discrimination task with pigeons. Stubbs and Galloway (1970) trained pigeons to peck a centre key and then to peck a right or left side key depending on the stimulus produced on the centre key. In one condition each correct response to a side key produced a brief illumination of the hopper-light and the illumination of the hopper-light was periodically accompanied by the delivery of primary reinforcers. In a second condition, correct responses did not produce light illuminations. Primary reinforcers were delivered according to a variety of simple schedules in both experimental conditions. Regardless of the schedule of primary reinforcement, the addition of the light-flash resulted in higher response

rates and greater accuracy than occurred when light-flashes were not contingent upon correct responses. As well as producing increased response rates then, it seems that brief conditioned reinforcers can improve accuracy of responding on complex discrimination tasks.

Research on Conditioned Reinforcers in Applied Settings

While the basic literature suggests a number of rules for the effective use of conditioned reinforcers, even the most fundamental questions cannot be confidently answered with respect to the effective use of conditioned reinforcers in applied training procedures.

The present research is primarily concerned with the application of conditioned reinforcers to the training of the mentally retarded. In recent years, behavior principles derived from the basic experimental analysis of behavior have been used to develop a variety of procedures for training the mentally retarded. Conditioned reinforcers have proven important in these procedures because of their advantages over primary reinforcers. For example, many conditioned reinforcers can be presented immediately and in small amounts, unlike most primary reinforcers. In addition, conditioned reinforcers are less likely than primary reinforcers to lose their effectiveness over long training sessions because of satiation. These and other advantages have resulted in the wide-spread use of conditioned reinforcers in applied settings, and in the development of elaborate token economies in which tokens are delivered contingent upon specified behavior and are ultimately exchanged for a variety of reinforcers (see Ayllon and Azrin, 1968).

Despite the wide-spread use of conditioned reinforcers in applied settings, very little is known about their effects. In mental retardation, as in many other areas, little fundamental research has been conducted to

determine the conditions sufficient for establishing conditioned reinforcers, the most effective schedules of pairing conditioned and primary reinforcers, and the most effective types of conditioned reinforcers in applied settings.

One study which did examine the conditions sufficient for establishing conditioned reinforcers was conducted by Lovaas, Frietag, Kinder, Rubenstein, Schaffer, and Simmons (1968). They initially established "good" as a stimulus in the presence of which a psychotic child received a bite of food independent of his behavior. They were then able to strengthen and maintain lever pressing with "good" as the only reinforcer. They found that "good" retained its control of lever pressing so long as "good" continued to be paired with food delivery in the lever-press situation. In a similar study, Reynolds and Risley (1968) described the conditions under which adult attention would function as a reinforcer. They found that they could increase a four-year-old child's rate of talking if they attended to the child verbally when she talked, and paired this attention with other reinforcers. Adult attention lost its reinforcing properties when it was presented in the absence of primary reinforcers for some time. Studies such as these, in which some aspect of conditioned reinforcers is the specific variable of interest, are quite rare in the applied literature. In recent research with retarded children at the St. Amant Centre in Winnipeg, Manitoba, two research topics related to conditioned reinforcers - the effects of different schedules of pairing primary and conditioned reinforcers and the effects of different types of conditioned reinforcers - have been examined.

The schedule of pairing of primary and conditioned reinforcers is one aspect of conditioned reinforcers that has received relatively little attention to date. If conditioned reinforcers are to be used for extended periods of time (e.g., verbal training procedures), they must periodically be

accompanied by primary reinforcers in order for their reinforcing properties to be maintained. It is very common in many training procedures for this accompaniment to occur on a one-to-one ratio; i.e., primary reinforcers accompany every presentation of the conditioned reinforcer. This was the case in the following studies which involve intensive training procedures for generating appropriate verbal behavior in retarded and autistic children: Barton (1970), who described a procedure for generating appropriate verbal answers to questions in a child who exhibited bizarre speech; McReynolds (1969), who examined the effects of brief time-outs on jargon and errors during a verbal imitation training procedure with retardates; Sailor and Taman (1972), who examined the effects of using the same or different stimuli in a procedure for training prepositional usage in autistic children; and, Whitman, Zakaras, and Chardos (1971), who described a procedure for training retardates to respond appropriately to simple instructions. Such usage does not attempt to capitalize on the potential advantages that conditioned reinforcers have over primary reinforcers.

While many training procedures require presentation of the conditioned reinforcer after each correct response, primary reinforcers need not accompany every presentation of the conditioned reinforcer. The basic literature (e.g., Weissman and Crossman, 1966; Zimmerman, 1957, 1959) suggests that if a primary reinforcer only intermittently accompanies the conditioned reinforcer, the likelihood of satiation is decreased and the durability of the conditioned reinforcer is increased. Recent research at the St. Amant Centre supports this conclusion. Stephens, Pear, Wray, and Jackson (in press) examined the effects of different values of FR schedules of primary reinforcement on the picture-naming behavior of retarded children. As in the previously mentioned applied studies, praise (i.e., "good boy") was contingent upon each

correct verbal response. On the other hand, primary reinforcers (small sugar coated chocolate candies) for correct responses were delivered intermittently according to an FR schedule. In other words, the frequency of pairing of the primary and conditioned reinforcers was determined by the value of the FR schedule in effect. It was found that the children learned to name the most pictures and emitted the most correct responses at FR values intermediate between FR 1 and the FR value at which each child's behavior extinguished. (Specifically, the best performance occurred between FR 10 and FR 15.) This suggests that the schedule according to which primary reinforcers accompany conditioned reinforcers must be studied if maximally effective training procedures are to be developed.

Similarly, other aspects of primary and conditioned reinforcers need to be investigated to optimize current training procedures. One aspect studied at St. Amant Centre concerns the effects of two different types of conditioned reinforcers: tokens and verbal praise. Tokens and verbal praise are the conditioned reinforcers most commonly used in procedures for training the mentally retarded. At present, however, there is no empirical basis for choosing one over the other. In many training procedures these conditioned reinforcers are used together on a one-to-one ratio, as in the following studies representative of the mental retardation literature: Bennet and Ling (1972), who described a procedure for teaching sentence-form answers to questions; Burgess, Burgess, and Esveldt (1970), who studied the generalization of imitative verbal responses from English to Spanish when only English responses were reinforced; Dalton, Rubino, and Hislop (1973), who examined the effectiveness of a token economy in producing improvement in the academic performance of children with Down's syndrome; Fjellstedt and Sulzer-Azaroff (1973), who described the effects of a token system on reducing latency of

direction following; Guess and Baer (1973), who examined the generalization of pluralization rules between the receptive and productive language modalities; Schumaker and Sherman (1970), who described a procedure for teaching use of appropriate verb tenses in retardates and examined generalization to untrained verbs; Stolz and Wolf (1969), who described a procedure for teaching a color discrimination to a functionally blind male retardate; and Wheeler and Sulzer (1970), who described a procedure for teaching a particular sentence form to a speech-deficient retarded child. It is possible however that when used alone, one of these conditioned reinforcers might prove more effective than the other.

A recent experiment (Stephens, 1974) at the St. Amant Centre investigated this possibility. In this experiment the effects of praise and tokens, as they are customarily used as conditioned reinforcers, were compared in a picture-naming task with retarded children. In one experimental condition praise (i.e., "good boy") was contingent upon each correct response. In the other experimental condition a token was contingent upon each correct response. Primary reinforcers were delivered according to the same schedule in both experimental conditions. Specifically, primary reinforcers accompanied the return of five tokens or the fifth occurrence of "good boy" in some phases, and accompanied the return of ten tokens or the tenth occurrence of "good boy" in other phases. In general, the children learned to name more pictures, emitted more correct responses, and spent less time engaging in inattentive behavior in the praise condition.

While the comparison of tokens and praise is useful with respect to developing effective training procedures, it is impossible to determine precisely what factors were responsible for the differences in performance in the praise and token conditions. There were at least four differences

between the conditions which could account for the differences in performance.

The first difference between tokens and praise was in the sensory modalities that they stimulated. Praise was primarily auditory and visual while tokens were primarily tactile and visual.

The second difference between tokens and praise was in the administration of primary reinforcers. In the token condition the subjects were required to return the tokens in exchange for a primary reinforcer. No comparable exchange response was required in the praise condition. The exchange response in the token condition could have affected performance in two ways. First, the exchange response required a period of time during which pictures could not be presented. No similar expenditure of time occurred in the praise condition. Thus there was less time available in token sessions to emit correct responses, to make errors, and to be inattentive. Second, the manipulation of tokens by the subject, necessitated by the required exchange response, probably increased the likelihood that the subjects would attend to the tokens (attend in the sense that tokens would acquire stimulus control over a subsequent response). Thus the differences in performance in the praise and token conditions might have been due to the subjects' attending more to tokens than to praise (i.e., the difference might have been due to the fact that tokens acquired discriminative properties that praise did not. Specifically, tokens might have discriminatively controlled low response rates.)

The third difference between tokens and praise which could account for the differences in performance is that tokens accumulated until they were exchanged while praise did not. The number of accumulated tokens provides discriminative cues to the likelihood of primary reinforcers. No parallel process occurs with praise. Previously mentioned basic research (e.g., Findley

and Brady, 1965; Kelleher 1957, 1958, 1963; and Stubbs and Galloway, 1970) indicates that schedules in which conditioned reinforcers accumulate (e.g., tokens) produce responding that is typically sporadic with frequent pausing until a number of tokens have been obtained. Furthermore, the pausing and low rates of responding that characterize performance on token schedules do not occur when a brief change in some exteroceptive stimulus serves as the conditioned reinforcer. The conditions which exist prior to the delivery of the first few tokens are quite dissimilar from those associated with primary reinforcers and as a result seem to function as discriminative stimuli for low response rates. Conditioned reinforcers such as a brief change in some exteroceptive stimulus, because of their transient nature, are less likely to acquire these discriminative functions. Thus the differences in performance in the token and praise conditions could be a result of the fact that tokens accumulated and as a result were more likely than praise to acquire discriminative functions.

The final difference between tokens and praise was that in the praise condition the stimuli contingent upon each correct response (i.e., "good boy") also accompanied primary reinforcers. In the token condition, however, the stimuli which were associated with primary reinforcers (i.e., the delivery of a fifth or tenth token) were not identical to the stimuli contingent upon other correct responses (i.e., the delivery of a first, second, third, or fourth token). As a result, possibly only the fifth and tenth tokens (depending on the schedule of primary reinforcement) acquired reinforcing value. Any differences in the token and praise condition, then, might have been a result of verbal praise being a more powerful conditioned reinforcer than the delivery of tokens not associated with primary reinforcers. Superior performance might not have occurred in the praise condition if "good boy" had

accompanied primary reinforcers and some other stimulus had occurred after correct responses not followed by primary reinforcers.

Any one or combination of the above factors could account for the differences in performance between the praise and token conditions. As Baer, Wolf, and Risley (1968) have advocated, applied behavior analysis should attempt to analyze effective procedures into their effective components. In other words, it is ultimately more useful to determine the effects of individual variables than to determine the effects of procedures which involve a number of variables. To do this in the present context would require a comparison between conditioned reinforcers which differ with respect to only one of the above factors.

Statement of the Problem

The basic literature suggests that in FR and FI schedules of primary reinforcement, brief conditioned reinforcers which do not accumulate (e.g., a light-flash) produce higher overall response rates than conditioned reinforcers which do accumulate (e.g., tokens). These findings received support in an applied study (Stephens, 1974) with retarded children which compared the effectiveness of tokens and praise as conditioned reinforcers in a picture-naming task. Tokens and praise, however, differed with respect to a number of variables which could have accounted for the differences in performance in that comparison. The purpose of the present research was to compare the effects of two conditioned reinforcers which differed only in that one accumulated while the other did not. Specifically, lights which were illuminated sequentially in a row (analogous to the accumulation of tokens) were compared to light-flashes (analogous to praise) as conditioned reinforcers in a picture-naming task with retarded children. This comparison was made at

two different values of an FR schedule.

In addition, to increase the likelihood that the children attended to both sequential lights and light-flashes, a specific response (additional to picture-naming responses) was required to produce primary reinforcers in some experimental phases. In short, light illuminations were simply paired with the delivery of primary reinforcers in some experimental phases whereas in other phases children were required to emit a specific response subsequent to light illuminations in order to produce primary reinforcers.

CHAPTER II

METHOD

Subjects

The subjects were three severely retarded male residents at the St. Amant Centre. The children used in this research were chosen for the following reasons:

- 1) They imitated verbal responses of the experimenter. For example, if the experimenter said, "ball", the child would emit the response "ball."
- 2) Each child had limited Picture-naming repertoires as determined by a standardized word-baseline procedure. Their limited picture-naming repertoires in combination with their ability to imitate verbal responses made these children suitable subjects for picture-naming training.

All three subjects served in previous research which involved a comparison of tokens and praise as conditioned reinforcers in a picture-naming task (Stephens, 1974). As a result, they were familiar with some aspects of the present procedure. While none of the subjects were experimentally naive, all had different experimental histories.

Gary was six years old, diagnosed as severely retarded, and had been hospitalized for two years at the time this research was initiated. He was institutionalized because of his extreme hyperactivity and complete lack of verbal behavior. For one year prior to this research, Gary had been involved in a behavior modification speech program and had served as a

subject in the previously mentioned experiment involving a comparison of tokens and praise as conditioned reinforcers in a picture-naming task.

Sidney was seven years old, diagnosed as severely retarded, and had been hospitalized for four years at the time this research was initiated. He had a history of seizures at an early age and was admitted because of his extreme hyperactivity and disruptive behavior. Sidney had a long history of refusing to eat meals. At mealtime he would emit such violent tantrums that three people were required to feed him. For this reason, the child was introduced into a behavior modification program approximately two years prior to this research. Self-feeding was established and subsequently Sidney served as a subject in two experiments. He was first a subject in a study comparing continuous, FR, and interlocking schedules of reinforcement in a picture-naming task (Stephens, Pear, Wray, and Jackson 1974), and was a subject in a comparison of tokens and praise as conditioned reinforcers in a picture-naming task.

Alec was eight years old and had been hospitalized for three years prior to this research. He was diagnosed as having Down's syndrome and was institutionalized for that reason. In addition to serving as a subject in the comparison of tokens and praise, he had previously served in an experiment which compared the effects of different teacher-subject ratios on picture-naming behavior (Biberdorf, 1974).

Apparatus

The research was conducted in a specially constructed operant conditioning research area in the St. Amant Centre. The cubicle used in this research was approximately 10 feet long and 8 feet wide and 10 feet high. It contained a low counter along one wall, a low child-sized table, three

child-sized chairs, and a Lehigh Valley Electronics Modular Human Intelligence System (#502-02). A one-way mirror and a small hole through which power cables passed were located in the wall between the experimental room and an adjacent equipment room. Subjects were seated behind the table opposite the experimenter. The table was placed with one edge adjacent to the counter such that when the subject was seated the counter was positioned to his immediate left. The Human Intelligence System was located on this counter within easy reach of the subject.

The Human Intelligence System consisted of six removable panels of which only two were operative during experimental sessions. The two operative panels were a candy dispenser panel for dispensing sugar coated chocolate candies ("Smarties"), and a stimulus-response panel containing two translucent response keys which could be illuminated by colored lights behind the keys. A rectangular metal box (12 inches x 4 inches x 4 inches) containing a lever and a row of ten red lights to be used as conditioned reinforcers was located on the table in front of the subject. The lights were approximately one half inch in diameter and protruded one half inch from the surface of the metal box. The operation of these lights and the Human Intelligence System was programmed by a digital logic system built to specification by DRT Associates (Winnipeg, Canada) and by electromechanical programming equipment from Lehigh Valley Electronics. The programming and recording equipment was housed in an adjacent cubicle. Two silent switches, one for counting correct responses and the other for operating an inattention timer, were held by the experimenter.

The picture cards used were selected from a Peabody Learning Kit. One "Smartie" was delivered contingent upon a correct verbal response according to the schedule of primary reinforcement in effect in a given

experimental phase. "Smarties" were chosen as the primary reinforcer on the basis of previous experience which indicated that the consumption of these candies was not incompatible with verbal responding. In addition, a one ounce cup of orange or apple juice, presented by the experimenter, accompanied the delivery of every fifth candy.

General Experimental Procedures

Preliminary Training. Prior to conducting research of this type it is necessary to ensure that the children have been taught to sit quietly, to imitate words, and to name pictures. These behaviors were originally established with procedures similar to those described by Martin, England, Kaprowy, Kilgour, and Pilek (1968), and were subsequently maintained in the studies in which each subject participated.

Attending. Often in research of this type, trials are initiated only when the subject is attending. This is done in order to avoid the possibility of reinforcing inattentive behavior on the part of the subject. Usually the subject is said to be attending when he makes eye-contact with the experimenter (e.g., Kircher, Pear, and Martin, 1971; Martin, Moir, and Skinner, 1969). In order to avoid in this experiment the possibility of experimenter bias which may exist when attending is defined as "eye-contact", a more objectively defined attending response, similar to that used by Stephens, Pear, Wray, and Jackson (1974) was required. Specifically, an attending response was defined as the depression of a translucent response key a sufficient distance to close a microswitch causing the offset of a colored light behind the key.

During the study, the experimenter sat with the appropriate pictures face down in front of him across from the child. At the start of

the session, the experimenter pressed a hand held switch which illuminated two response keys and started an inattention timer which was located in the room housing the programming equipment and therefore was not visible to the child. In order to have a picture presented to him, the child was required to emit a key press response of sufficient force to turn off the key lights. In one experimental condition the response keys were illuminated by a green light and in the other experimental condition the response keys were illuminated by a red light. When the response keys were illuminated by a green light only a response to the right key would turn off the key lights. When the response keys were illuminated by a red light only a response to the left key would turn off the key lights. A response to the appropriate key turned off the attending lights (key lights) and stopped the inattention timer, at which point the experimenter immediately presented a picture. The experimenter pressed his switch to turn on the attending lights and restart the timer immediately after the child had responded to the picture or after five seconds had elapsed with no response. The onset of the attending lights marked the beginning of each trial.

Inattention time, which was automatically recorded by the timer, was defined as the total amount of session time in which the attending lights were illuminated. The offset of the attending lights and the presentation of a picture were the only consequences of key pressing. Key presses while the attending lights were off (i.e., while a picture was being presented) had no programmed effect. While the attending lights were illuminated, the experimenter simply waited and watched for the child to turn off the lights. As a result, the number of picture presentations or trials per session was determined by the subject.

In order to establish the attending response, the experimenter held

the picture beside the response keys during the preliminary training sessions and verbally prompted (i.e., said "Press the button.") the child to press the key. When the subject did so, the experimenter turned the card so that the picture was facing the subject and said, "What's that?" If the subject correctly named the picture, he was reinforced. Pictures were used that the subject could name to increase the probability of correct responses. Incorrect responses were ignored (i.e., the experimenter made no comment). Over several trials the verbal prompts to press the key were faded out and the position of the picture was gradually changed until it was held face down directly in front of the experimenter. After a number of sessions it was observed that the children often pressed the appropriate key when the attending lights were illuminated and rarely pressed it when the lights were not illuminated. In addition, it was observed that when the children had pressed the appropriate key they also tended to emit some verbal response to the subsequently presented picture. Instances in which the subject pressed the key and did not respond to the picture were very infrequent. These informal observations suggested that the attending light and picture presentations exerted adequate control over the attending response.

Misbehavior. Typically in research of this type a number of behaviors have been classified as misbehavior either because they compete with attending responses or because they are extremely disruptive. Punishment is then usually made contingent on these behaviors (e.g., Kircher, Pear, and Martin, 1971). This experimenter felt, however, that it would be inappropriate to study the effects of conditioned reinforcers against a background of punishment. The administration of punishers on inattentive behavior might confound the effects of the conditioned reinforcers on this class of behavior. Thus, the following procedures previously employed in a similar study by

Stephens (1971) were adhered to throughout the experiment:

1. No punishment was made contingent on inattentive behaviors or disruptive behaviors. The subjects could turn in their seats, stand up, bang on the table or equipment, play with the curtains behind them, etc. In general, they could emit almost any behavior as long as they remained across the table from the experimenter.
2. The physical environment was arranged such that there was little opportunity for the subject to obtain destructible items or apparatus crucial to conducting the experiment. The only objects on the table were the picture being currently presented, one data sheet, and the box containing ten stimulus lights and a lever. The subject was seated with the back of his chair against the wall and the table within six inches of his chest. This restricted the reach of the subject to those items located on the table. The experimenter held the data sheet on the table by resting one arm on it. The picture being used was held in the other hand. If the child attempted to obtain these items the experimenter simply kept a firm grip and did not attend to the child. The panel containing the stimulus lights was placed in the centre of the table at the start of each session. The subjects were allowed to position the panel anywhere on the table but were not allowed to lift it from the table. As soon as the child began to lift the panel the experimenter placed one hand on it to prevent the behavior but did not attend to the child in any other way. The experimenter removed his hand as soon as the child stopped attempting to lift the panel. Attempts to obtain the items on the table or to lift the stimulus-response panel soon extinguished. During all but the initial sessions of the experiment, these behaviors were extremely infrequent.

3. The only behaviors punished were those which would remove the subject from the contingencies of reinforcement in effect during experimental sessions. In this research, the only behaviors which satisfied this criterion were attempts to leave the experimental situation. While the children were allowed to stand and move behind the table, they were not allowed to walk past the corner of the table. If they did so, the experimenter said, "No!" and reached across the table and firmly seated the child. Only one of the three subjects attempted to leave the table and this behavior occurred on only two occasions.
4. Because the presentation of pictures always occurred just prior to the delivery of reinforcers it is possible that picture presentation acquired the status of a conditioned reinforcer. If so it could be argued that pictures should be presented only while the subject was sitting quietly, to prevent strengthening of "misbehaviors" which might occur along with key pressing. Without denying the possible validity of this argument, the experimenter nevertheless presented pictures contingent on a key press regardless of the other behavior of the subject. It was felt that if misbehavior influenced the number of pictures presented, this could confound the effects of the conditioned reinforcers examined. For example, if one conditioned reinforcer produced more emotional behaviors than another, and if the experimenter did not present pictures to the subject while he was engaging in these behaviors, then the dependent variables could be affected in a way that would not be a direct result of the independent variables per se, but rather a result of the differential presentation of pictures.
5. While waiting for the subject to press the lever, the experimenter did not attend to him. The experimenter looked off to the side at the

subject's attending lights to ensure that his (the experimenter's) attention would not reinforce undesirable behavior on the part of the subject.

Picture-naming baseline. Since the experiment involved a comparison of the effects of two experimental conditions on picture-naming behavior, it was necessary to determine beforehand the picture names that each child could pronounce and the pictures that each child could name. This was done to ensure that any differences in picture-naming behavior in either experimental condition were a result of the independent variables investigated, rather than a result of the pictures in one condition being known prior to the experiment or the picture names not being pronounceable in one condition. In order to ensure that all pictures to be taught were unknown and pronounceable, the following steps were taken.

1. Contingent upon a key press response, the experimenter presented a picture and said, "What's that?"
2. If the child correctly named the picture the experimenter said, "Good boy," and proceeded to the next picture. If the child did not correctly name the picture the experimenter said, "What's that? A _____ (name of picture):" If the child correctly imitated the picture name, the experimenter said, "Good boy," and proceeded to the next picture. If the picture name was not correctly imitated, that picture was discarded from the experiment.
3. A large set of pictures was presented as above once each day, on three consecutive days. As shown in Figure 1, pictures that were correctly named without prompts on all three occasions were called known pictures. Pictures that were not correctly named but whose names were correctly imitated on all three occasions were called unknown pictures. All other

pictures were discarded from the experiment. During these procedures every fifth "Good boy" was accompanied by the operation of the candy dispenser and the delivery of a candy.

Pictures categorized as known and unknown were then randomly divided into two pools. One pool of unknown pictures was taught according to the contingencies of reinforcement associated with the sequential light condition, and the other pool of unknown pictures according to the contingencies of reinforcement associated with the light flash condition. When the unknown pictures from a word baseline were nearly depleted as a result of being learned during the experiment, additional baselines were taken according to the above procedures and new unknown and known pictures were selected. During training the presentation of unknown pictures was interspersed with the presentation of known pictures selected from the same pool.

Picture-naming procedure. The procedure used for teaching the children to name pictures was similar to that described by Stephens (1971). In general, the procedure for teaching an unknown picture required the child to name each unknown picture on a number of occasions when presentations of the unknown picture were systematically interspersed with presentations of three known pictures (to ensure that correct responses were under the control of the appropriate stimulus, i.e., the unknown picture) drawn from the same pool (see above) as the unknown picture. A sample daily session sheet for the picture-naming procedure is shown in Figure 2 and a schematic representation of the picture-naming procedure in Figure 3. The specific procedure involved the following steps:

1. The experimenter presented a randomly chosen unknown picture and said, "What's that? A _____ (name of picture)." This was called a prompt trial. If the child imitated the name incorrectly or

Subject: _____ Dates: _____

Symbols: correctly imitated - P
 correctly named - 1
 incorrectly imitated - X

<u>Picture</u>	<u>Trial</u>			<u>Final Picture</u>
	<u>1</u>	<u>2</u>	<u>3</u>	<u>Category</u>
ball	1	1	1	known
car	P	P	P	unknown
house	1	P	P	discarded
doll	P	X	P	discarded
tree	X	X	X	discarded
baby	1	1	P	discarded
tent	1	1	X	discarded

Figure 1. Sample baseline sheet for determining known and unknown pictures.

failed to respond vocally within five seconds of the prompt, the experimenter repeated step 1 on the next trial. If the child correctly imitated the name, the experimenter proceeded to step 2 on the next trial.

2. The experimenter presented the same unknown picture and said, "What's that?" This was called a question trial. If the child incorrectly named the picture or did not respond within five seconds, the experimenter returned to step 1 with the same picture on the next trial. If the child correctly named the picture the experimenter proceeded to step 3 on the next trial.
3. When step 2 was completed successfully, the procedure in steps 1 and 2 were followed on a randomly selected known picture.
4. When step 3 was completed successfully, two more question trials each were given for the unknown and the known pictures. The sequence of presenting the unknown and known pictures was varied over successive renditions of step 4 to prevent the children from learning the order of presentation of pictures.
5. Steps 1 - 4 were repeated twice more with the same unknown picture and a second and third known picture.
6. Steps 1 - 5 were carried out for another randomly selected unknown picture.

When steps 1 - 5 had been completed successfully for an unknown picture, that picture was said to have "reached criterion". (Thus, it took a minimum of 24 correct imitation and naming responses, 12 for the unknown picture and 12 for the three known pictures, for an unknown picture to reach criterion.) Once an unknown picture reached criterion it was then tested (with a question trial, only) at the beginning of the next three consecutive

Subject: _____ Experimenter: _____

Date: _____ Time: _____

NW: _____ NW: _____

Step	Step 5					
↑	NW P		NW P		NW P	
↓	NW Q		NW Q		NW Q	
↓	KW ₁ P		KW ₂ P		KW ₃ P	
↓	KW ₁ Q		KW ₂ Q		KW ₃ Q	
↓	NW Q		KW ₂ Q		KW ₃ Q	
↓	NW Q		NW Q		NW Q	
↓	KW ₁ Q		KW ₂ Q		NW Q	
↓	KW ₁ Q		NW Q		KW ₃ Q	

NW P		NW P		NW P	
NW Q		NW Q		NW Q	
KW ₁ P		KW ₂ P		KW ₃ P	
KW ₁ Q		KW ₂ Q		KW ₃ Q	
KW ₁ Q		NW Q		NW Q	
KW ₁ Q		KW ₂ Q		KW ₃ Q	
NW Q		KW ₂ Q		NW Q	
NW Q		NW Q		KW ₃ Q	

Symbols

NW
P - unknown (new) word, prompt trial

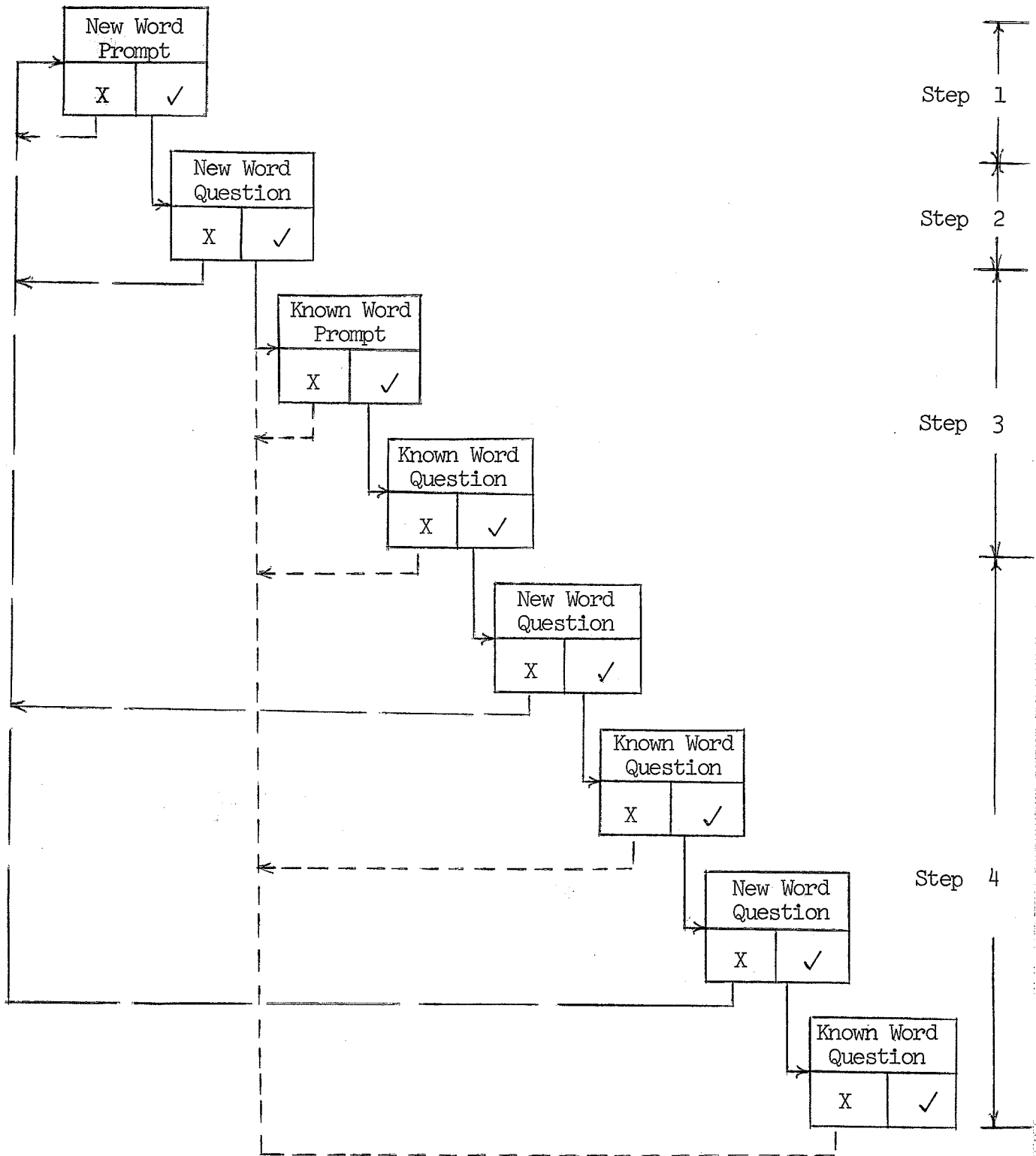
NW
Q - unknown (new) word, question trial

KW
P - known word, prompt trial

KW
Q - known word, question trial

Figure 2. Daily session sheet for the picture-naming procedure.

Steps 1 - 5 are discussed fully in the text under the heading, Picture-Naming Procedure.



Symbols

- X - incorrect imitative or naming response or response omission.
- ✓ - correct imitative or naming response.

Figure 3. Schematic Representation of Steps 1 - 4 of Picture-Naming Procedure

sessions in the experimental condition in which it had reached criterion. If the child correctly named the picture on these three occasions it acquired the status of a "learned picture". If it was incorrectly recalled on any of these occasions it was returned to step 1 and the procedure was repeated. An unknown picture was discarded from the experiment and another unknown picture presented if the former did not reach criterion within six sessions, or if it reached criterion six times without being learned.

Specific Experimental Procedure and Phases

The experiment consisted of a comparison of two procedures for teaching children to name pictures, differing only in the type of conditioned reinforcer used in each procedure. Two twenty minute sessions, separated by a ten minute recess, were conducted each day with each child. In one session, sequentially illuminated lights were contingent upon correct responses while in the other session, light-flashes were contingent upon correct responses. The order of these sessions was alternated from day to day. A different attending-response key and key color were associated with each experimental condition. In the sequential light condition the response keys were illuminated by red lights and a picture was presented contingent upon an attending response on the left key. Responses on the right key had no effect. In the light-flash condition the response keys were illuminated by green lights and a picture was presented contingent upon an attending response on the right key. In these sessions responses on the left key had no effect.

At the start of each session in both experimental conditions the experimenter pressed a button which illuminated the attending keys and activated an inattention timer. An attending response on the appropriate key turned off the key lights, stopped the inattention timer, and resulted in

the immediate presentation of a picture. The key lights were illuminated and the inattention timer activated by the experimenter immediately following a correct or incorrect response to the picture presented. If the child failed to respond to a prompt or question within five seconds the key lights and inattention timer were automatically activated by the logic system. Thus, the onset of the key lights can be considered the beginning of a trial. The number of trials per session then, was determined by the subject (i.e., if the subject pressed the appropriate attending key only once, the session would consist of one trial, and so on).

A candy was delivered after every fifth correct response (i.e., an FR 5 schedule) in some phases and after every tenth correct response (i.e., an FR 10 schedule) in other phases. The schedule of primary reinforcement in the sequential light condition and the light-flash condition was always identical within each phase. In both experimental conditions every fifth candy was accompanied by the delivery of a one-half ounce cup of juice. The juice was delivered in a half-full one-ounce plastic cup and was placed directly in front of the subject immediately after each fifth candy was dispensed.

The subject was not required to return the cup. Generally, empty cups were simply left on the table. The experimenter did not require the subject to consume either the candies or the juice. The inattention timer and key lights were activated simultaneous with reinforcer delivery. It was not unusual for the subjects to consume reinforcers while emitting attending and verbal responses or to collect a number of reinforcers before consuming them.

The specific procedures used in the various phases of the study were as follows:

Phase 1. An FR 5 schedule in which five correct responses were

required for primary reinforcement was in effect in both the sequential light condition and the light-flash condition during Phase 1. In the sequential light condition, continuously illuminated lights were contingent upon each correct imitative or naming response. The experimenter pressed a silent hand held button immediately following each correct response. Each button press illuminated a light on a panel in front of the subject. The panel contained a row of ten lights, half of which were not operative during this phase. (These lights were always illuminated from left to right - from the subject's point of view.) Contingent upon the first correct response, the sixth light from the left was illuminated and remained on. Contingent upon the second correct response the seventh light from the left was illuminated and remained on. This sequential illumination continued from left to right following correct responses until five lights were illuminated. One second after the fifth light was illuminated all five lights went off and a candy was automatically dispensed. This sequence of light illuminations and reinforcer delivery was repeated following subsequent correct responses until the session ended. If the child emitted an incorrect response or failed to respond within five seconds of a prompt or question, no change occurred in the number of lights illuminated. In other words, there were no consequences scheduled for errors or response omissions, other than the illumination of the subject's attending keys and activation of the inattention counter. As well as being recorded by the logic system, correct responses and errors in both experimental conditions were recorded on the data sheet (see Figure 2) immediately after each inattention period commenced.

In the light-flash condition correct responses and errors were defined and treated the same as in the sequential light condition except that light-flashes, rather than continuous light illuminations, were contingent

upon correct imitative and naming responses. The experimenter pressed a silent hand-held button immediately following each correct response. Each button press illuminated five lights on the panel in front of the subject for one second. (The lights were the same as those used in the sequential condition - the five lights on the right half of the panel.) A candy was automatically dispensed accompanying the offset of each fifth flash of the row of five lights. As in the sequential condition there were no consequences scheduled for errors or response omissions. In both experimental conditions then, the same event (the offset of the same five lights) immediately preceded the delivery of primary reinforcers. The only difference between the conditions was that, contingent upon correct responses, the lights flashed briefly (analogous to "good boy") in one condition, whereas they were illuminated sequentially and accumulated (analogous to tokens) in the other condition. This phase lasted 27 sessions in each condition for Gary, 19 for Sidney and 21 for Alec.

Phase 2. During Phase 2 it was possible that the children did not attend to the lights and as a result the lights may not have acquired conditioned reinforcing properties in either condition. In order to increase the likelihood that the children attended to the lights (i.e., to increase the likelihood that the lights would acquire control over behavior), a lever-press response was required to produce primary reinforcers after every fifth correct response in both experimental conditions during Phase 2. The lever for this response was mounted directly below the tenth light from the left on the panel in front of the child. In the sequential light condition one light was illuminated contingent upon each correct response and remained on. This procedure was identical to the procedure used in Phase 1 except that after the fifth light was illuminated, it remained on. The first lever

press after all five lights were illuminated operated the candy dispenser and turned off the lights. In the light-flash condition all five lights were illuminated for one second contingent upon each correct response, as in Phase 1. However, the lights remained illuminated after each fifth onset. The first lever press subsequent to this continuous illumination operated the candy dispenser and turned off the lights. In both conditions then, the same event (i.e., a lever press in the presence of five illuminated lights) immediately preceded the delivery of each primary reinforcer. Lever presses at other times had no effect. The experimental conditions were identical in Phase 1 and Phase 2 in all other respects.

The lever-press response was established in one training session immediately following Phase 1. The children were verbally prompted to "press the lever" when all five lights were illuminated. All subjects acquired the response after only two or three prompts and the subsequent reinforcer deliveries. Phase 2 began on the day following this lever training. It was also specified that if during experimental sessions the subjects failed to press the lever within five seconds of the illumination of all five lights, the experimenter would press the lever himself and remove the candy subsequently delivered. However, since none of the children ever failed to press the lever within five seconds of the illumination of all five lights, this contingency was never encountered. Phase 2 lasted 24 sessions in each condition with Gary, 27 with Sidney, and 20 with Alec.

Phase 3. This phase consisted of a reversal to the conditions of Phase 1, in order to access the effects of the lever pressing requirement in Phase 2. In other words, in this phase the subjects were no longer required to press the lever (although the lever was not removed) in order to produce primary reinforcers. As in Phase 1, a candy was automatically dispensed

accompanying the offset of each fifth flash of the row of five lights in the light-flash condition, and one second after the fifth light was illuminated, accompanying the offset of all five lights, in the sequential light condition. This phase lasted 8 sessions in each condition for Gary, 11 sessions for Sidney, and 13 sessions for Alec.

Phase 4. This phase consisted of a return to the conditions of Phase 2. In other words, in both experimental conditions a lever-press response was required to produce primary reinforcers. In the sequential light condition, the first lever-press after all five lights were illuminated operated the candy dispenser and turned off the lights. In the light-flash condition, the lights remained illuminated after each fifth onset. The first lever-press subsequent to this continuous illumination operated the candy dispenser and turned off the lights. This phase lasted 9 sessions in each condition with Gary, 19 sessions with Sidney, and 16 with Alec.

Phase 5. This phase was identical to Phase 4 (and Phase 2) except that in both experimental conditions the schedule of delivery of primary reinforcers and the number of lights illuminated were increased according to an FR 10 schedule of primary reinforcement. In other words, a candy was delivered after every tenth correct verbal response in each condition. The purpose of this manipulation was to determine if the differences in performance which appeared at the lower fixed-ratio value in Phases 2 and 4 would be increased at the higher fixed-ratio value. In the sequential light condition one light was illuminated, and remained on, contingent upon each correct response. The lights were sequentially illuminated from left to right, contingent upon correct responses, until the entire row of ten lights was illuminated. The first lever-press after all ten lights were illuminated operated the candy dispenser and turned off the lights. In the light-flash

condition all ten lights were illuminated for one second, contingent upon each correct response. The lights remained illuminated after each tenth onset and the first lever-press subsequent to this continuous illumination operated the candy dispenser and turned off the lights. In both conditions then, the same event (i.e., a lever press in the presence of ten illuminated lights) immediately preceded the delivery of each primary reinforcer. This phase lasted 16 sessions in each condition for Gary, 10 sessions for Sidney, and 15 sessions for Alec.

Phase 6. This phase consisted of a reversal to the conditions in effect in Phases 2 and 4. In other words, the delivery of primary reinforcers and the number of lights illuminated were presented according to an FR 5 schedule in both experimental conditions. A lever-press response produced primary reinforcement after every fifth correct verbal response. This phase lasted 16 sessions in each condition for Gary, 11 sessions for Sidney, and 13 sessions for Alec.

Phase 7. In this phase the sequential light condition was the same as in Phases 6, 4, and 2. The light-flash condition was changed, however, in that the lights illuminated contingent upon correct responses which did not produce primary reinforcers were not the same as the lights illuminated contingent upon correct responses which did produce primary reinforcers. Specifically, after each first, second, third, and fourth correct response, only one light (the tenth light from the left) was illuminated for one second. After each fifth correct response all five of the left-most lights were illuminated and remained on. The first lever-press subsequent to this continuous illumination operated the candy dispenser and turned off the lights. In other words, the light illuminations which were contingent upon all but fifth correct responses were different from the light illuminations contingent

upon fifth correct responses.

Gary was unavailable after Phase 6 and as a result was not studied in this phase. This phase lasted 11 sessions in each condition for Sidney and 12 for Alec.

Dependent Variables

The following dependent measures were examined in all phases of this experiment.

Inattention time per trial. This measure was the average amount of time per trial between the onset of the child's attending key lights and the execution of an attending response. This was calculated by dividing total inattention per session by total trials per session. This measure could also be called the average "latency of the response", which is the term generally used in other discrete trial procedures.

Number of trials per session. This measure was the number of times the subject pressed the attending key and was subsequently presented a picture. The total number of trials per session was equal to the sum of the correct and incorrect responses per session.

Number of correct responses per session. This measure consisted of the total number of correct responses per session on both prompt and question trials (i.e., the total number of correct imitative and naming responses per session).

Number of errors per session. This measure included errors of omission (i.e., no verbal response within 5 seconds of a lever press), errors in pronunciation, and incorrect responses on both imitation and naming trials.

Proportion of correct responses. This measure consisted of the proportion of trials (picture presentations) on which correct responses were emitted.

Number of picture names learned. This measure consisted of the number of picture names learned by each child according to the previously described criterion for a learned picture.

The two experimental conditions were compared with respect to each of these measures to determine the relative effectiveness of each procedure. In addition, they were compared with respect to one other measure - the distribution of inattention time within fixed-ratio requirements. While one timer recorded total inattention time per session, five other timers cumulatively recorded the amount of inattention per session that occurred between the delivery of each reinforcer and the first correct response, between each first and second correct response, between each second and third correct response, between each third and fourth correct response, and between each fourth and fifth correct response in the FR 5 conditions. In the FR 10 condition the five timers recorded the amount of inattention per session that occurred between the delivery of each reinforcer and the second correct response, between each second and fourth correct response and so on. In all cases the sum of the cumulative inattention time recorded on these five timers equalled the value recorded on the total inattention timer.

Interobserver Reliability

The picture-naming task required that the experimenter decide whether the children's responses were correct or incorrect. The consistency of these decisions was checked by computing interobserver reliability coefficients. Approximately one-fifth of all experimental sessions were recorded on audio tape and verbal responses were played to an independent observer after the observer had familiarized herself with the criteria the experimenter used to distinguish between correct and incorrect verbal responses. Twenty-two sessions

in each experimental condition with Sidney were taped, nineteen with Gary, and twenty with Alec. The total number of responses emitted by the subjects in these sessions was 1379, 2119, and 2715 respectively.

The tape was stopped after each correct response and the observer was required to score the response as correct or incorrect prior to hearing the experimenter's decision. The experimenter's decision on each response was indicated to the observer, after the observer made her decision, by the type of trial that followed each response. While listening to the tapes with the observer, the experimenter entered each response on a picture-naming session sheet (see Figure 2) identical to the one originally used. For each response, his original decision could be determined by noting whether a prompt or question trial for a known or unknown picture had followed that response. His original decision was then compared to the observer's decision and an agreement or disagreement was recorded. The interobserver reliability measures used were the ratio of agreements to agreements plus disagreements on responses that the experimenter called correct and the ratio of agreements to agreements plus disagreements on responses that the experimenter called incorrect. Trials on which no verbal response occurred were excluded from the calculations.

Interobserver reliability for Gary was .95 for correct responses and .89 for incorrect responses. The reliability measure for Sidney was .92 for correct responses and .84 for incorrect responses. The reliability measure for Alec was .88 for correct responses and .82 for incorrect responses.

Stability Criterion

The design of this experiment allows comparison of the two experimental conditions within each of the phases of the experiment. It is also possible to compare each phase to the preceding and subsequent phase, provided

that the data in each phase was relatively stable prior to the initiation of the next phase. In order to facilitate such comparisons, new phases were initiated only if no decreasing or increasing trends were observed in the data for at least one week prior to the initiation of the new phase and only if a difference (or lack of difference) between experimental conditions was consistently evidenced for the same period of time.

CHAPTER III

RESULTS

Phase 1

In Phase 1, light-flashes and sequential lights were compared as conditioned reinforcers. A lever-press response was not required to produce primary reinforcers. Figure 4 shows the mean number of seconds of inattention per trial in each session in each experimental condition. During Phase 1 there was no consistent difference between experimental conditions in the amount of time Sidney spent engaging in inattentive behavior. This was also true of Gary during the first half of Phase 1, whereas during the second half of the phase he spent slightly less time engaging in inattentive behavior in the light-flash condition than in the sequential light condition. Alec consistently spent less time engaging in inattentive behavior in the light-flash condition.

Figure 5 shows the number of trials per session in each experimental condition. There was no consistent difference in the number of trials per session that Sidney initiated in each experimental condition. Gary, however, tended to initiate more trials per session in the light-flash condition during the last half of Phase 1 and Alec consistently initiated more trials per session in the light-flash condition throughout Phase 1.

Figure 6 shows the number of correct imitative and naming responses per session in each experimental condition. Alec consistently emitted more

Figure 4. The mean number of seconds of inattention per trial for each subject over all sessions in the light-flash and sequential light conditions.

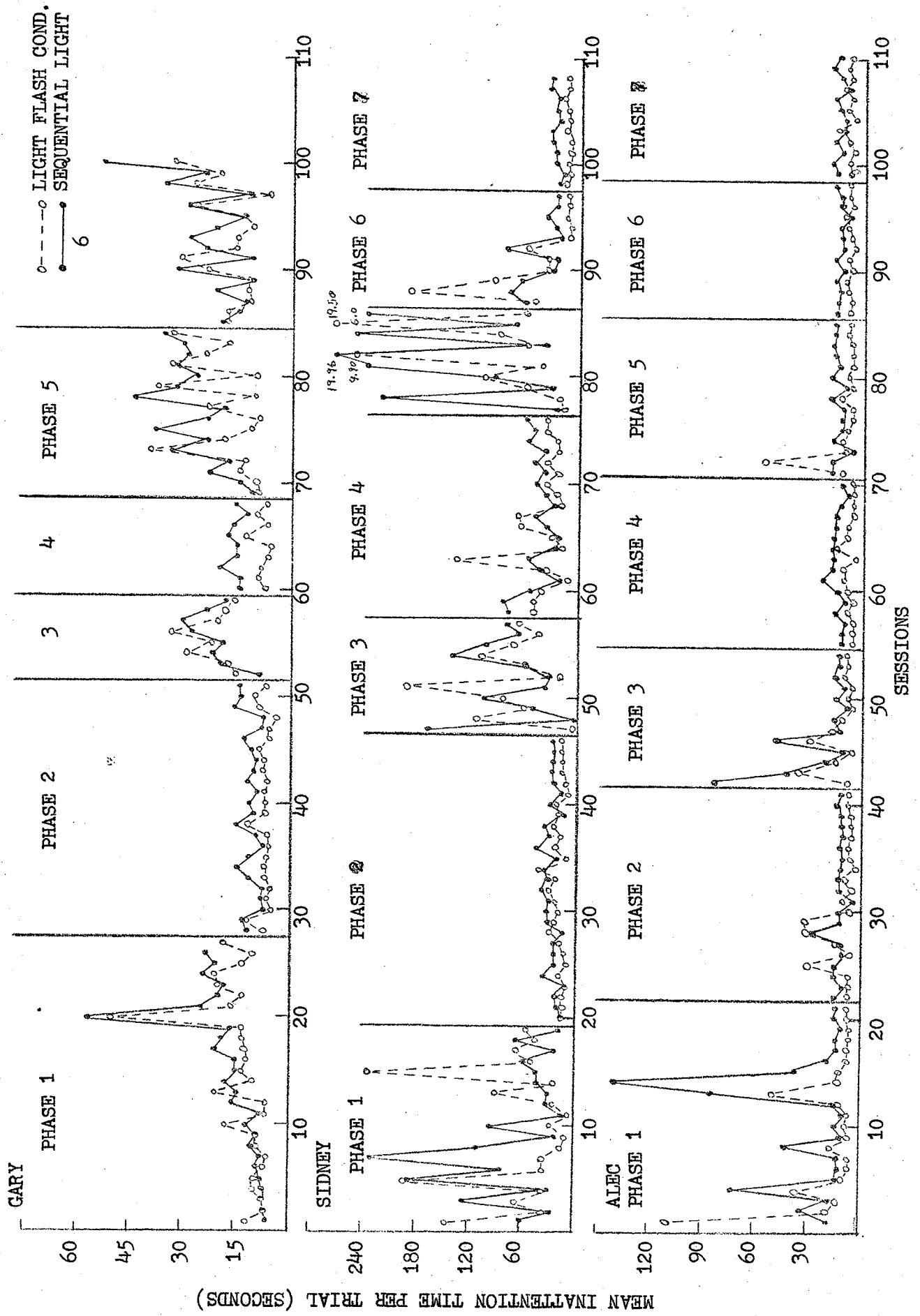


Figure 5. The total number of trials per session for each subject in all phases of the light-flash and sequential light conditions.

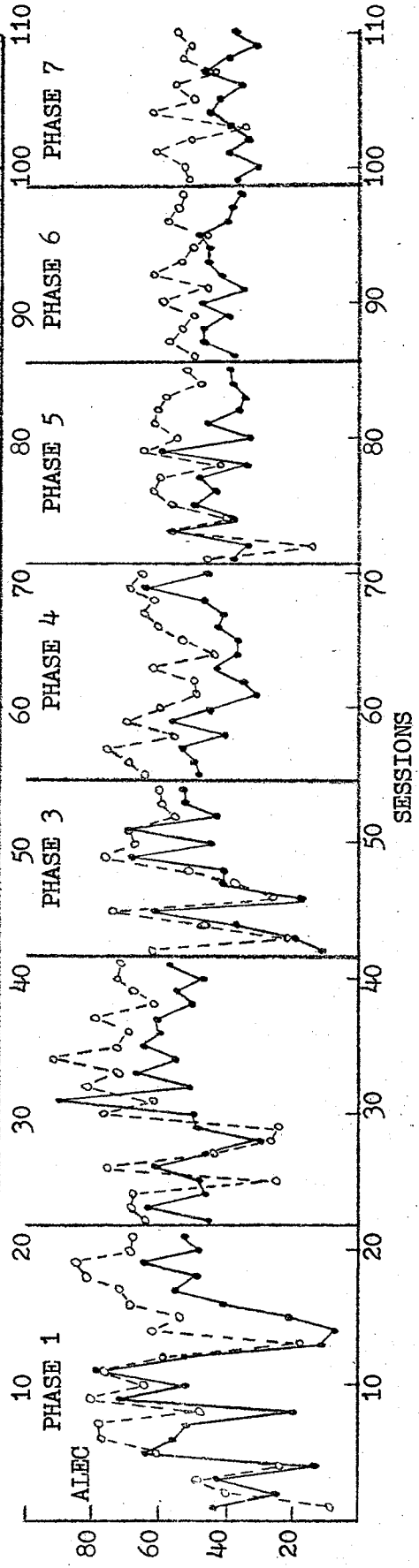
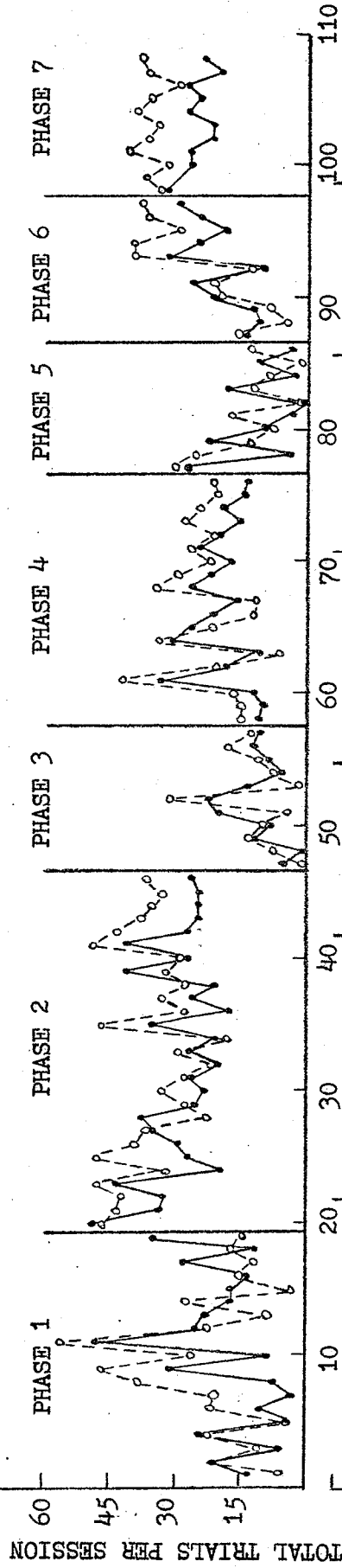
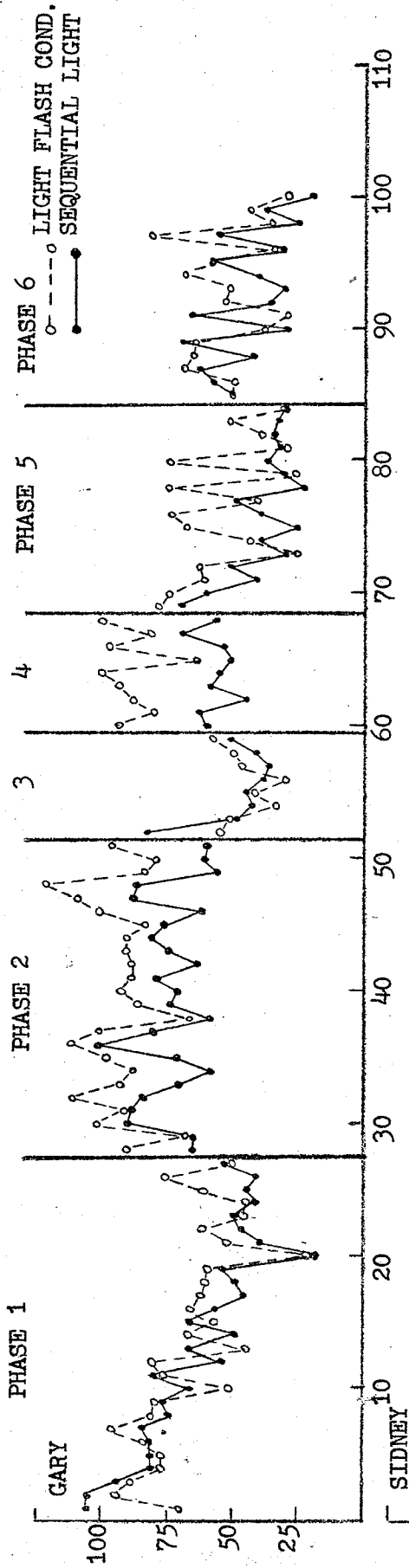
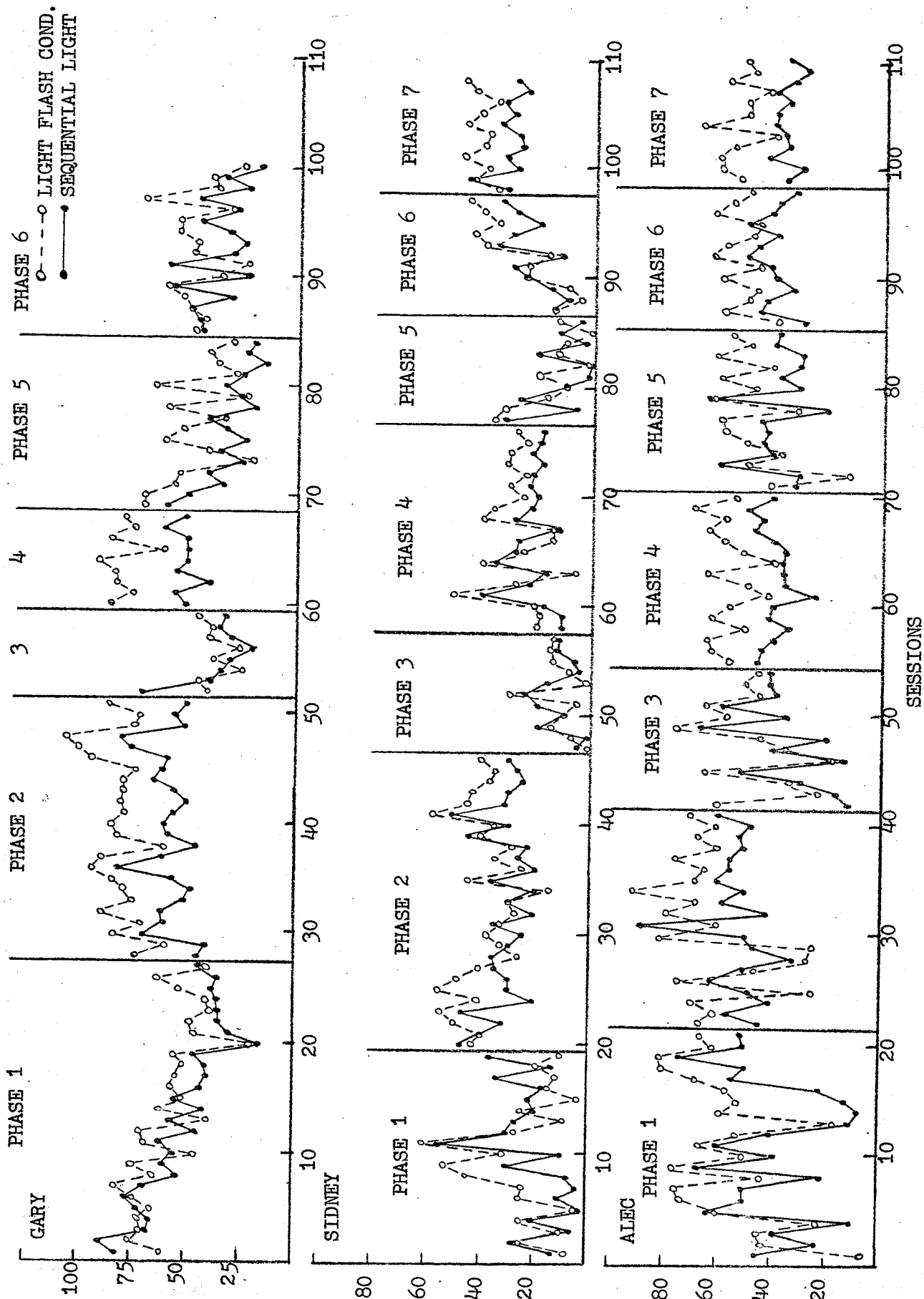


Figure 6. The number of correct responses per session for each subject in all phases of the light-flash and sequential light conditions.

CORRECT RESPONSES PER SESSION



correct responses per session in the light-flash condition during Phase 1. Gary tended to emit more correct responses per session in the light-flash condition only during the last half of the phase. Sidney did not consistently emit more correct responses in either experimental condition.

Figure 7 shows the number of errors per session in each experimental condition. For Gary and Sidney there was no consistent difference in the number of errors per session in each condition. This was also the case with Alec except during the last five sessions of the phase, in which he consistently made more errors in the light-flash condition.

Figure 8 shows the proportion of trials per session on which correct responses were emitted. For all subjects there was no consistent difference between conditions in the proportion of trials per session on which correct responses were emitted.

Figure 9 shows the cumulative number of pictures learned by each subject in each experimental condition. During Phase 1 Gary and Alec learned to name more pictures in the light-flash condition while Sidney learned the same number of pictures in each condition.

The means of each dependent measure across each phase are shown in Figure 10 for Gary, Figure 11 for Sidney, and Figure 12 for Alec. In calculating the means for the two experimental conditions, data for the first three sessions in each phase were omitted to help insure that the means more accurately represented the terminal effects of the variables investigated.

Figures 10 and 11 show that Gary and Sidney spent slightly less time per session engaging in inattentive behavior, initiated slightly more trials per session, and emitted slightly more correct responses per session in the light-flash condition while Gary made fewer errors in that condition. Figure 12 shows that, on the average, Alec spent considerably less time engaging in

Figure 7. The number of incorrect responses per session for each subject in all phases of the light-flash and sequential light conditions.

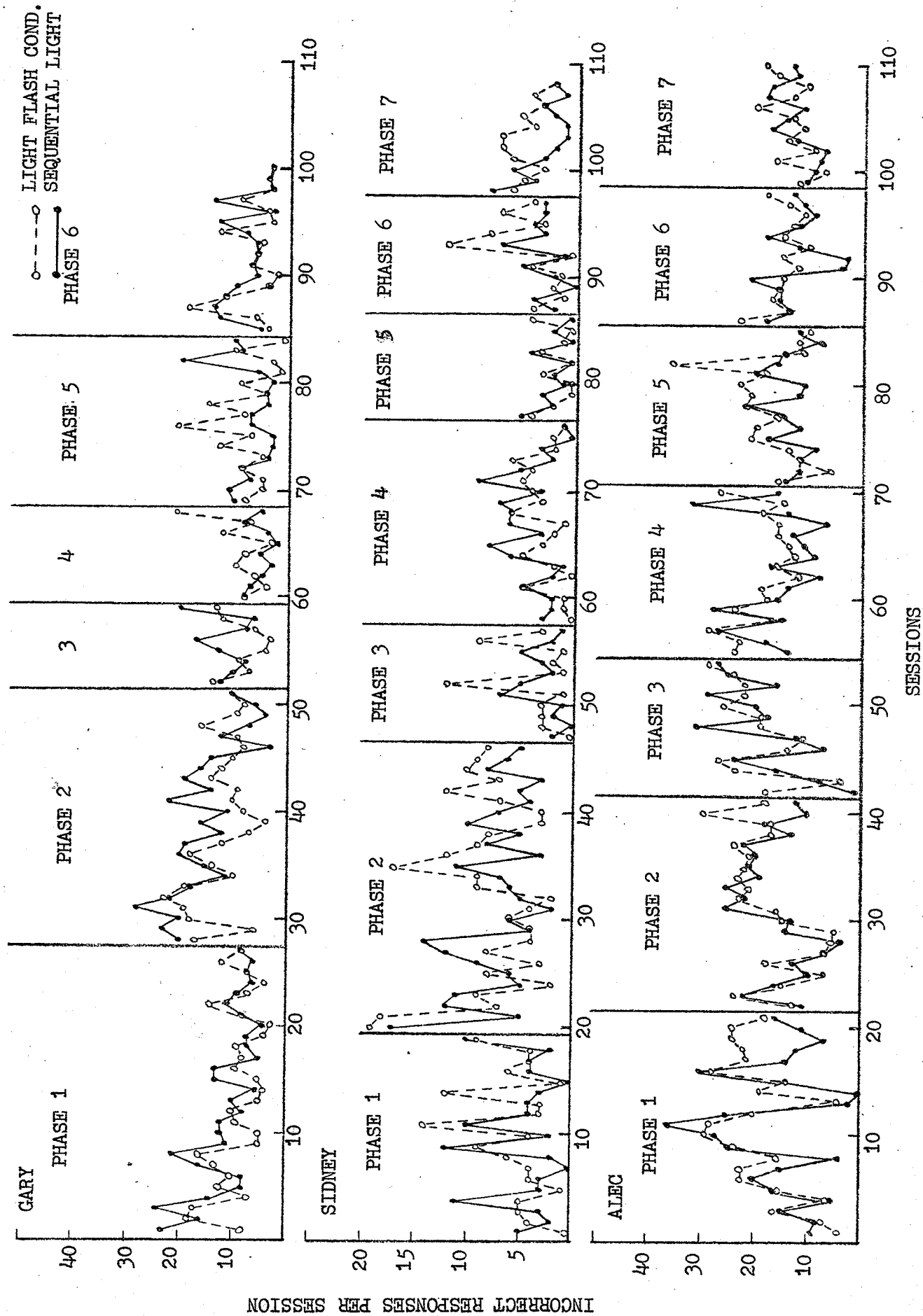


Figure 8. The proportion of trials on which correct responses were emitted for all subjects in all phases of the light-flash and sequential light conditions.

"PROPORTION OF CORRECT RESPONSES PER SESSION"

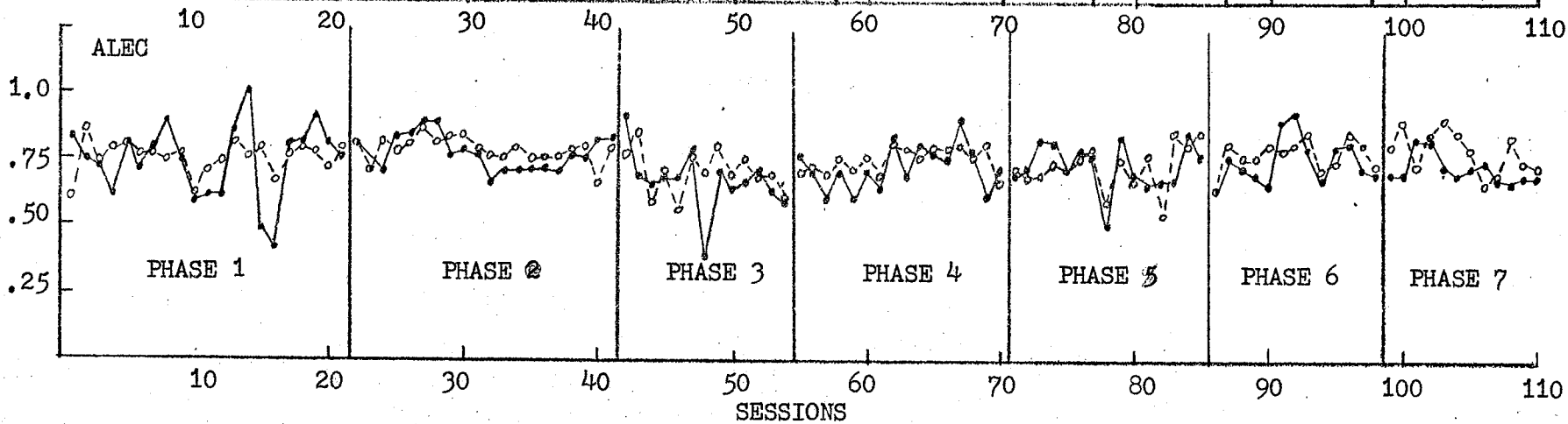
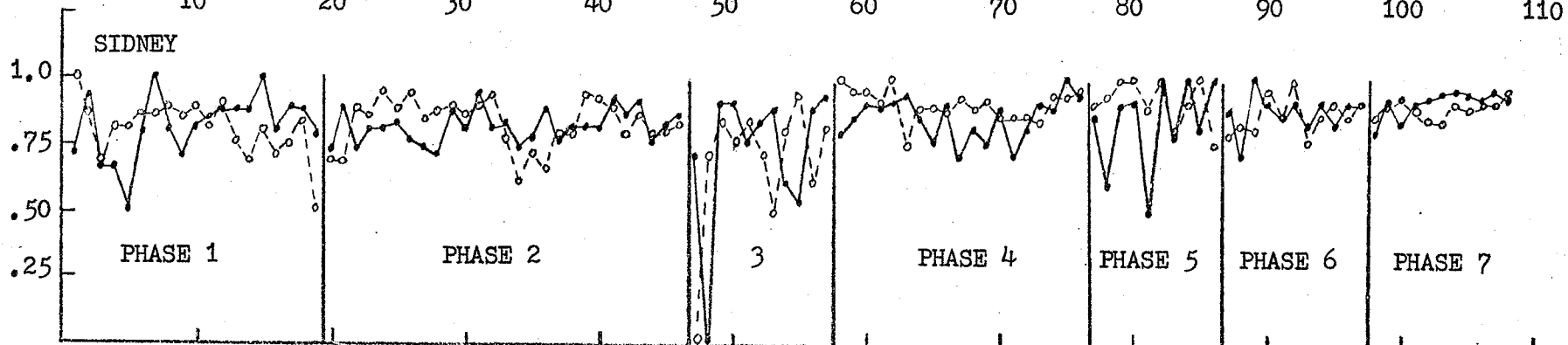
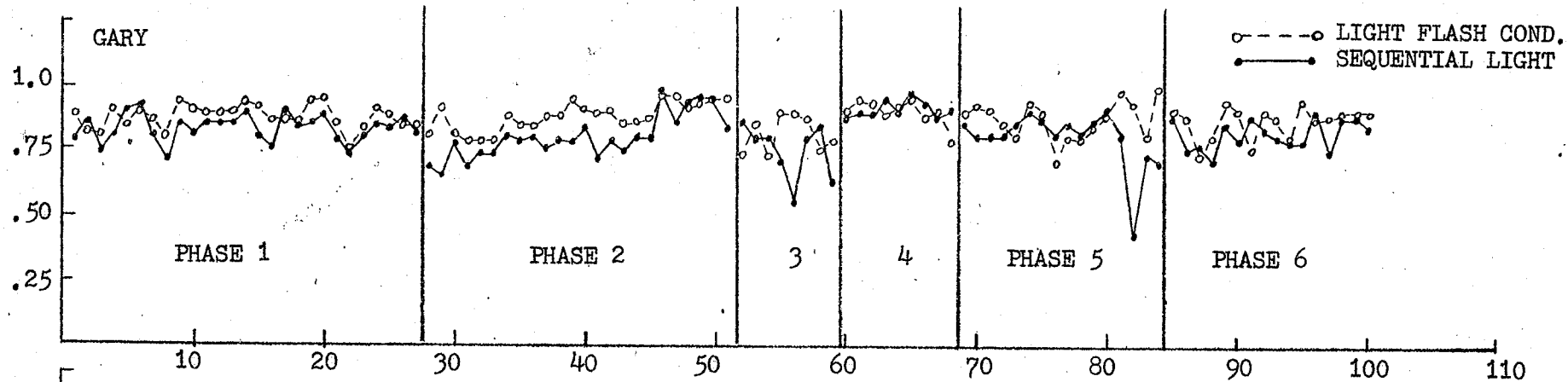


Figure 9. Cumulative number of pictures learned
by each subject in each phase in the
light-flash and sequential light conditions.

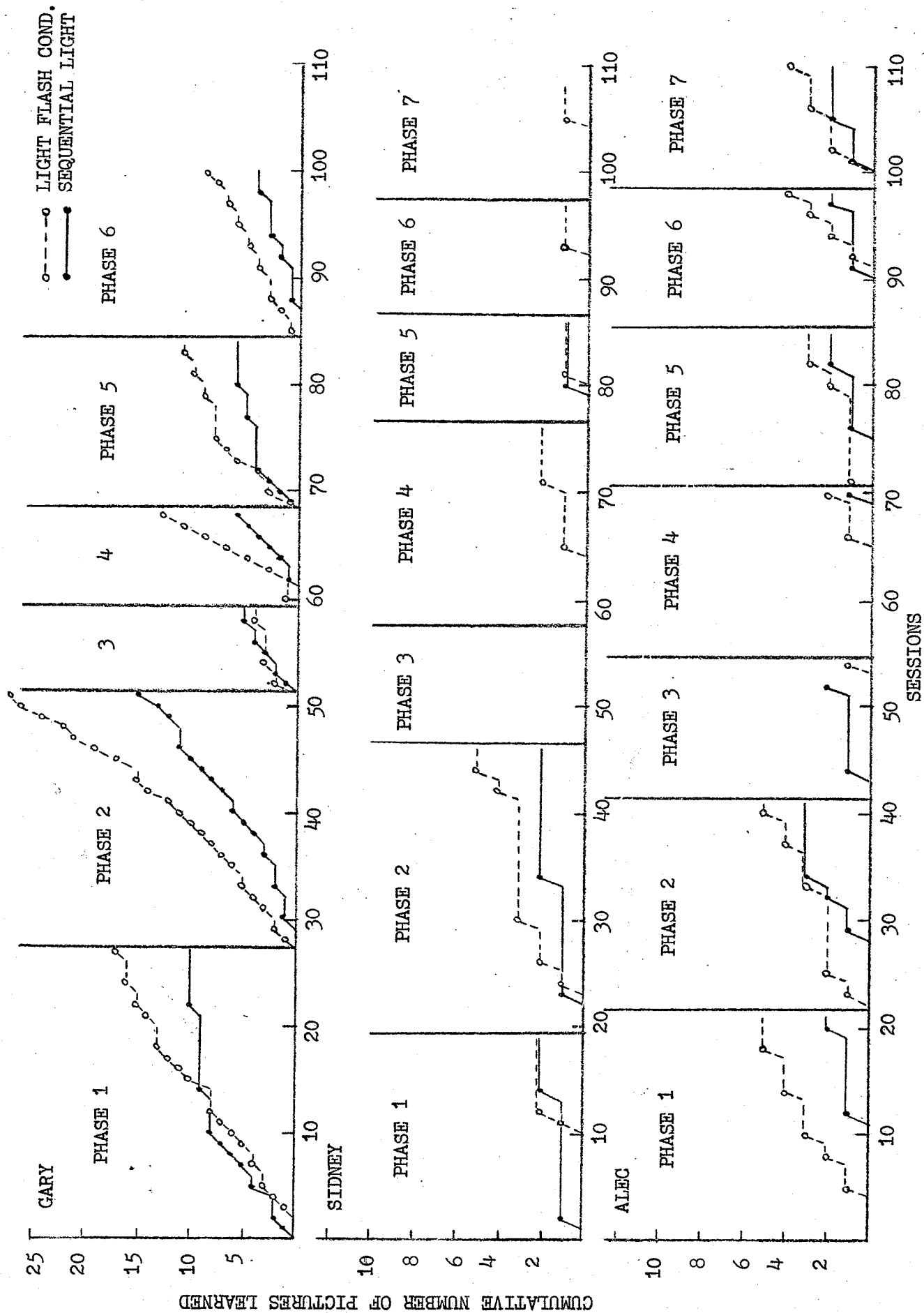
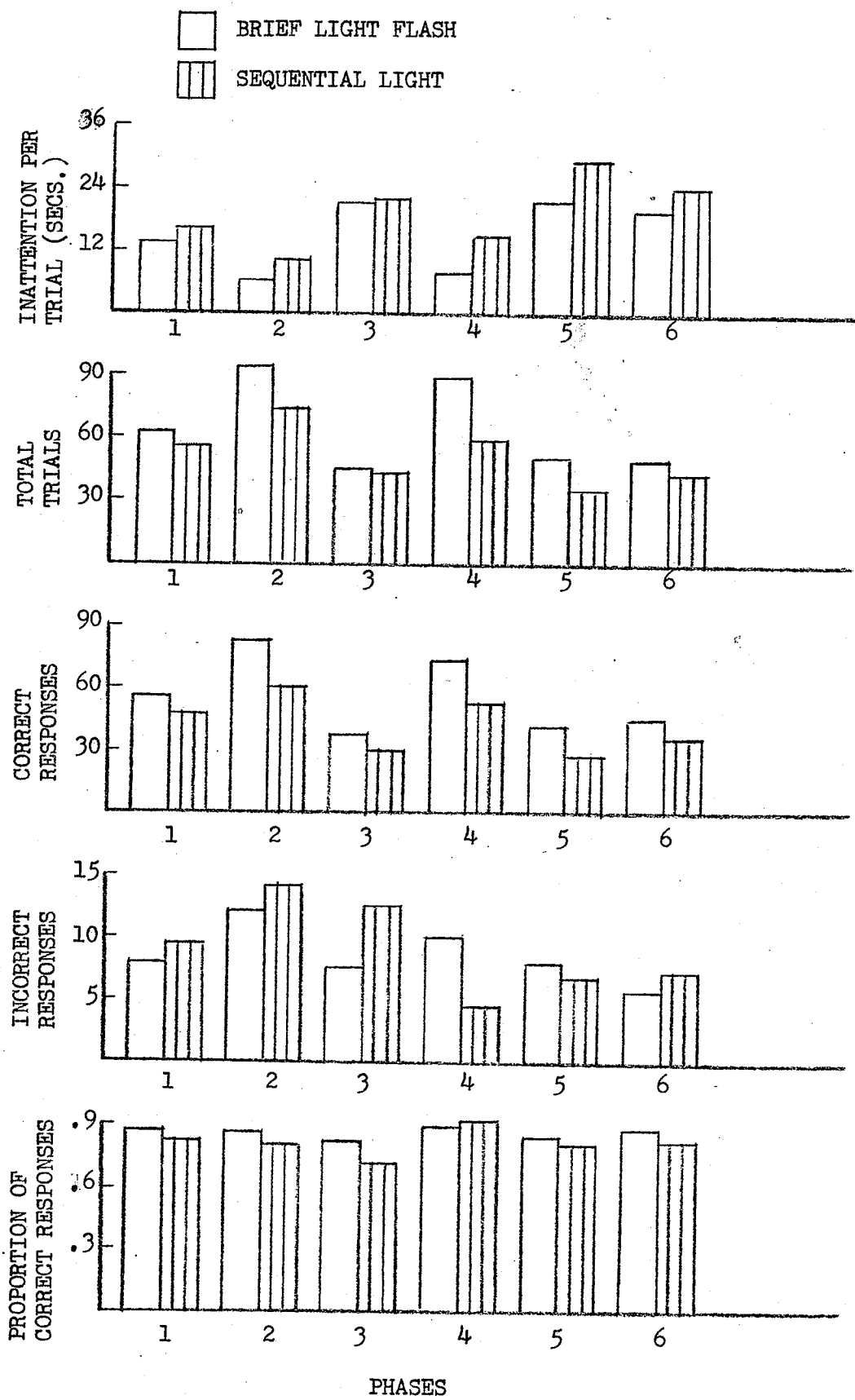


Figure 10. Means of several dependent measures for Gary in each phase in the light-flash and sequential light conditions.



PHASES

Figure 11. Means of several dependent measures for Sidney in each phase in the light-flash and sequential light conditions.

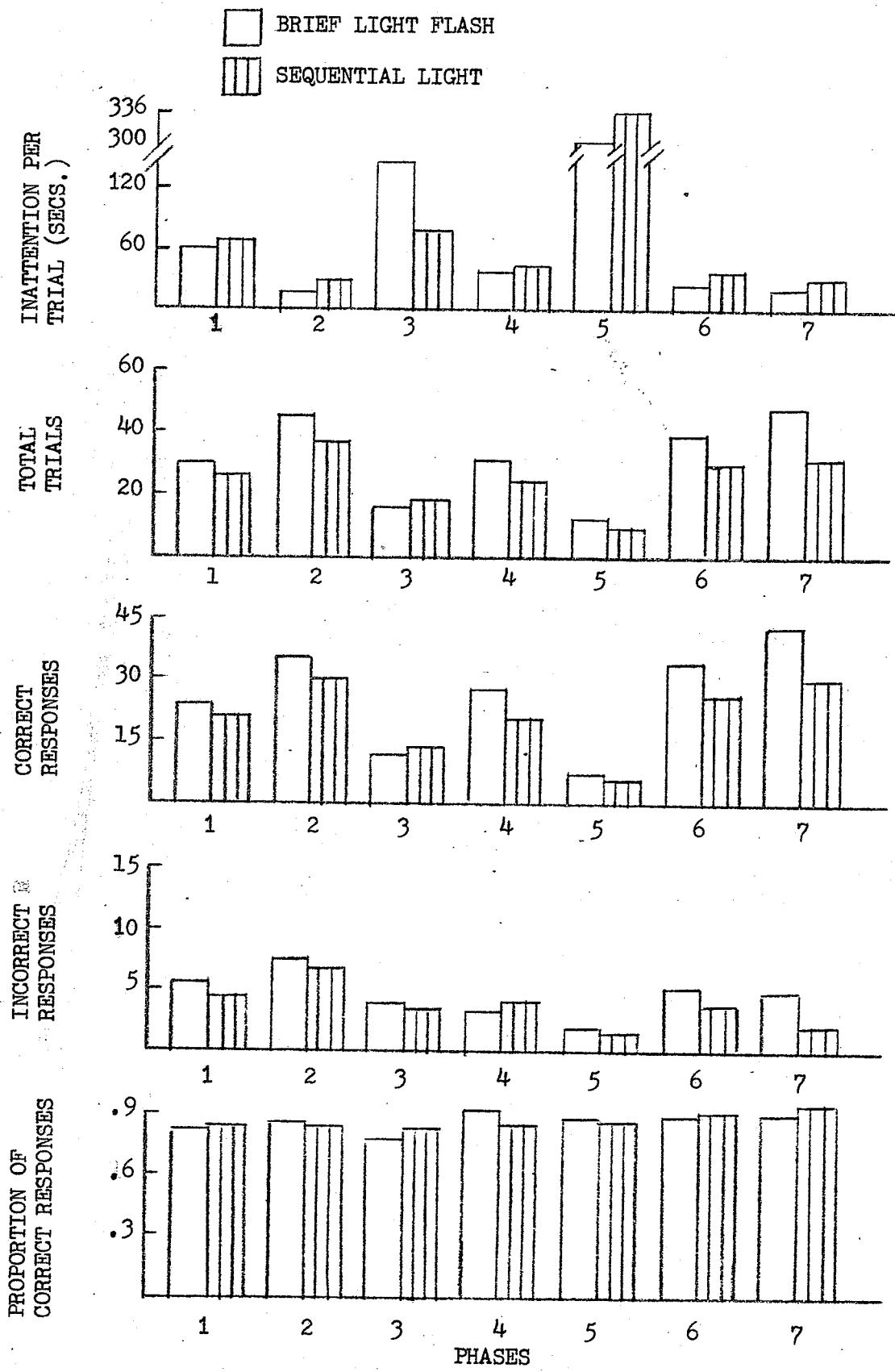
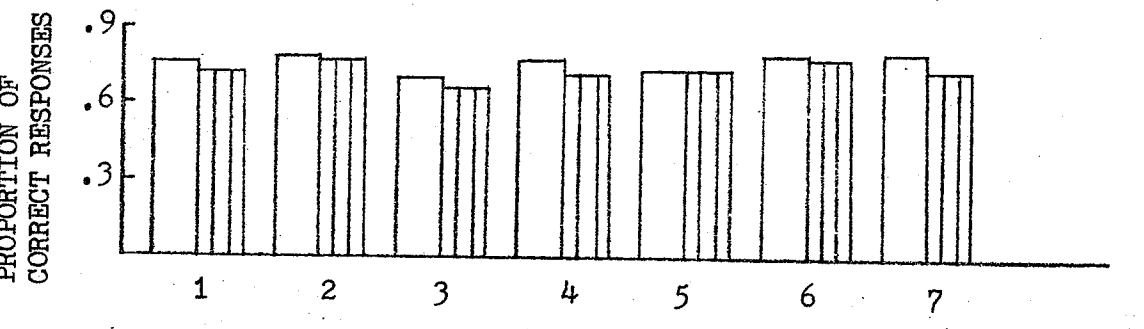
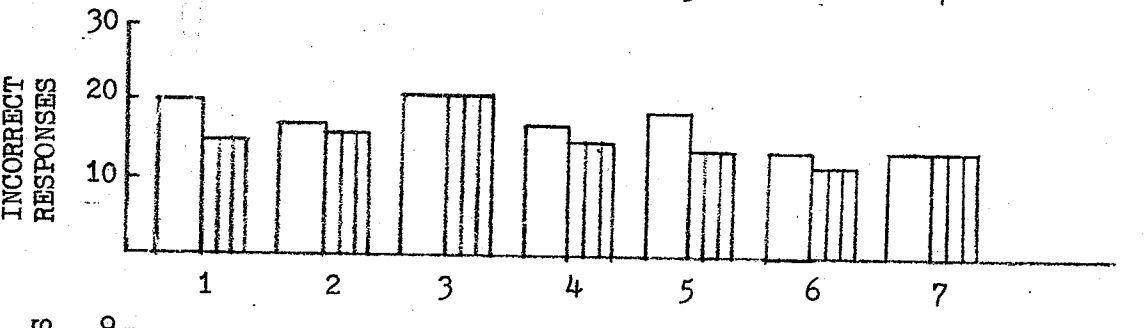
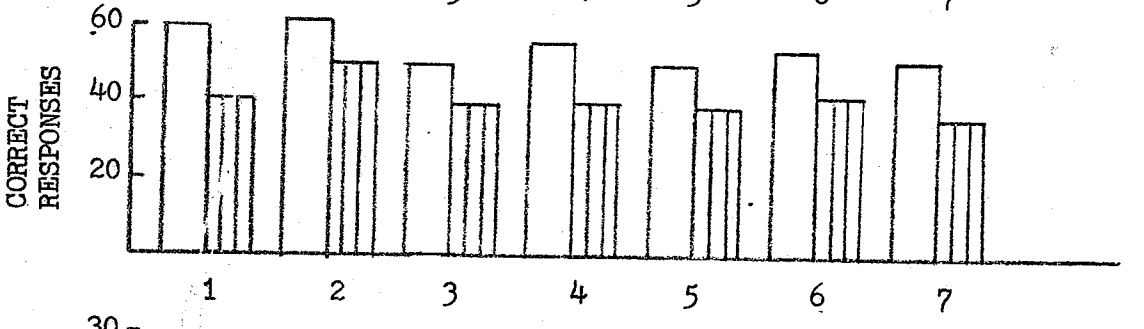
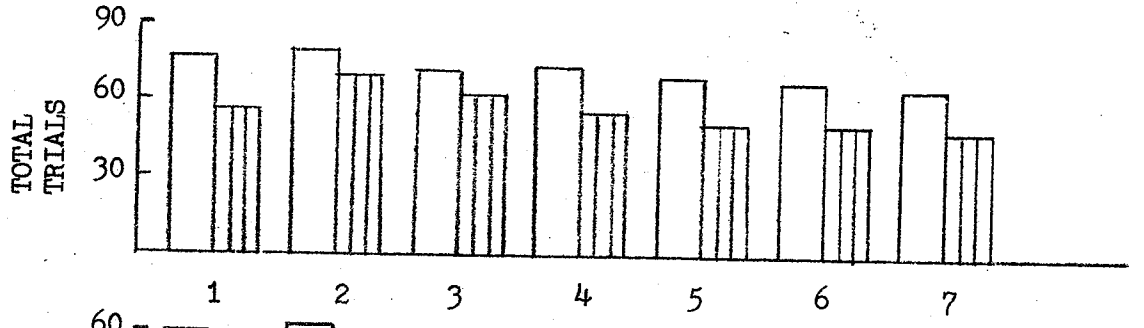
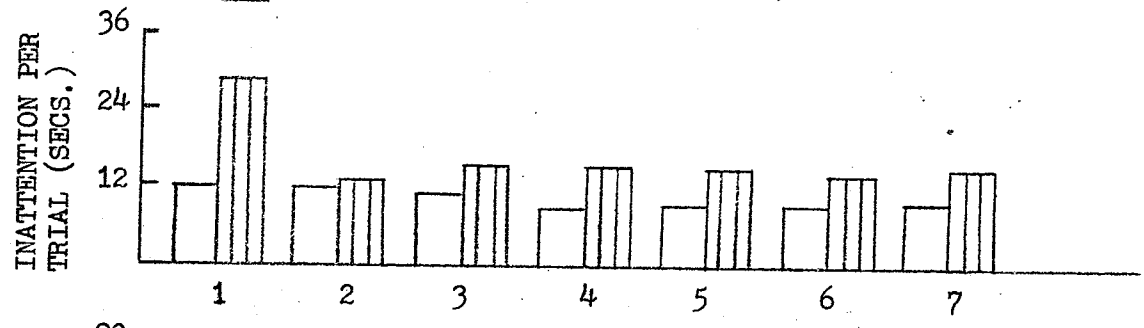


Figure 12. Means of several dependent measures for Alec in each phase in the light-flash and sequential light conditions.

BRIEF LIGHT FLASH
 SEQUENTIAL LIGHT



PHASES

inattentive behavior, initiated many more trials per session, and emitted many more correct and incorrect responses in the light-flash condition during Phase 1. In short, the picture-naming performance of one subject was considerably better in the light-flash condition while there was little difference between conditions in the performance of the other two subjects.

Phase 2

During Phase 2 a specific lever-press response was required to produce primary reinforcers in both experimental conditions. As a result, Gary and Sidney's performance on the picture-naming task improved in both conditions relative to Phase 1, while Alec's performance remained unchanged. The performance of all subjects was better in the light-flash condition than in the sequential light condition during Phase 2.

Figure 4 shows that all three subjects spent less time engaging in attentive behavior in the light-flash condition than in the sequential light condition. Figures 5 and 6 show that Gary consistently initiated more trials per session and emitted more correct responses per session in the light-flash condition, and that this was also the case for Sidney and Alec during later sessions in the phase. Figures 7 and 8 show that for all subjects there was no consistent difference in the number of errors per session in each condition, or in the proportion of trials on which correct responses were emitted. Both Gary and Sidney, however, made more errors per session in both experimental conditions during Phase 2 than during Phase 1. Figure 9 shows that all subjects learned to name more pictures in the light-flash condition than in the sequential light condition during Phase 2.

In general, the average performance of all subjects was superior across a number of dependent measures in the light-flash condition. (See

Figures 10, 11, and 12). Figures 10 and 11 also show that Gary and Sidney's performance improved in both experimental conditions during Phase 2 relative to their performance in Phase 1. They spent less time engaging in inattentive behavior, initiated more trials and emitted more correct responses in both experimental conditions during Phase 2 than during Phase 1. Alec who consistently showed superior terminal performance in the light-flash condition during Phase 1, did not show overall improvement when the lever-press contingency was introduced in Phase 2.

Phase 3

During Phase 3 a lever-press response was no longer required to produce reinforcers in either experimental condition. As a result, the performance of all three subjects abruptly deteriorated in both experimental conditions. This was the case for Alec even though the addition of the required lever-press response in Phase 2 had produced no change in his performance in that phase. Alec's performance on the picture-naming task during Phase 3 improved in both experimental conditions after a number of sessions. His performance during the last half of the phase resembled his performance in Phase 1 and 2. Gary and Sidney's performance during Phase 3 never recovered to the Phase 2 level.

When a lever-press response was no longer required in Phase 3, Gary and Sidney's performance was no longer superior in the light-flash condition. This was also the case with Alec during the first part of Phase 3. Once Alec's performance in both experimental conditions in Phase 3 had recovered to the Phase 2 level, however, his picture-naming behavior was consistently superior in the light-flash condition.

Figure 4 shows that there was no consistent difference in the

amount of time that Gary and Sidney spent engaging in inattentive behavior in Phase 3, whereas Alec consistently spent less time engaging in inattentive behavior in the light-flash condition during the last part of Phase 3. Figures 5 and 6 show that there was also no consistent difference in the number of trials Gary or Sidney initiated in each condition, or in the number of correct responses they emitted in each condition. Alec, on the other hand, initiated more trials and emitted more correct responses during the latter sessions in Phase 3. Figures 7 and 8 show that for all subjects there was no consistent difference between conditions in the number of errors per session or in the proportion of trials on which correct responses were emitted. Figure 9 shows that Alec and Gary learned to name one more picture in the sequential light condition than in the light-flash condition while Sidney did not learn any pictures in either condition. It should be mentioned, however, that because Sidney and Alec learned to name pictures at a low rate, the number of pictures learned is probably not a very sensitive dependent measure.

Figure 12 shows that Alec's average performance across a number of dependent measures was superior in the light-flash condition. Figures 10 and 11 show, however, that Gary and Sidney's average performance was not significantly better in either experimental condition during Phase 3. In essence, then, Phase 3 replicated Phase 1. Gary and Sidney's performance in both conditions was inferior to their performance when the lever-press contingency was in effect (Phase 2) and showed no differential effect when the lever-press requirement was absent. Alec's terminal performance was superior in both conditions and a differential effect was present whether the lever-press requirement was present (Phase 2) or absent (Phases 1 and 3).

Phase 4

Phase 4 consisted of a return to the conditions in effect in Phase 2. In other words, a lever-press response was required in both experimental conditions. The effects of this manipulation in Phase 4 paralleled its effects in Phase 2. As in Phase 2, the performance of all subjects on the picture-naming task was consistently superior in the light-flash condition. All subjects spent less time engaging in inattentive behavior (Figure 4), initiated more trials per session (Figure 5), emitted more correct responses per session (Figure 6), and learned to name more picture (Figure 9) in the light-flash condition than in the sequential light condition. With all subjects there was little consistent difference between experimental conditions with respect to the number of errors per session (Figure 7) or the proportion of trials on which correct responses were emitted (Figure 8).

Gary and Sidney's performance in both experimental conditions in Phase 4 improved across a number of dependent measures relative to their performance in Phase 3. Figures 11 and 12 show that on the average, Gary and Sidney spent less time engaging in inattentive behavior, initiated more trials and emitted more correct responses in both conditions during Phase 4 than during Phase 3. Figure 12 shows that Alec's average performance during Phase 4 remained relatively unchanged in both experimental conditions relative to his performance in the preceding phase.

Phase 5

In Phase 5 the schedule of primary reinforcement was increased from FR 5 to FR 10. During Phase 5, Sidney's performance was similar in both experimental conditions across all dependent measures. Gary and Alec, on the other hand, performed consistently better on the picture-naming task in the

light-flash condition. The latter two subjects spent less time engaging in inattentive behavior (Figure 4), initiated more trials per session (Figure 5), emitted more correct responses per session (Figure 6), and learned to name more pictures (Figure 9), in the light-flash condition than in the sequential light condition. While there was little consistent difference in the proportion of trials on which correct responses were emitted (Figure 8), both Gary and Alec tended to make more errors per session in the light-flash condition than in the sequential light condition (Figure 7).

As a result of the increase in the fixed-ratio requirement in Phase 5, Gary and Sidney's performance deteriorated in both experimental conditions while Alec's performance remained relatively unchanged in both conditions. Figures 10 and 11 show that on the average, Gary and Sidney spent more time engaging in inattentive behavior, initiated fewer trials, and emitted fewer correct responses in Phase 5 than in Phase 4. By the end of the phase, Sidney's picture-naming behavior had virtually extinguished in both experimental conditions.

Phase 6

This phase consisted of a reversal to the conditions in effect in Phase 4. In other words, the schedule of primary reinforcement was decreased from FR 10 to FR 5.

During this phase the performance of all subjects on the picture-naming task was superior in the light-flash condition. All subjects spent less time engaging in inattentive behavior (Figure 4), initiated more trials per session (Figure 5), emitted more correct responses per session (Figure 6), and learned to name more pictures (Figure 9), in the light-flash condition than in the sequential light condition. There were no consistent differences between experimental conditions with respect to the number of errors per

session (Figure 7) or the proportion of trials on which correct responses were emitted (Figure 8).

Figure 11 shows that during Phase 6, Sidney's average performance improved across a number of dependent measures in both experimental conditions relative to his performance during Phase 5. During the last half of the phase his performance was consistently superior to his performance in the preceding phase. Gary and Alec's average performance (Figures 10 and 11 respectively) remained generally unchanged in both experimental conditions in Phase 6, relative to their performance in Phase 5. In both conditions then, Gary's performance failed to recover to the Phase 4 level whereas Sidney and Alec's performance closely resembled their performance in Phase 4.

Phase 7

In the light-flash condition during Phase 7, all five lights were illuminated after each fifth correct response as was the case in the previous phase. After all correct responses other than fifth correct responses, however, a single light was briefly illuminated. There was no change in the performance in either experimental condition of the two subjects spent less time engaging in inattentive behavior (Figure 4), initiated more trials per session (Figure 5), emitted more correct responses per session (Figure 6), and learned to name more pictures (Figure 9) in the light-flash condition than in the sequential light condition. Figure 8 shows that there was no difference between conditions in the proportion of trials on which correct responses were emitted. Figure 7 shows that Sidney consistently made more errors in the light-flash condition while Alec made about the same number of errors in both conditions.

Figures 11 and 12 show that the average performance of Sidney and

Alec respectively, across a number of dependent measures, was in both conditions similar to their performance in the previous phase.

Distribution of Inattention Time

For each subject the mean number of seconds of inattention was distributed into five segments in each experimental condition. In those phases in which an FR 5 schedule of primary reinforcement was in effect, inattention time was distributed according to whether it occurred between the delivery of a primary reinforcer and a first correct response, between a first and second correct response, between a second and third correct response, between a third and fourth correct response, or between a fourth and fifth correct response. In Phase 5, in which an FR 10 schedule of primary reinforcement was in effect, inattention was distributed according to whether it occurred between the delivery of a primary reinforcer and a second correct response, between a second and fourth correct response, between a fourth and sixth correct response, and so on. Under both schedules of primary reinforcement then, inattention time was distributed into five segments. The mean amount of inattention time per phase that occurred in each segment is shown in Figures 13, 14 and 15.

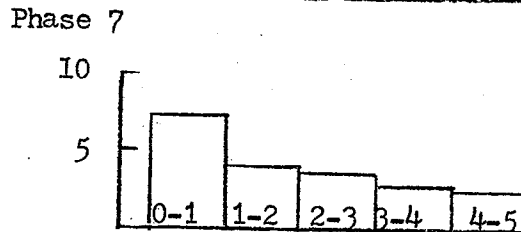
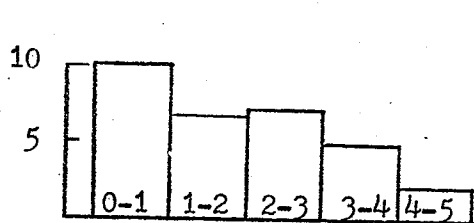
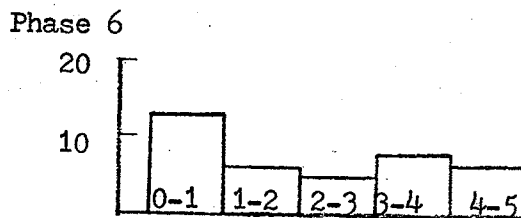
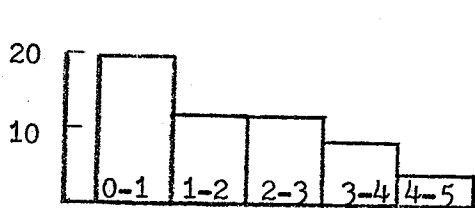
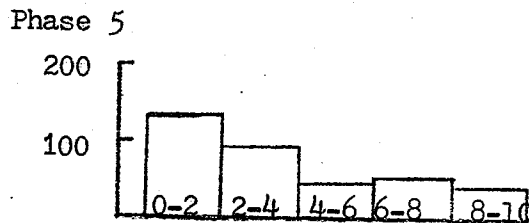
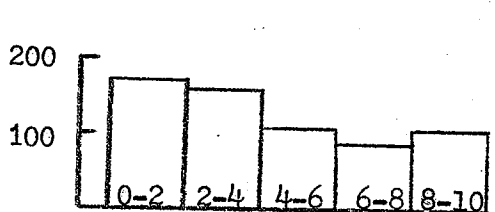
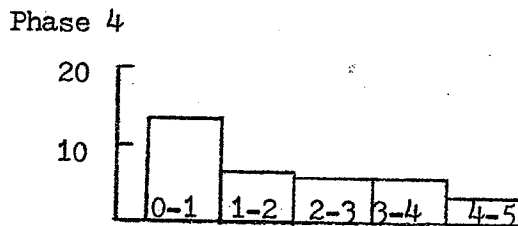
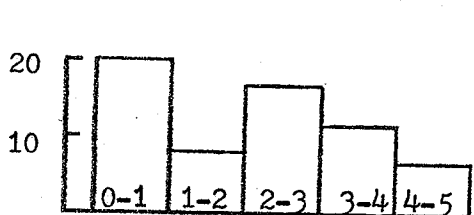
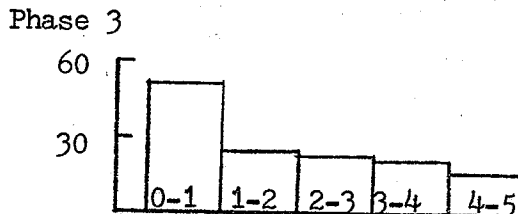
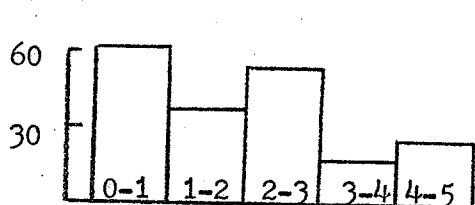
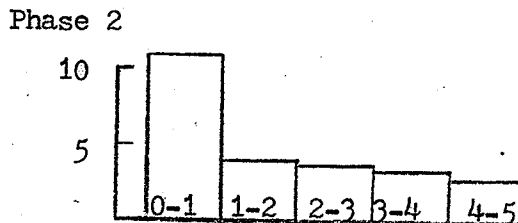
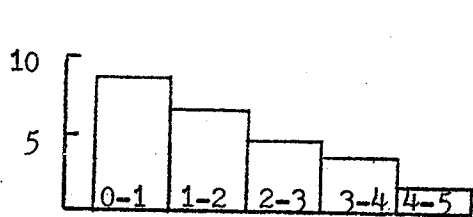
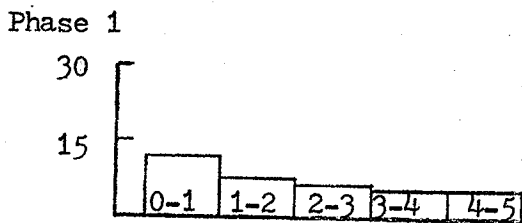
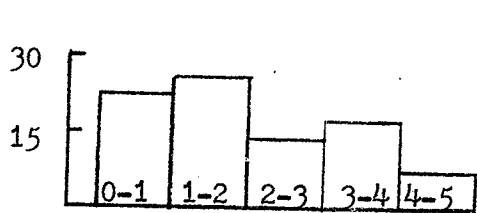
Figure 13 shows that during Phase 1 in which a lever-press response was not required, most of Alec's inattention in the light-flash condition occurred between the delivery of primary reinforcers and first correct responses and decreased between subsequent correct responses as the fixed-ratio requirement was completed. In the sequential light condition the amount of inattention in each segment was higher than the corresponding segment in the light-flash condition and an orderly decrease in inattention from segment to segment was not apparent. Figure 14 shows that in the light-flash condition during Phase 1, Sidney engaged in the most inattentive behavior between the delivery

Figure 13. Mean number of seconds of total inattention which occurred between successive correct responses in each phase in the light-flash and sequential light conditions with Alec.

SEQUENTIAL LIGHT

BRIEF LIGHT FLASH

MEAN INATTENTION BETWEEN SUCCESSIVE CORRECT RESPONSES (SECONDS)



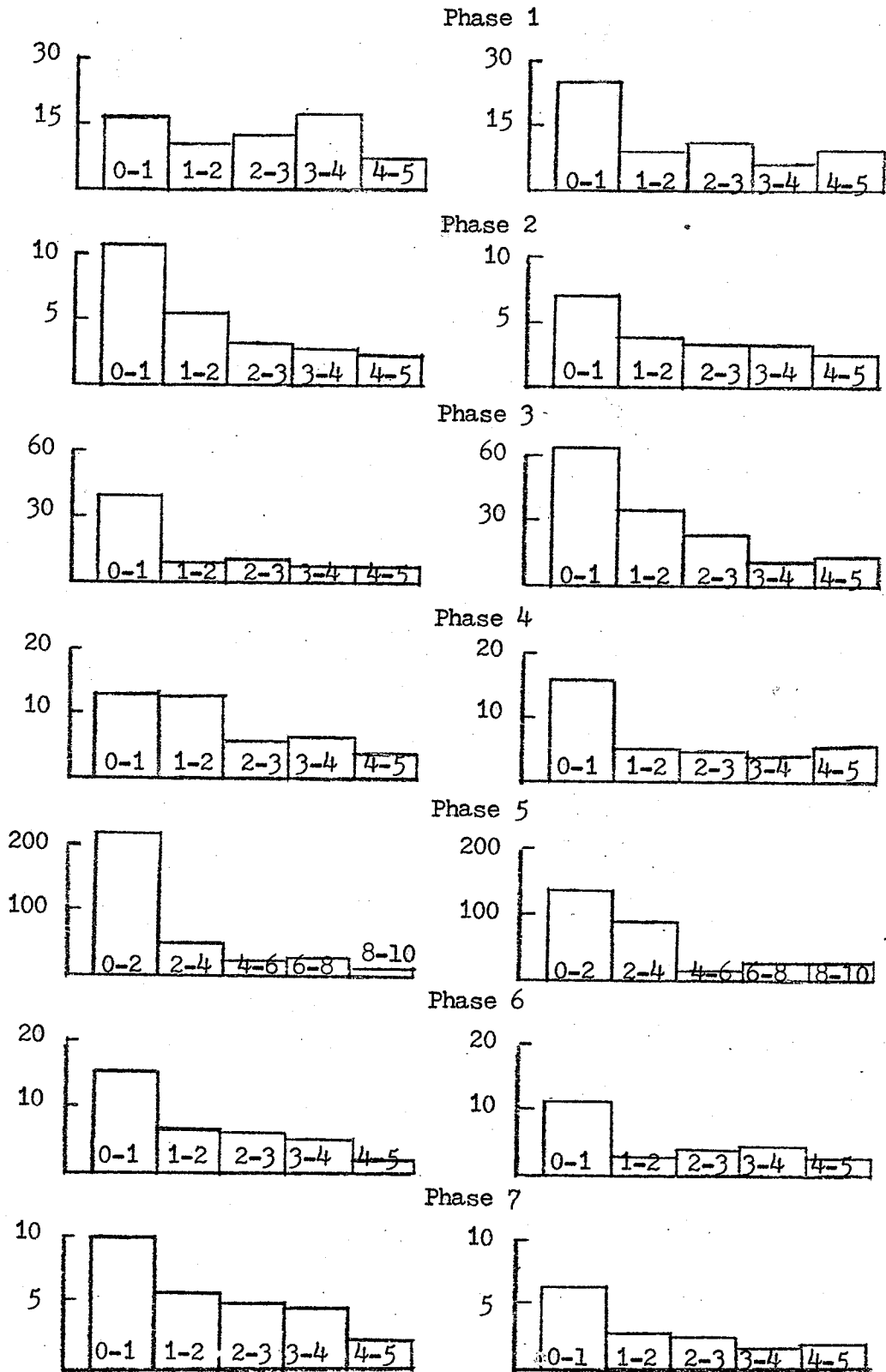
SUCCESSIVE CORRECT RESPONSES

Figure 14. Mean number of seconds of total inattention which occurred between successive correct responses in each phase in the light-flash and sequential light conditions with Sidney.

MEAN INATTENTION BETWEEN SUCCESSIVE CORRECT RESPONSES (SECONDS)

SEQUENTIAL LIGHT

BRIEF LIGHT FLASH



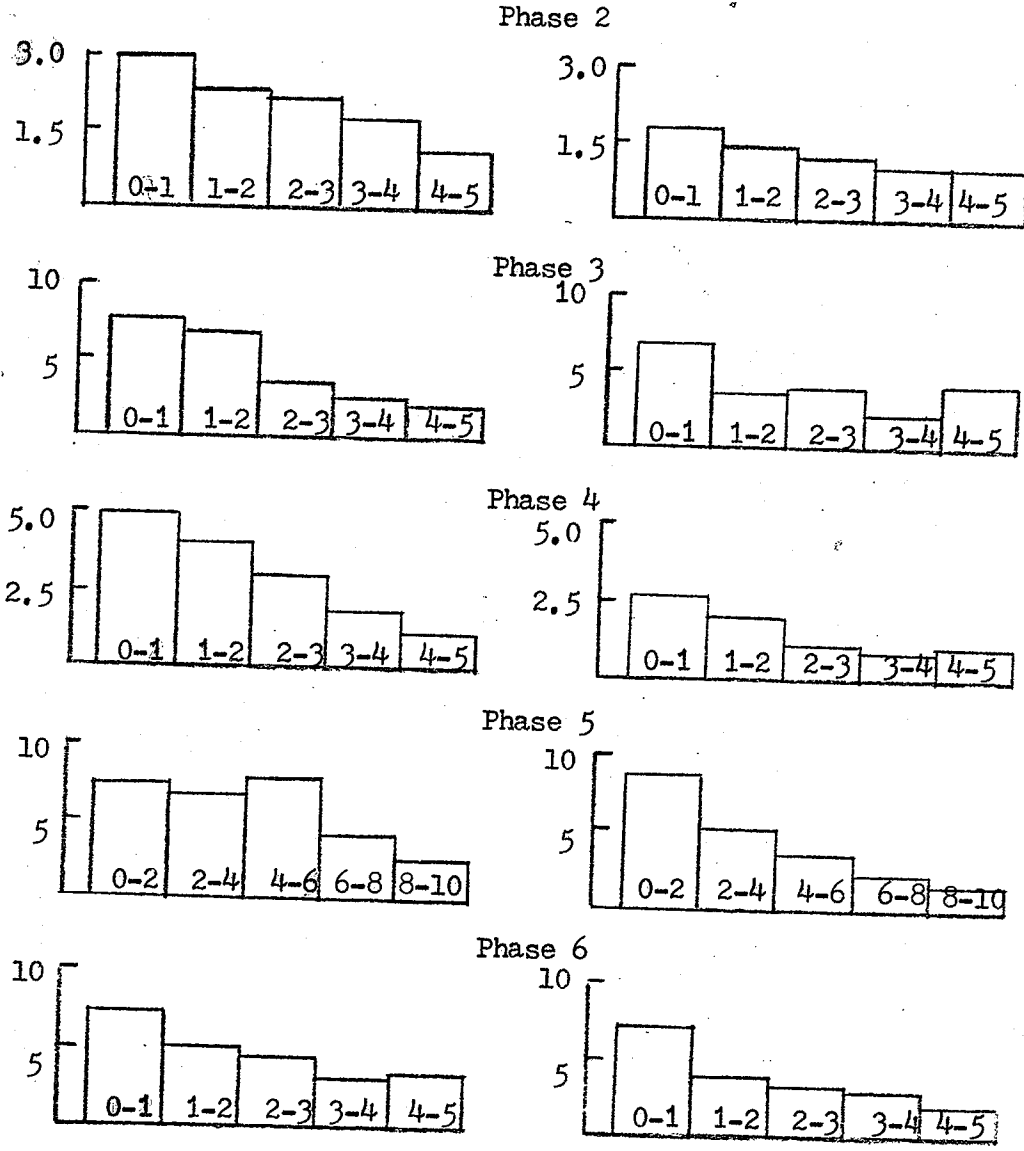
SUCCESSIVE CORRECT RESPONSES

Figure 15. Mean number of seconds of total inattention which occurred between successive correct responses in each phase in the light-flash and sequential light conditions with Gary.

MEAN INATTENTION BETWEEN SUCCESSIVE RESPONSES (SECONDS)

SEQUENTIAL LIGHT

BRIEF LIGHT FLASH



SUCCESSIVE RESPONSES

of primary reinforcers and first correct responses. In the sequential light condition, inattention was more evenly distributed over all segments with the least amount of inattention occurring in the fifth segment. Data on the distribution of Gary's inattention (Figure 15) was not recorded during Phase 1.

During Phase 2 in which a lever-press response was required, the inattention time of all subjects was similarly distributed within each experimental condition; that is, in both experimental conditions, inattention time decreased from segment to segment as the fixed-ratio requirement was fulfilled. However, inattention time was higher in the sequential light condition than in the light-flash condition in all but the fifth segment where it was lower for Sidney (Figure 14) and Alec (Figure 13).

The consistent decrease in the distribution of inattention time from segment to segment that occurred with all subjects in both conditions in Phase 2 was no longer as apparent in Phase 3 in which a lever-press response was no longer required to produce reinforcement. In Phase 3 an orderly decrease in the distribution of inattention was only apparent in the sequential light condition with Gary (Figure 15) and the flashing light condition with Alec (Figure 13) and Sidney (Figure 14). For all subjects, however, the most inattention occurred in the first segment of the distribution in both experimental conditions.

The distribution of inattention time during Phase 4 was similar to the distribution in Phase 2 in which a specific lever-press response was also required. In both experimental conditions inattention time tended to decrease from segment to segment except in the sequential light condition with Alec (Figure 13). As in Phase 2, inattention time for all subjects was generally higher in the sequential light condition than in the light-flash condition in

all segments but the fifth.

During Phase 5 in which an FR 10 schedule was in effect, the majority of Sidney's inattention time occurred between the delivery of primary reinforcers and fourth correct responses (i.e., in the first two segments of the distribution). Inattention in the latter segments was low in both experimental conditions (Figure 14). Gary (Figure 15) and Alec (Figure 13) generally spent more time engaging in inattentive behavior in the early segments than in the late segments in both experimental conditions. In addition, they generally spent more time engaging in inattentive behavior in all segments in the sequential light condition than in the brief light-flash condition.

During Phase 6 the schedule of primary reinforcement was reversed from FR 10 to FR 5. For all subjects, inattention time was higher in the sequential light condition in all segments but the fifth. In the fifth segment inattention time was higher in the light-flash condition than in the sequential light condition for all subjects.

During Phase 7 a single light was briefly illuminated in the light-flash condition after all correct responses other than fifth correct responses. For both Sidney (Figure 14) and Alec (Figure 13), inattention time was higher in the first segment in each experimental condition than in any subsequent segment. As in the previous phase, both subjects spent more time engaging in inattentive behavior in all segments in the sequential light condition except the fifth segment. The amount of inattention occurring in the fifth segment was similar in both experimental conditions for both subjects.

In general then, there was a consistent decrease in the distribution of inattention time from segment to segment in both experimental conditions, with a greater amount of inattention occurring in the sequential light

condition than in the light-flash condition in all segments but the fifth. The amount of inattention which occurred in the fifth segment was generally higher in the light-flash condition. These effects were evidenced for two subjects only when a lever-press response was required but were evident for the other subject whether or not a lever-press response was required.

CHAPTER IV

DISCUSSION

In general, the performance of all subjects on the picture-naming task was better in the light-flash condition than in the sequential light condition. Gary and Sidney's performance was superior in the light-flash condition only in those phases in which a lever-press response was required to produce reinforcers. Alec's performance was superior in the light-flash condition in all phases, regardless of whether a lever-press response was or was not required. Besides producing superior performance in the light-flash condition, the required lever-press response produced an improvement in Gary and Sidney's performance in both experimental conditions whereas this manipulation had no effect on Alec's performance in either condition.

When the FR 5 schedule of primary reinforcement was increased to an FR 10 schedule, Sidney's picture-naming behavior deteriorated in both experimental conditions. While Gary's picture-naming behavior also deteriorated in both experimental conditions during the FR 10 phase, both he and Alec continued to perform consistently better on the picture-naming task in the light-flash condition than in the sequential light condition.

The light-flash condition in Phase 7 differed from the light-flash condition in preceding phases in that, during Phase 7, the light-flashes which were contingent on correct responses not followed by primary reinforcers were different from the light-flashes contingent upon correct responses

followed by primary reinforcers. This change had no effect on the performance of the two subjects who experienced this phase. Both Sidney and Alec continued to perform better in the light-flash condition.

There were two main differences between the light-flash condition and the sequential light condition which could account for the superior performance in the light-flash condition in Phases 1 to 6. First, these conditions differed in that the sequential lights accumulated until primary reinforcers were delivered while the light-flashes did not. This accumulation provided stimuli on the basis of which the likelihood of the primary reinforcers could be easily discriminated by the subject. No parallel process occurred in the light-flash condition. Second, in the light-flash condition, the stimuli contingent upon each correct response (i.e., the momentary onset of five lights) also accompanied the primary reinforcers, and may have served as discriminative stimuli and conditioned reinforcers. The discriminative and conditioned reinforcing functions of the contingent stimuli in the light-flash condition may have produced higher performance than the contingent stimuli in the sequential light condition because in the sequential light condition, the stimuli which were associated with primary reinforcers (i.e., the illumination of five or ten lights) were not identical to the stimuli contingent upon other correct responses (i.e., the illumination of one, two, three or four lights). Since only the illumination of five or ten lights was paired with primary reinforcers in the sequential light condition, it could be that only the illumination of five lights or ten lights served as discriminative stimuli and powerful conditioned reinforcers, thus maintaining lower levels of performance.

The second explanation was tested in Phase 7. In this phase the light illuminations were similar in both conditions, in that the light

illuminations which followed each fifth correct response and accompanied the primary reinforcer were not the same as the light illuminations which followed the other correct responses. Specifically, in the light-flash condition a single light was illuminated after all correct responses except those that produced the primary reinforcer. This manipulation equated the two conditions except that the sequential lights accumulated whereas the light-flashes did not. If the previous superiority of the light-flash condition was due to the fact that the light-flashes which were contingent upon each correct response also accompanied primary reinforcers, then this manipulation should have produced a decrease in the superiority of the light-flash condition. This was not the case. In spite of this change, performance remained superior in the light-flash condition. While it may have been due to the subjects' extensive history in the light-flash condition, the failure of this manipulation to produce a decrease in performance in the light-flash condition suggests that the superior performance in the light-flash condition was a result of the accumulation of sequential lights providing discriminative cues as to the likelihood of primary reinforcement, that the light-flashes did not.

As mentioned in the Introduction, basic research (e.g., Kelleher, 1957, 1958) indicates that when conditioned reinforcers which accumulate (e.g., tokens) are utilized in FR schedules of primary reinforcement, responding is typically sporadic with frequent pausing until a number of tokens have been obtained. Other research on similar schedules (e.g., Findley and Brady, 1965; Kelleher, 1963; and Stubbs and Galloway, 1970) indicates that the initial pausing and low rate of responding does not occur when a brief change in some exteroceptive stimulus serves as the conditioned reinforcer. The conditions which exist prior to the delivery of the last token are

conditions which are never associated with primary reinforcers. As a result these conditions seem to function as discriminative stimuli controlling low response rates. Conditioned reinforcers such as light-flashes, because of their transient nature, are less likely to acquire these discriminative functions. This could account for the superior performance in the light-flash condition in the present research.

Data on the distribution of inattention (Figures 13, 14 and 15) provides support for the conclusion that the illumination of only a few or no lights in the sequential light condition, discriminatively controlled low response rates. In those FR 5 phases in which performance was superior in the light-flash condition, the amount of inattention occurring between the delivery of primary reinforcers and first correct responses, between first and second correct responses, and between second and third correct responses was generally higher in the sequential light condition than in the light-flash condition. This was not the case between third and fourth, and fourth and fifth correct responses. In many cases the amount of inattention occurring between fourth and fifth correct responses was lower in the sequential light condition than in the light-flash condition. This would seem to indicate that in the sequential light condition, the absence of illuminated lights or the presence of only a few illuminated lights discriminatively controlled low response rates. While a comparable process was often evident in the light-flash condition, inattention was generally distributed more evenly in that condition.

The introduction of a required lever-press response (Phases 2 and 4) had two main effects. First, the performance of two subjects (Gary and Sidney) was superior in the light-flash condition only in those phases in which a lever-press response was required to produce primary reinforcers. During

phases in which a lever-press response was not required, there was no difference in the performance of these subjects in the light-flash and sequential light conditions. Second, the performance of these two subjects improved considerably in both experimental conditions in those phases in which the lever-press response was required. The performance of a third subject (Alec) was superior in the light-flash condition whether or not a lever-press response was required, and the introduction of a lever-press requirement did not result in improved performance in either experimental condition. However, when the lever-press response was no longer required, (Phase 3), the performance of all three subjects was disrupted in both experimental conditions. Alec's performance recovered in both conditions whereas Gary and Sidney's performance did not improve during the phase.

The effects of the required lever-press response can probably be partially accounted for in terms of its effect on the reinforcing value of the response-contingent stimulus lights in each experimental condition. It is possible that Gary and Sidney attended to the light-flashes and sequential lights only in those phases in which a lever-press response was required, and as a result the lights served as discriminative stimuli and conditioned reinforcers only in those phases. Alec, on the other hand, may have attended to the lights whether or not a lever-press response was required, and as a result the lights served as discriminative stimuli and conditioned reinforcers in all phases.

Keller and Schoenfeld (1950) stated that the simple pairing of a stimulus with the delivery of other reinforcers is not necessarily a sufficient procedure for creating conditioned reinforcers. They proposed that a stimulus must be a discriminative stimulus for some response in order to acquire reinforcing properties. In other words, in order for a stimulus to function

as a reinforcer, the organism must first "attend" to the stimulus. Ensuring that a stimulus impinges upon the appropriate sensory receptors does not guarantee that an organism will attend to the stimulus. We can only ensure that an organism will attend to a stimulus by establishing the stimulus as a discriminative stimulus for some operant response (Terrace, 1966). Discriminative stimuli are typically established through the procedure of differential reinforcement. This procedure specifies that a class of responses is reinforced only in the presence of a particular stimulus, and is never reinforced in the absence of that stimulus. The stimulus is said to be a discriminative stimulus when the probability of occurrence of members of the response class is higher in the presence of the stimulus than in its absence.

The development of stimulus control in complex stimulus situations presents additional problems. Differential reinforcement of responding in a complex stimulus situation does not guarantee that all dimensions of the stimulus situation will acquire discriminative functions. For example, Reynolds (1961) reinforced pigeons for key pecking in the presence of a white triangle on a red background but did not reinforce responding in the presence of a white circle on a green background. When he separately presented these four stimulus components in extinction, he found that responding did not occur in the presence of the white circle or the green background. However, he also found that for both pigeons only one dimension of the complex stimulus control (discriminative functions). One pigeon responded only in the presence of the red background and the other pigeon only in the presence of the white triangle.

While only one dimension of the complex stimulus acquired control over responding in the Reynold's study, other studies (e.g., Butter, 1963; Fink and Patton, 1953) have demonstrated that a complex stimulus can acquire

control over responding along more than one dimension. In complex stimulus situations, however, it is difficult to predict whether a given stimulus dimension will acquire discriminative control over a response differentially reinforced in its presence. Control by a particular dimension or property can be guaranteed only by differential reinforcement based on the presence or absence of that dimension or property alone. Such differential reinforcement may be considered a sufficient condition for developing stimulus control, though whether or not it is a necessary condition is presently not known. When such stimulus control has been established the organism may be said to be attending to the stimulus.

In the present research the experimental setting may be considered a complex stimulus situation, in which light illuminations following correct responses were only one component. The periodic pairing of the light illuminations with primary reinforcers did not guarantee that the children attended to the lights (i.e., that the lights acquired discriminative control over some subsequent response). If the children did not attend to the lights, the lights could not properly be referred to as conditioned reinforcers and reinforcing effects could not be assumed. To increase the likelihood that the children attended to the lights, a specific attending response (i.e., a lever-press) was required and was differentially reinforced in the presence of the lights. While this did not necessarily guarantee that the children would attend to the lights, it increased the likelihood of that occurring. In this context, the results of the present research would suggest a number of conclusions.

The present research indicates that the performance of some subjects is superior in the light-flash condition only if a specific response is required to produce the reinforcers. It also indicates that for some subjects,

such a requirement results in improved performance when either light-flashes or sequential light illuminations are contingent upon correct responses. This suggests that when a specific attending response is not required, response-contingent lights may not function as conditioned reinforcers for all subjects even though the lights are periodically paired with the delivery of primary reinforcers. When a specific attending response is required, however, the lights seem to acquire discriminative properties and the onset of the lights seem to function as conditioned reinforcers. (Since the subjects in the present research were observed to press the lever very infrequently in the absence of light illuminations, and always pressed the lever when the lights were illuminated, it seems safe to conclude that light illuminations discriminatively controlled lever-press responses.) Thus it seems that performance may be superior when a specific response is required, simply because for some subjects, response-contingent stimuli function as conditioned reinforcers only under those conditions.

The performance of other subjects, however, does not seem to improve when a specific response such as a lever-press is required to produce primary reinforcers. In such cases, two alternative conclusions are possible. Some subjects may attend to response-contingent stimuli even when a specific attending response is not required, or they may not attend whether or not a specific response is required. In the present research, Alec's performance did not improve in either condition when a lever-press response was required. Since his performance was consistently superior in the light-flash condition, and the performance of the other subjects was also superior in the light-flash condition when a lever-press response was required, it seems most likely that Alec attended to the lights whether or not a lever-press response was required. It was also observed that during phases in which a lever-press response was

required, Alec rarely pressed the lever when the lights were illuminated. This would suggest that the lights discriminatively controlled his lever-press responses. In other words, he seemed to attend to the lights in phases requiring lever-press responses. Since his performance in those phases not requiring lever-press responses closely resembled his performance when a lever-press response was required, it seems likely that he also attended to the lights in phases not requiring lever-press responses. In general, then, Alec seemed to attend to the lights whether or not a lever-press response was required whereas Gary and Sidney only attended to the lights in those phases requiring a lever-press response.

It might be expected that once attending occurred with Gary and Sidney, it would continue even when the lever-press response was no longer required. This was not the case. Removal of the lever-press requirement resulted in a deterioration in the picture-naming behavior of both of these subjects in both experimental conditions and eliminated the superiority of the light-flash condition. This was also the case with Alec, for whom the lever-press requirement had produced no improvement in performance. While the deterioration in performance was only a temporary phenomenon with Alec, Gary and Sidney's performance did not recover until the lever-press requirement was re-introduced. This would seem to suggest that when the lever-press response was no longer required, the subjects stopped attending to the lights, thereby removing the possibility of the lights functioning as conditioned reinforcers. This alone could account for the deterioration in performance.

While the failure to attend might be sufficient to account for the deterioration in Gary and Sidney's performance, it does not readily account for the temporary disruption of Alec's performance. It seems unlikely that Alec stopped attending to the lights when the lever-press response was no

longer required, since he previously seemed to attend to the lights in Phase 1 under similar conditions. An alternative explanation is that the stimuli associated with the lever-press response and light offset may themselves have acquired reinforcing properties. This seems likely since these stimuli immediately preceded consummatory responses. Since many of these stimuli no longer occurred when the lever-press response was no longer required, the removal of the lever-press requirement could be viewed as the removal of a number of conditioned reinforcers. This could account for the abrupt deterioration in Alec's performance in Phase 3 and could account for similar aspects of Gary and Sidney's performance. The immediate deterioration in the performance of all three subjects might have been a result of the removal of the conditioned reinforcing stimuli associated with the lever-press and light offset, whereas the lack of recovery of Gary and Sidney's performance might have been a result of the failure of these subjects to attend to the lights.

One other aspect of the present results which merits discussion is the effect of the FR 10 schedule in Phase 5. The introduction of this schedule resulted in the near extinction of Sidney's behavior in both experimental conditions. However, in a previous study in which a number of fixed-ratio values were examined (Stephens et al., 1974), Sidney performed equally well on a picture-naming task under FR 10 and FR 5 schedules of primary reinforcement. Extinction did not occur in that research until a fixed-ratio value of twenty-five was reached. In that research the experimenter said, "Good boy" after each correct response in all experimental conditions. No other conditioned reinforcers were presented and thus there were no stimuli on which basis the likelihood of delivery of primary reinforcers could be easily discriminated. In the present case the children could discriminate the likelihood of delivery of primary reinforcers in the sequential light condition on

the basis of the number of lights illuminated. Perhaps extinction occurs at lower fixed-ratio values when the likelihood of reinforcement can be easily discriminated. While this might account for Sidney's extinction in the sequential light condition, it cannot account for extinction in the light-flash condition unless extinction in that condition occurred simply on the basis of generalization from the sequential light condition.

Stephens et al. (1974) noted that superior performance occurred in those conditions associated with the intermediate fixed-ratio schedule values (greater than FR 5 but less than FR 20) as a result of an overall increase in responding. In other words, the higher fixed-ratio schedule, in any comparison up to a certain limit, resulted in more total responses per session, both correct and incorrect, rather than increasing only correct responses. In the present research superior performance in the light-flash condition was also largely a function of an overall increase in responding in that condition. Thus, while the children learned to name the most pictures in those conditions in which they emitted the most correct responses, they also tended to emit the most incorrect responses in those conditions.

The present research has a number of implications for the use of conditioned reinforcers in procedures for training the mentally retarded. First, the research suggests that the simple pairing of a stimulus with the delivery of other reinforcers does not guarantee that the stimulus will acquire reinforcing properties. The likelihood of a stimulus acquiring reinforcing properties is increased if a specific response is required to produce the reinforcer in the presence of that stimulus. This implies that of the two most commonly used conditioned reinforcers - tokens and praise - tokens are more likely than praise to acquire reinforcing properties. As tokens are conventionally used, a specific response is required to produce reinforcement,

in that tokens must be exchanged for primary reinforcers. This should increase the likelihood of tokens acquiring reinforcing properties. In typical usage, however, praise is simply paired temporally with the delivery of other reinforcers. This does not guarantee that the subjects will attend to praise and therefore, that praise will acquire reinforcing properties. To guarantee that stimuli such as verbal praise function as conditioned reinforcers, a specific response, such as a lever-press response, should be required to produce primary reinforcers. Moreover, any comparison of tokens and praise as conditioned reinforcers should require such a response in both conditions to increase the likelihood that the subjects attend to both types of stimuli.

The present research also implies that when fixed-ratio schedules of primary reinforcement are employed, conditioned reinforcers which do not accumulate (e.g., light-flashes, praise) are more effective than conditioned reinforcers which do accumulate (e.g., sequential lights, tokens). (Over all sessions, each child learned to name considerably more pictures in the experimental condition in which the conditioned reinforcers did not accumulate; i.e., the light-flash condition. Gary, Sidney, and Alec learned to name 1.8, 2.4, and 1.7 times as many pictures respectively in the light-flash condition as in the sequential light condition.) Conditioned reinforcers which accumulate provide discriminative cues as to the likelihood of primary reinforcers and as a result seem to control low response rates until a number of conditioned reinforcers have been obtained. This discriminative control of low rates does not seem as likely to occur with conditioned reinforcers which do not accumulate, and might not occur if fixed-ratio schedules of primary reinforcers on a variable-ratio schedule (in which reinforcers occur after a varying number of responses have been emitted) the number of tokens in possession would not directly indicate the likelihood of delivery of primary

reinforcers. In those conditions, therefore, conditioned reinforcers which accumulate might not come to control low response rates.

A final implication of this research is that fixed-ratio behavior might extinguish at lower schedule values when conditioned reinforcers which accumulate are used than when conditioned reinforcers which do not accumulate are used. Thus, if one of the goals of a training program is to maintain a high number of responses with infrequent primary reinforcers, the latter type of conditioned reinforcer might be preferable.

CHAPTER V

SUMMARY

The results of this study indicate that performance on a picture-naming task is generally superior when conditioned reinforcers which do not indicate the likelihood of delivery of primary reinforcers (e.g., light flashes) are contingent on correct responses than when conditioned reinforcers which do indicate the likelihood of delivery of primary reinforcers (e.g., sequentially illuminated lights which accumulate) are contingent upon correct responses. For two subjects this was the case only when a specific lever-press response was required to produce primary reinforcers. In addition, when a lever-press response was required, these two subjects performed better in both experimental conditions than when a specific attending response was not required. These findings indicate that the association of a stimulus in temporal contiguity with a reinforcer is not always a sufficient procedure for establishing the stimulus as a conditioned reinforcer. It seems that in order for a stimulus to function as a conditioned reinforcer, the stimulus must discriminatively control an operant response.

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