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Conditionability of Successively Presented Compound Stimulus Elements in a Conditioned Suppression Procedure, as a Function of Prior Conditioning to One of the Compound Elements

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CONDITIONABILITY OF SUCCESSIVELY PRESENTED COMPOUND STIMULUS ELEMENTS IN A CONDITIONED SUPPRESSION PROCEDURE, AS A FUNCTION OF PRIOR CONDITIONING TO ONE OF THE COMPOUND ELEMENTS

by

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The present study was designed to investigate the selective conditionability of successively presented stimulus elements, in a conditioned suppression procedure, as a function of prior conditioning to one of the elements.

Kamin (1968) has demonstrated that the conditioning of a stimulus element prior to its simultaneous presentation with an element without such a history, produces no conditioning to the latter element in the compound. This failure of conditioning he termed "the blocking effect." Such stimulus "blocking" as been reliably demonstrated with various procedural variations in both discriminated operant behavior (Miles and Jenkins, 1965; Southerland and Mackintosh, 1964) and classical conditioning procedures (Kamin, 1968; Rescorla and Wagner, 1972; Wagner, 1969). Much of the research uses the basic conditioned suppression procedure to demonstrate the "blocking effect." The degree of stimulus conditioning is measured by the decrease in the rate of an operant behavior occuring during the stimulus, which terminates with a brief response-independent shock (Estes and Skinner, 1941). The stimulus, either visual, auditory, or kinesthetic, has been identified as a conditioned stimulus (CS), while the response-independent shock has been seen as an unconditioned stimulus (UCS) (Rescorla, 1969). The following diagram illustrates the basic procedural variations and relevant controls for Kamin's (1968) "blocking effect," where L, N and LN refer respectively to light, noise (80dB white-noise), and the light-noise compound. The number of stimulus pairings with the UCS are indicated in parentheses, to the right of each stimulus-letter designate. The test stimulus is presented without the UCS, with the degree of response suppression measured in terms of the response rate in the CS, relative to the rate in the absence of the CS. A ratio of .50 indicates no suppression, and a ratio of .00 indicates complete response suppression.

Procedure for "Stimulus Blocking"

Group	CS_1	CS_1, CS_2-UCS	Test CS_2	Suppression Ratio
B	N(16)	LN (8)	L	.45
F	L(16)	LN (8)	N	.50
G	-	LN (8)	L	.05
H	-	LN (8)	N	.25

Groups B and F illustrate the procedure and typical results of the "blocking effect." The prior conditioning to the CS_1 element is shown to be the critical determinant for the failure of conditionability in the CS_2 test element. Groups G and H, without prior conditioning to CS_1, provide evidence that each element in the compound is conditionable.

A number of variables and/or observations functional to the production of the "blocking effect" have been demonstrated and interpreted by Kamin (1968, 1969a, and 1969b). Sixteen CS_1-UCS pairings were found to be optimal, more than sixteen pairings did not increase the "blocking effect," although any less than sixteen pairings produced a proportional increase in the later condtionability to the CS_2 element. Such increases in conditionability result in decreases in the CS response rate (conditioned suppression ratios that are below .50). Covarying with the number of CS_1-UCS pairings, the amount of commensurate conditioning produced by the pairings, was found to be another indicator of the amount of conditioning of the CS_2 element in the compound. By increasing the number of CS_1-UCS pairings, complete or "asymptotic" suppression of the response rate during CS_1 was obtained. This prior conditioning prevented conditioning to the CS_2 element when the stimuli were presented simultaneously--a "blocking effect." On the other hand if the amount of suppression evidenced in CS_1 was less than complete, a proportional increase of conditioning to the CS_2 element was evidenced by the decrease in the response rate during CS_2 in the test phase. The intensity of the CS_1 element was seen to be another covariant variable with the number of CS_1-UCS pairings. A tone intensity of 80dB reliably prevented conditioning to the CS_2 element in the compound. However, as the intensity of the CS_1 element was decreased to 50dB, more severe suppression was obtained to the CS_2 element following the simultaneous presentation of CS_2 in the compound stimulus condition. An earlier analysis of Kamin (1965) showed that with a single stimulus element, generally more and faster conditioning took place with stimuli of greater intensities. The 50dB group, for example, showed less than complete or "asymptotic" suppression when a 50dB stimulus was used prior to the compound-CS pairings. The comparison of CS intensities (50 to 80dB) had not controlled for differential rates of CS conditioning, so that the CS intensity variable in the "blocking effect" is still unclear (Honig, 1970).

Kamin (1968) has demonstrated two procedures that eliminate the "blocking effect," and produce conditioning to the CS_2 element. Both procedures entail manipulations of the UCS during the compound-CS pairings. If the intensity of the UCS is greatly increased during compound-CS presentations, or if two (rather than one) UCS follow the compound CS, the "blocking effect" does not occur. And conditioning of the CS_2 element is established.

Kamin's (1968, 1969a, 1969b) interpretations of the "blocking effect" entail the following sequence of approaches. The first approach is based upon a selective role of attention in classical conditioning. The second element (CS_2) is a "redundant element," since CS_1 already perfectly predicts the onset of shock. Fewer CS_1-UCS trials reduces the redundancy of compound elements. This type of "information theory" was advanced by Kamin (1968) from a similar procedure measuring discriminated operant behavior, in which a "redundant" predictor of food availability did not serve an effective discriminative stimulus (S^D) (Egger and Miller, 1962). The elimination of the "blocking effect" by manipulation of the UCS in compound pairings provides the basis of Kamin's (1968, 1969b) "surprise hypothesis." The interpretation rests clearly upon a cognitive analysis.

A recent reinterpretation of the "blocking effect" by Rescorla and Wagner (1972) provides an analysis with a less cognitive orientation. Pilot research for this interpretation was provided by an extension of Egger and Miller's (1962) "informationess" view of by Wagner (1969). The series of experiments clearly demonstrates that the "blocking effect" can reliably be produced in a conditioned suppression procedure if the first element (CS_1) is reliably followed by the UCS prior to compound stimulus pairings. Conditioning to the superimposed (CS_2) element was found to occur if the CS_1 element was uncorrelated with the UCS prior to simultaneous compounding. The term given by Wagner (1969) for this type of "informationess" is "stimulus validity" (Wager, 1968).

The formalization of Wagner's (1969) theoretical evidence, and Rescorla's (1969) formulation of a dual-component theory of classical conditioning, has been integrated into a common theory to explain compound element conditioning. While it is beyond the scope of this manuscript to describe the accompanying mathematical model, an outline of the general theory is presented. THe basic theory describes the relationship between compound stimulus elements as dependent upon their individual "associative strengths." Associative strength is determined by the prior history of conditioning to each compound element. Two processes of conditioning have been demonstrated by Rescorla (1969) to explain how the initial history of stimulus elements will effect the latter "associative strength" of the combined elements in the compound. When a CS is reliably followed by a UCS (excitatory conditioning), its joining with an element without such a history will produce a compound stimulus with a "strong associative strength." Since the CS_1 element already elicits a large CR, very little or no further conditioning to the compound stimulus containing CS_1 can take place--a "blocking effect." The two variables (according to this theory) prerequisite to "complete blocking" are: 1) Excitatory conditioning to the CS_1 element, i.e., CS_1-UCS pairings, and 2) CS_1 elicits the maximal CR that "the UCS will hold" (Rescorla and Wagner, 1972). Kamin's (1968) "asymptote suppression" observation carried a similar application. Once complete learning or "asymptotic" suppression of CS_1 was attained, no further conditioning was exhibited in the CS_2 compound element. Decrements in learning on CS_1 trials can occur if CS_1 is not reliably followed by the UCS. This process is labled "inhibitory conditioning" by Rescorla (1969). If a CS_1 element is so conditioned, it will produce a compound of "weak associative strength," when it is added to an element without such a history. Compound stimuli with "weak associative strength" may be further conditioned when they are reliably followed by a UCS, producing conditionable elements, or no "blocking." Since this process ("inhibitory conditioning") produces no CR to the CS_1 elements, increments in learning will take place up to the maximal CR on compound-CS -UCS pairings. A compound with "weak associative strength" can also be produced if both elements of the compound have not had prior histories of conditioning. Again, conditioning of both elements may begin with the first compound-UCS pairing. The series of experiments by Wagner (1969) and Rescorla and Wagner (1972) have provided empirical evidence for the role of dual processes in the classical conditioning of compound stimulus elements. The results of these studies are summarized as follows: 1) The conditionability of a compound stimulus element was found to be a direct function of the prior excitatory or inhibitory history of conditioning to each element, in the manner described by the basic theory. 2) Similar data were presented in an experimental design employing an "alternating" procedure of stimulus compounding with either excitatory or inhibitory conditioning to one of the elements. Prior conditioning to one of the elements was not found to be a necessary condition to produce the "blocking effect;" alternating conditioning to a compound stimulus, with single element pairings would suffice. 3) The "blocking effect" was demonstrated in a variety of procedural variations, including variations in the effects of reinforcement, non-reinforcement, number of trials, and intensity of the UCS.

The conditionability of compound stimulus elements, following prior conditioning to one of the elements, has not been investigated with procedural variations in the temporal relationships between compound stimulus elements. The present study was designated to determine if a successive presentation of compound elements would yield conditionable stimulus elements.

METHOD

Subjects

Nine experimentally naive male albino Sprague-Dawley rats, approximately 200 days old, were procured from the Upjohn Company, Kalamazoo, Michigan, and served as subjects. All subjects were maintained on a schedule of water deprivation such that prior to Phase 1, each subject was given five minutes access to water per day. During each phase of experimentation, water availability was decreased to three minutes, since pilot data from this experimenter indicated that an increased deprivation was necessary to maintain behavior on interval schedules. Purina Rat Chow was freely available in the home cage of each subject. Subjects were individually housed in wire-mesh cages contained in a temperature and humidity-controlled animal room. Experimental sessions were run at the same time daily so that differential deprivation levels would not alter daily response rates. Subject B-1 developed a skin infection during the study and was treated with a vitamin supplement in the post-session watering, which eliminated the infection symptoms within 48 hours.

Apparatus

Three experimental chambers were each 18 cm wide by 21.6 cm long by 18.5 cm deep. Side walls and the hinged top were constructed of plexiglass, while the back wall (painted flat black) and the intelligence panel were constructed of aluminum. A standard LVE/BRS rodent lever was located 4.5 cm from the right side of the intelligence panel, 3.5 cm above the grid floor. A 27 gram downward displacement on the lever defined the bar press. A 24 volt D.C. bulb producing 7.5 watts through a plastic white diffuser was located 10 cm above the response lever, 14 cm above the grid floor. A Mallory No. 628 Sonalert Tone Generator located 14 cm above the grid floor in the center of the back wall, produced a pure tone of 2800 Hz at 97 dB.

The grid floor was constructed of 15 aluminum rods, parallel to the intelligence panel and back wall, each .32 cm in diameter and 1 cm apart. Prior to each session the grid floors were cleaned with a Lysol solution and rinsed with water to insure constant shock application.

The 24 volt D.C. solinoid-operated dipper produced .1 cc of water into a recessed cup 3.5 cm from the leftside of the intelligence panel, adjacent to the response lever.

The experimental chambers were positioned in sound-attenuated cabinets, each with A.C. ventilation fans producing additional audio masking (84 dB) of external noises. The three cabinets were contained in a room adjacent to the shock-generator and computer-programming systems.

The shock was generated by a BRS Model SG002 constant-current shock generator, producing 1.3 ma to a high speed mercury-wetted shock scrambler model 255 by Davis Instruments, switching polarity to each of the 15 grids in each chamber simultaneously.

All on-line experimental-event programming and data collection were generated using the SKED software system (Snapper and Kadden, 1973) on a PDP/8L computer by Digital Equipment Corporation, Maynard, Massachusetts, the interface was developed and constructed by SKED Users Groups (SUG), Kalamazoo, Michigan. Data collection was augmented with a computer-energized BRS Model C-3 cumulative recorder for each chamber. Computer-control allowed the simultaneous and independent exposure to contingencies for each of the three chambers per experimental group.

Procedure

Prior to the onset of Phase I, subjects were assigned to three groups: B, C, and D (N = 3 per group), and adapted to the deprivation schedule for a period of seven days. Sessions were conducted once daily.

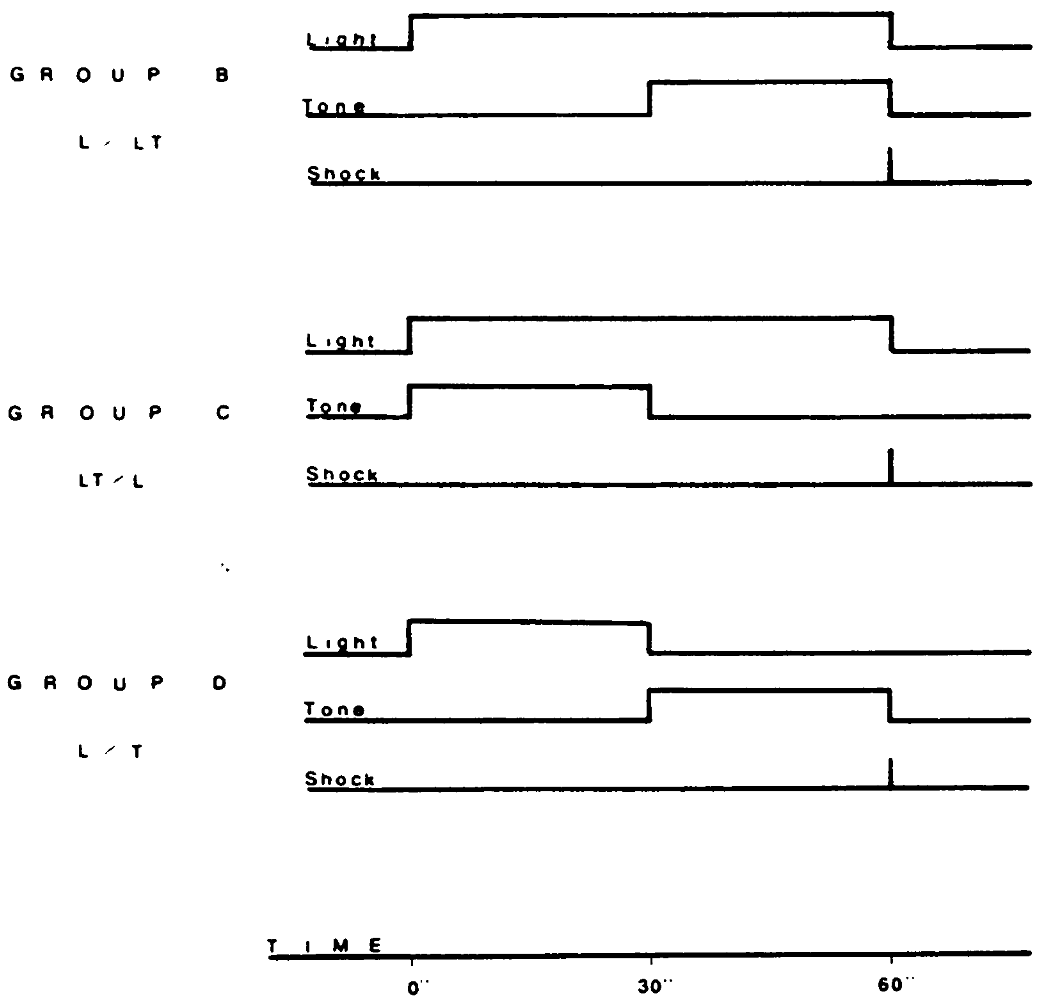
All subjects were exposed to the following mean-interval sequences of a constant probability variable-interval schedule of reinforcement (Catania and Reynolds, 1968): VI-12", VI-25", and VI-50", providing 3" access to water following the first response after each interval completion in the schedule. Sessions were terminated by the completion of either 75 reinforcers or 60 minutes elapsed time. VI schedules were advanced to the next mean-interval sequence upon completion of five consecutive sessions without a response pause of 60" or longer. Seven such consecutive sessions were required for all S's exposed to the VI-50" schedule, before the next phase began.

In the next phase, all subjects were exposed to the VI-50" schedule of reinforcement with three seconds access to water, for the entire session. Independent of the ongoing baseline (VI-50"), four pairings of tone and shock were presented during the session on a variable time twelve minute schedule (VT-12'), such that the first pairing was not presented within the first fifteen minutes of the session and the range of interval presentations was 8-16 minutes between presentations. Tone duration was 60", with its termination followed by a .5", 1.3 ma shock. Two suppression ratios, B/A+B and B/a+B, were calculated for each pairing, where B equals number of responses during the tone presentation, A equals number of responses 60" prior to the tone onset, and a equals the response rate per minute for the entire session. Response rates for the period prior to each pairing were also calculated to ascertain the effect of the pairings upon the operant baseline. Four pairings (trials) were presented each session such that 16 trials (within four sessions) terminated this phase.

S's in all groups were then exposed to the VI-50" schedule of reinforcement (operant baseline), however, groups B, C, and D received different compound stimulus pairing presentations on the VT-12' presentation schedule. Figure 1 illustrates the pairing procedure for each group of subjects. The subjects in Group B (L/LT) were presented with 30" duration of the light-tone compound, ending with the .5", 1 ma shock. The subjects in Group C (LT/L) were exposed to the simultaneous presentation of light and tone, followed by 30" of light alone, ending in the brief shock. Finally, Group D (L/T) was exposed to 30" of light, followed by 30" of tone, ending in brief shock. Both suppression ratios (B/A+B, B/a+B) and the pre-compound stimuli baseline response rates were calculated. Four trials were presented each session, for a total of eight trials. The session following the eighth trial initiated the final phase.

In the last phase, conditioning to the light element was tested by the VT-12' presentation of the 30" duration light, without the UCS, upon the VI-50" operant baseline. Four presentations of the light stimulus were exposed to Groups B and D, while seven such exposures were given to the subjects in Group C. Again, both suppression ratios and the pre-stimulus presentation baseline response rates were calculated.

Figure 1. Time-line illustration of compound stimulus presentations for each condition of successive stimulus presentation.


GROUP B
L / LT
Light
Tone
Shock
GROUP C
LT / L
Light
Tone
Shock
GROUP D
L / T
Light
Tone
Shock
TIME
0"
30"
60"

RESULTS

Conditionability of stimulus elements was measured by comparison of response rate during the CS, relative to the rate in its absence. The comparison of these rates were expressed in the form of two suppression ratios: B/A+B and B/a+B, where "B" was the response rate during the CS, "A" was the rate of response in an equal interval prior to CS onset, and "a" was the response rate for the entire session. Pre-CS response rates (the "A" measure in the B/A+B ratio) for each stimulus presentation were also provided as an indication of baseline variability.

Figures 2-10 indicate that the general form of the two suppression ratios as a function of stimulus presentation, were very similar for S's in each compound stimulus condition. Due to this similarity in the form of the two ratios across stimulus presentations, suppression ratios described in this section will refer only to the B/A+B measure. Suppression ratios for the B/A+B measure were greater than those for the B/a+B ratio when the pre-CS response rates were smallest. When the pre-CS rates were highest, the B/A+B exhibited larger suppression ratios than did the B/a+B measure.

Figures 2-4 indicate that following the fourth T-UCS presentation, all S's in Group B displayed suppression ratios at or near .00 for the remaining T-UCS presentations. When the L/LT successive compound was introduced, each subject in Group B displayed suppression ratios of .00 for the remaining seven presentations of the LT component of

Figure 2. Suppression ratios and pre-CS response rate as a function of stimulus presentation for subject B-1 in condition L/LT.

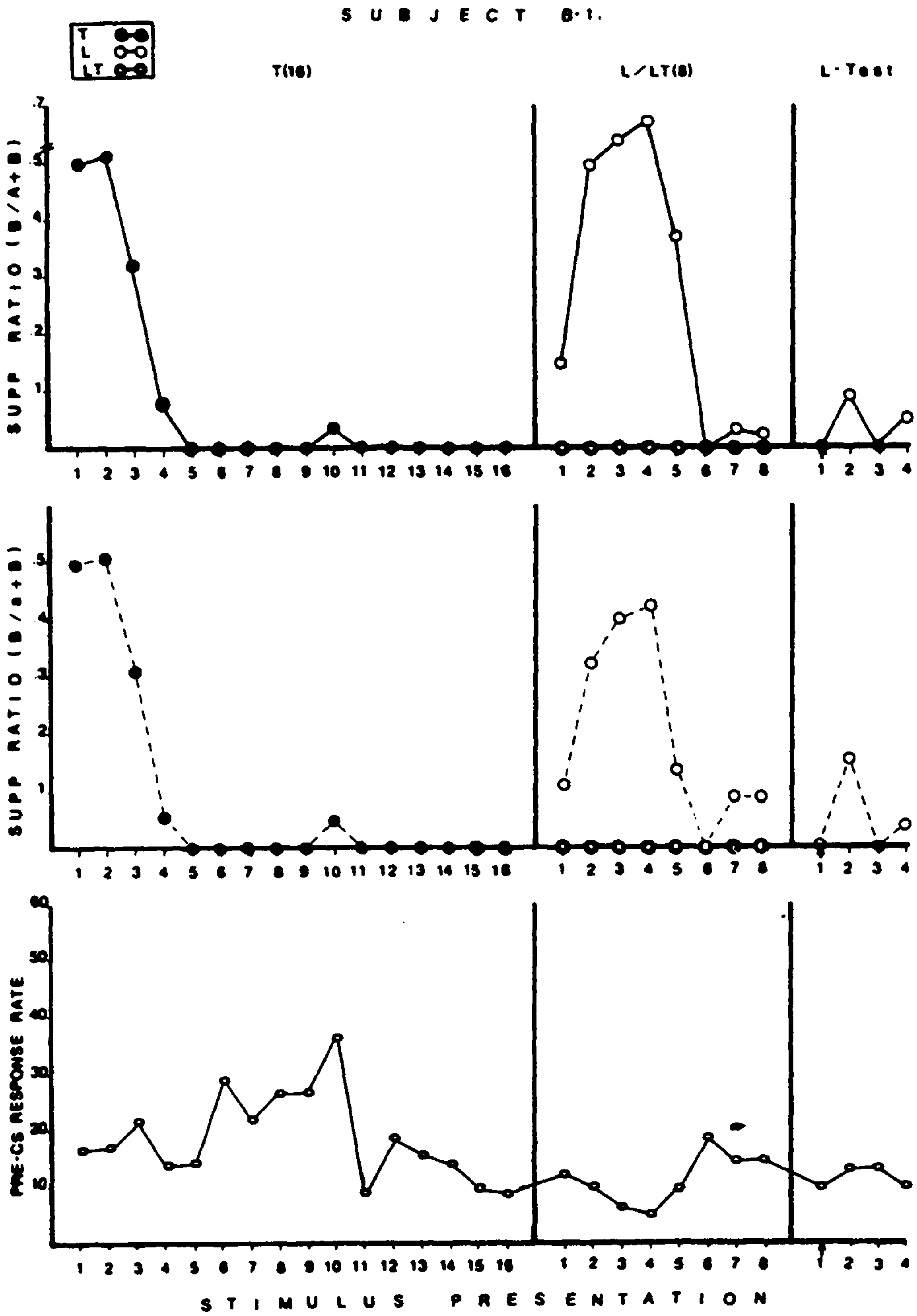

SUBJECT B-1.
T
L
LT
T(16)
L/LT(8)
L-Test
SUPP RATIO (B/A+B)
SUPP RATIO (B/a+B)
PRE-CS RESPONSE RATE
STIMULUS PRESENTATION

Figure 3. Suppression ratios and pre-CS response rate as a function of stimulus presentation for subject B-2 in condition L/LT.

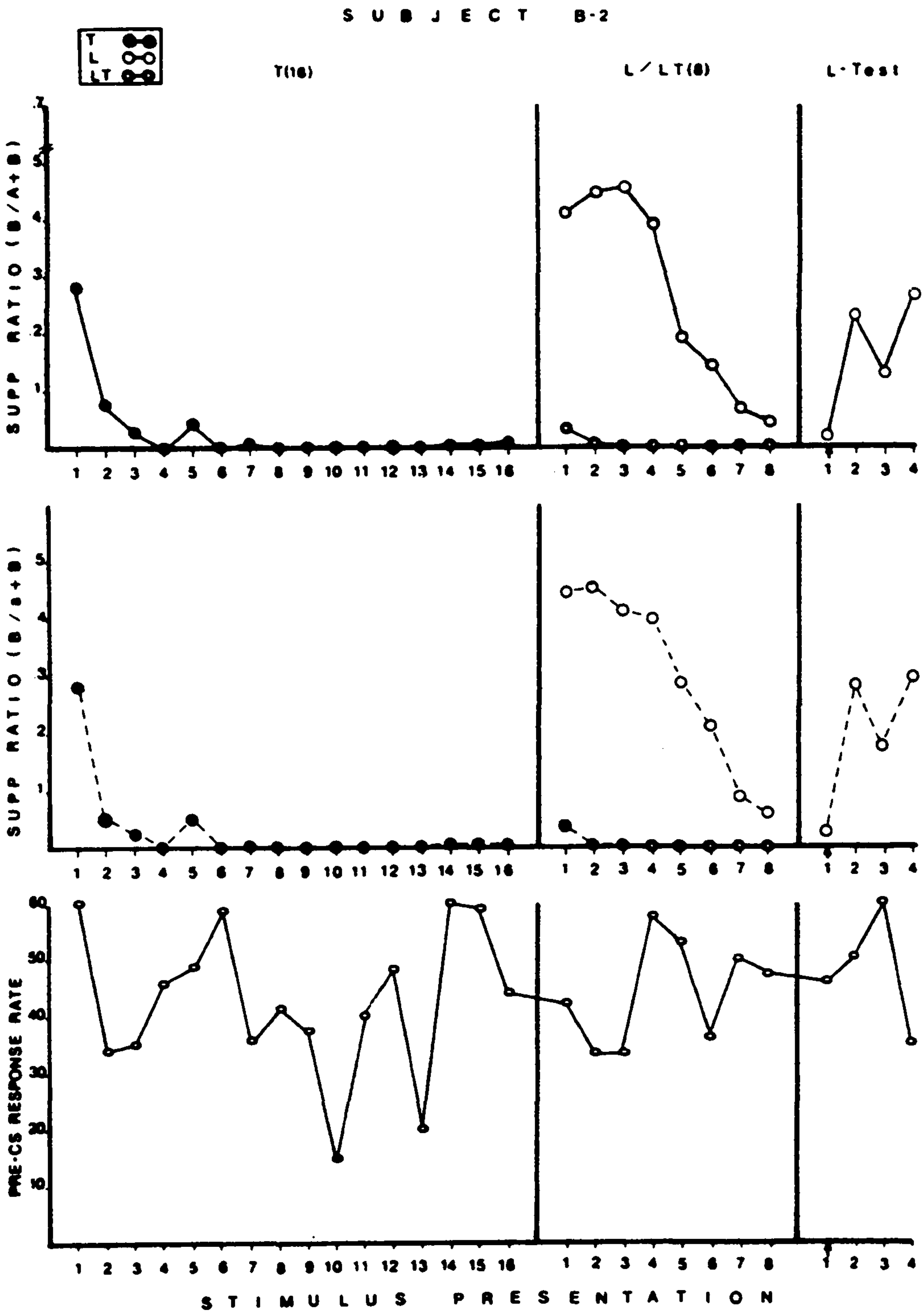
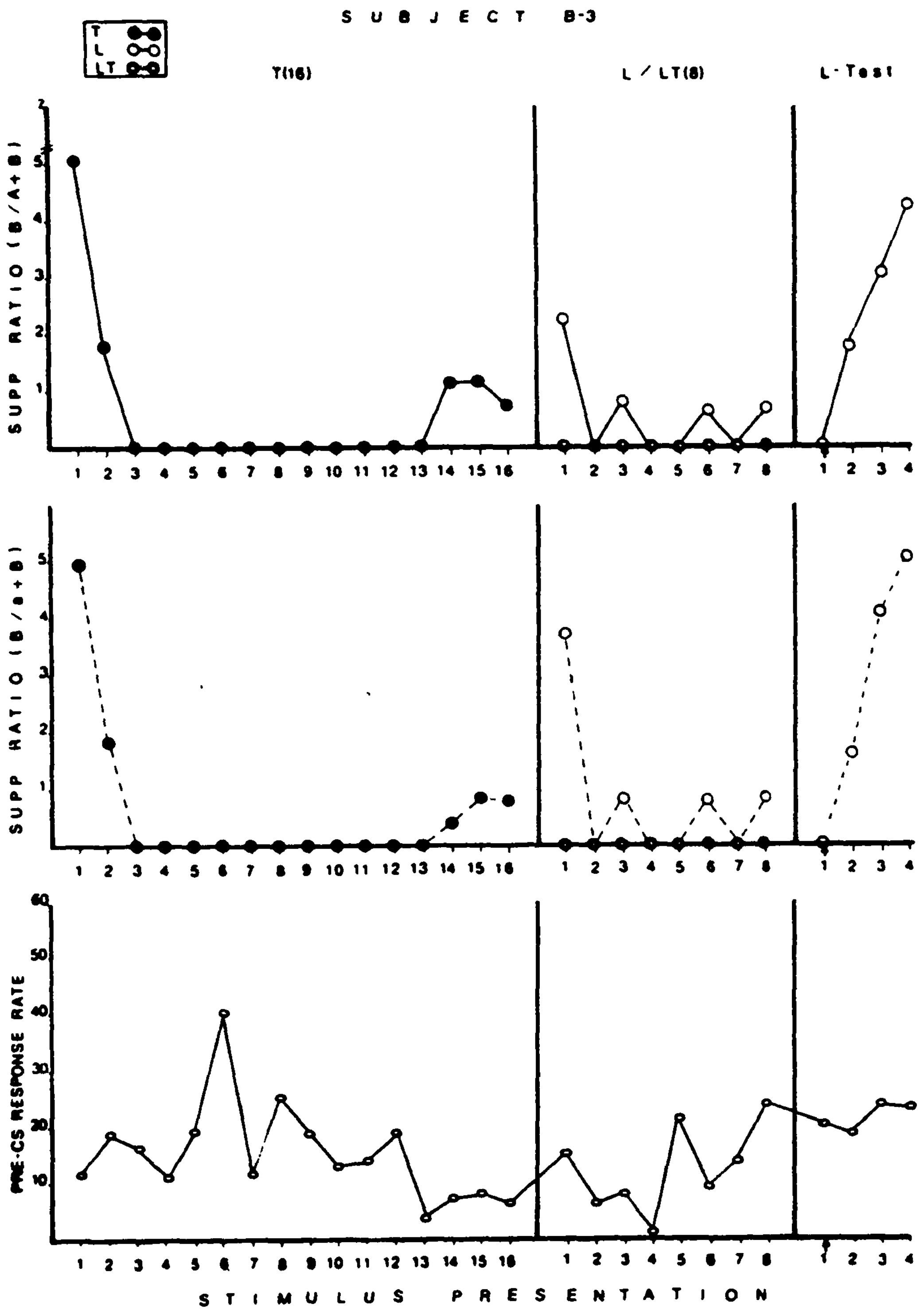

SUBJECT B-2
T
L
LT
T(16)
L/LT(8)
L-Test
SUPP RATIO (B/A+B)
SUPP RATIO (B/a+B)
PRE-CS RESPONSE RATE
STIMULUS PRESENTATION

Figure 4. Suppression ratios and pre-CS response rate as a function of stimulus presentation for subject B-3 in condition L/Lt.


SUBJECT B-3
T
L
LT
T(16)
L / LT(8)
L-Test
SUPP RATIO (B/A+B)
SUPP RATIO (B/A+B)
PRE-CS RESPONSE RATE
STIMULUS PRESENTATION

the component. Figure 2 indicates that following an initial increase in the suppression ratio for the L component of the compound, a rapid decrease in the suppression ratio was evidenced, so that near zero suppression was displayed on the last two presentations of the L component in the L/LT compound. Figure 3 illustrates the similar increase and more gradual decrease in suppression ratio for B-2, in conditioning of the L component of the L/LT compound. B-3 (Fig. 4) demonstrated smaller variability of suppression ratios for the L component of the L/LT compound, with a final compound ratio of .085 for the L component. The L-Test procedure produced suppression ratios at or near zero for all subjects in Group B, respectively, for the first test presentation of the L stimulus without the UCS. Figures 2-4 illustrate that subsequent test presentations for trials 2-4 produced suppression ratios of .00-.11, .15-.26, and .17-.40 for S's B-1, B-2, and B-3, respectively. Baseline pre-CS rates for B-1 (Fig. 2) throughout the stimulus presentation conditions were 9-36, 5-21, and 12-15, respectively, for conditions T-UCS, L/LT, and L-Test. B-2 (Fig. 3) pre-CS rates for the stimulus conditions (sequentially) were 16-62, 35-59, and 35-60. B-3 (Fig. 4) displayed response rates similar to B-1, yet with a rate of 1/min. on trial #4 of compounding and with higher response rates during the L-Test condition.

Figures 5-7 indicate a rapid decrease in suppression ratios to a point near or at zero for all S's in Group C's T-UCS presentations. Similarly a rapid decrease in the suppression ratio for the LT component of the compound LT/L was displayed for C-1, C-2, and C-3 (Fig. 5-7). Greater variability of suppression for the L component

Figure 5. Suppression ratios and pre-CS response rate as a function of stimulus presentation for subject C-1 in condition LT/L.

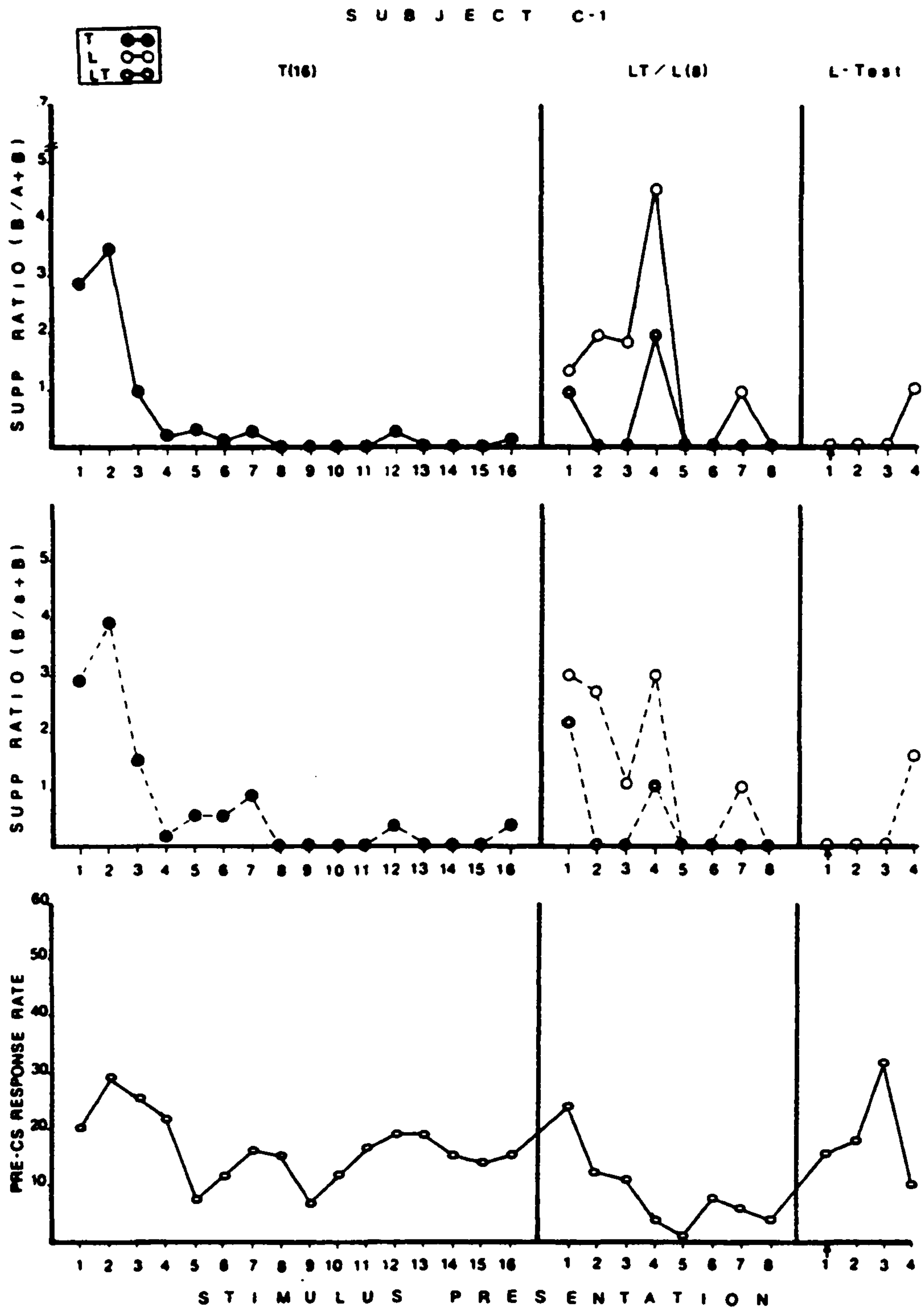

SUBJECT C-1
T
L
LT
T(16)
LT / L(8)
L-Test
SUPP RATIO (B/A+B)
SUPP RATIO (B/a+B)
PRE-CS RESPONSE RATE
STIMULUS PRESENTATION

Figure 6. Suppression ratios and pre-CS response rate as a function of stimulus presentation for subject C-2 in condition LT/L.

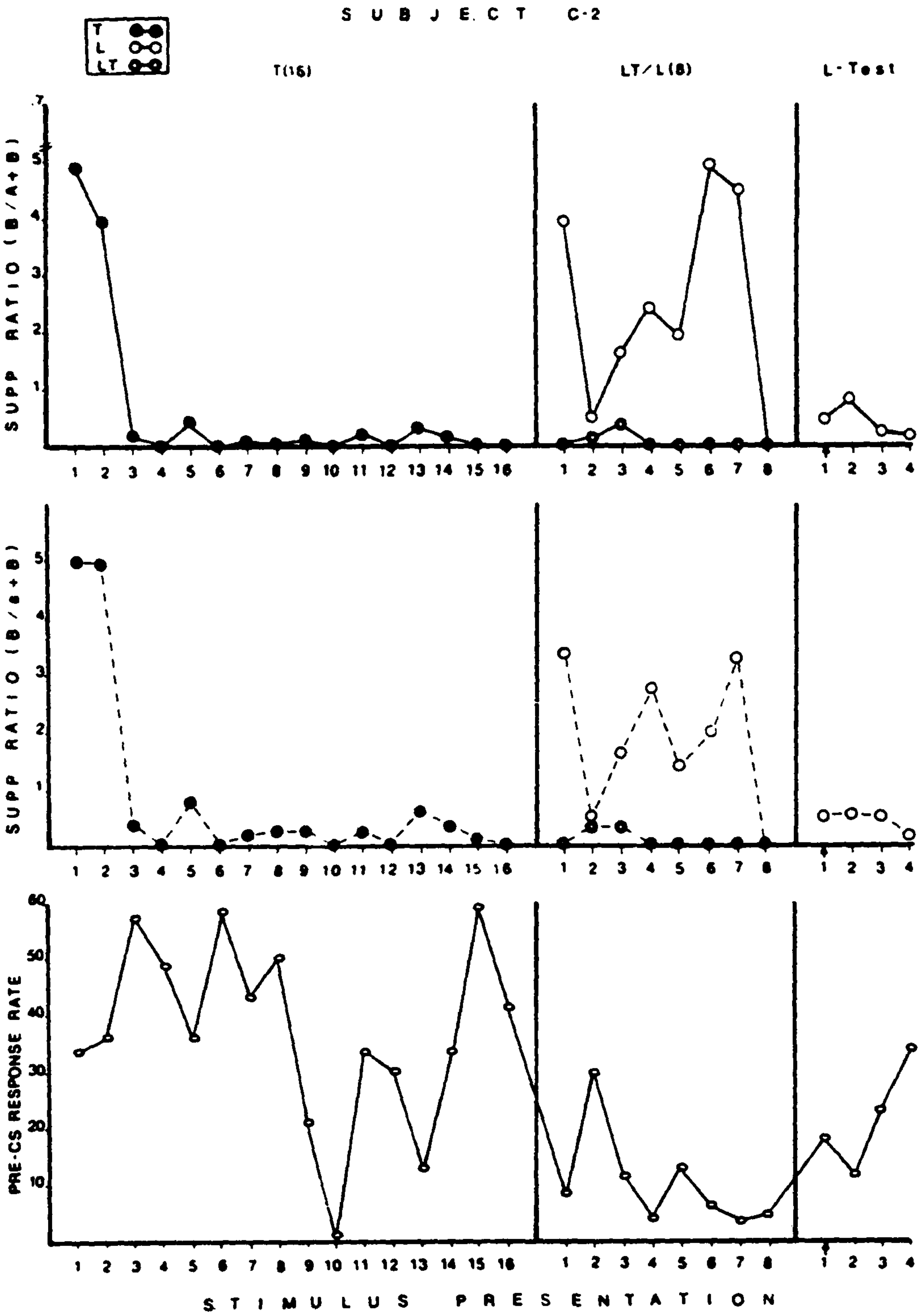
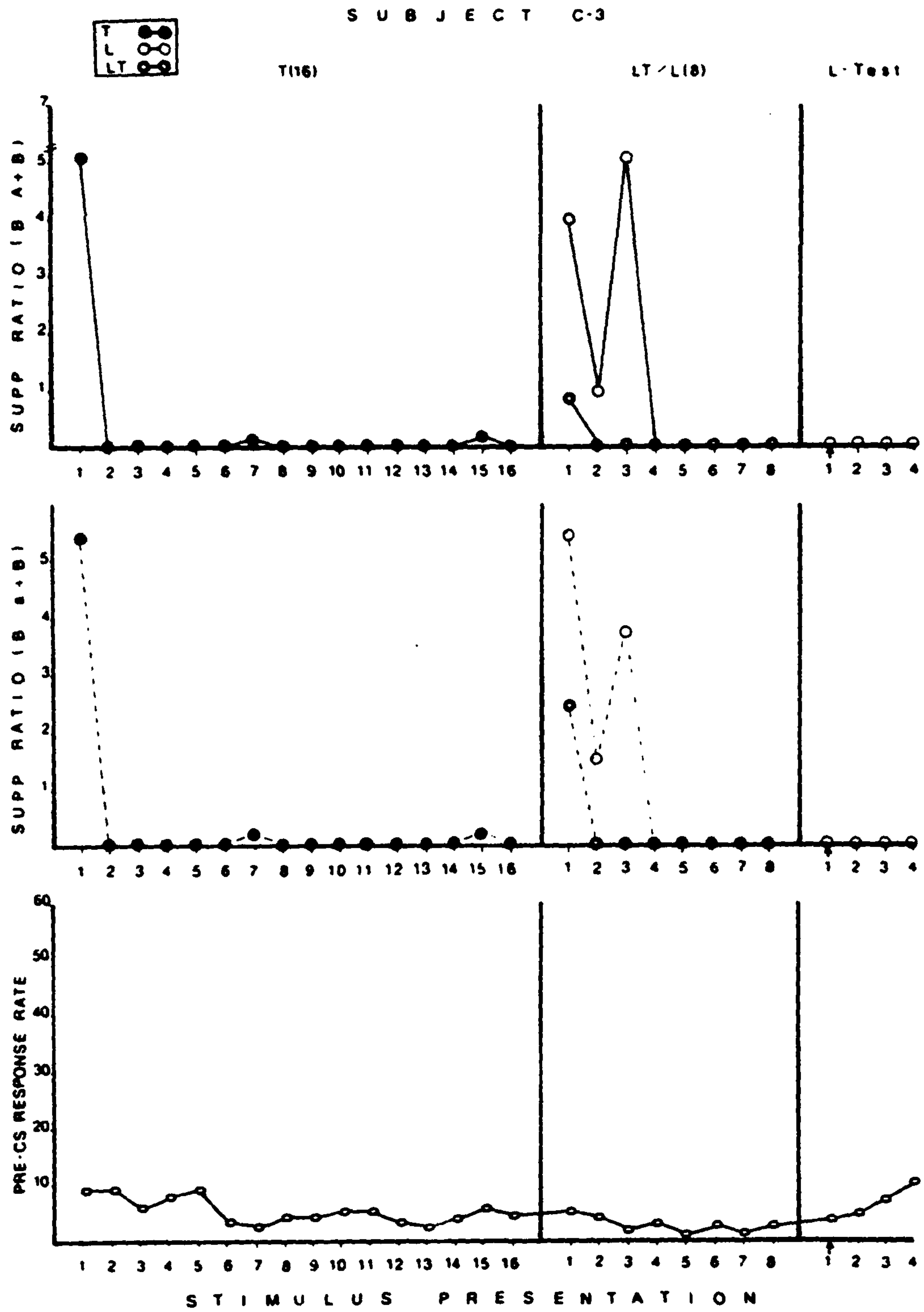

SUBJECT C-2
T
L
LT
T(16)
LT/L(8)
L-Test
SUPP RATIO (B/A+B)
SUPP RATIO (B/a+B)
PRE-CS RESPONSE RATE
STIMULUS PRESENTATION

Figure 7. Suppression ratios and pre-CS response rate as a function of stimulus presentation for subject C-3 in condition LT/L.


S U B J E C T C-3
T
L
LT
T(16)
LT / L(8)
L-Test
SUPP RATIO (B A+B)
SUPP RATIO (B a+B)
PRE-CS RESPONSE RATE
S T I M U L U S P R E S E N T A T I O N

of LT/L compound was evidenced for all S's, with a final compound suppression ratio for the L component of .00, .00, and .32 for C-1, C-2, and C-3, respectively. The first presentation of the L-Test stimulus produced suppression ratios at or near zero for each subject in condition LT/L. Subsequent test presentations evidenced increasing suppression ratios for subject C-1. Pre-CS response rates across stimulus conditions for C-1 were 9-21, 1-28, and 12-32, respectively. C-2 yielded pre-CS rates of 1-59, 4-30, and 13-32. Finally, C-3 displayed pre-CS rates of 3-10, 1-5, and 4-12 for the T-UCS, LT/L, and L-Test procedures, respectively.

Figures 8-10 illustrate the zero suppression for each subject by the end of T-UCS presentations. D-3 (Fig. 10) demonstrated greater variability of suppression during the T-UCS presentations. D-1 (Fig. 8) displayed zero suppression ratios for the remaining seven presentations of the T component of the L/T compound. Suppression ratios for the L component were more variable, terminating the compound presentations with a suppression ratio of .32. D-2 (Fig. 9) displayed .00 suppression ratios for the T component of the L/T compound in trials 3-7, yet ended its final T component in this phase with a ratio of .20. D-3 (Fig. 10) displayed ratios of near .00 for the T component in presentations 1-5, followed by a large degree of variability in ratios, ending the phase with a ratio of .00. The first test presentation of the L stimulus for S's D-1, D-2, and D-3 produced suppression ratios of .00 for each subject. Subsequent ratios for D-1, D-2, and D-3 on test trials 2-4 produced near zero ratios for D-2 and D-3, with increasing ratios for D-3 terminating

Figure 8. Suppression ratios and pre-CS response rate as a function of stimulus presentation for subject D-1 in condition L/T.

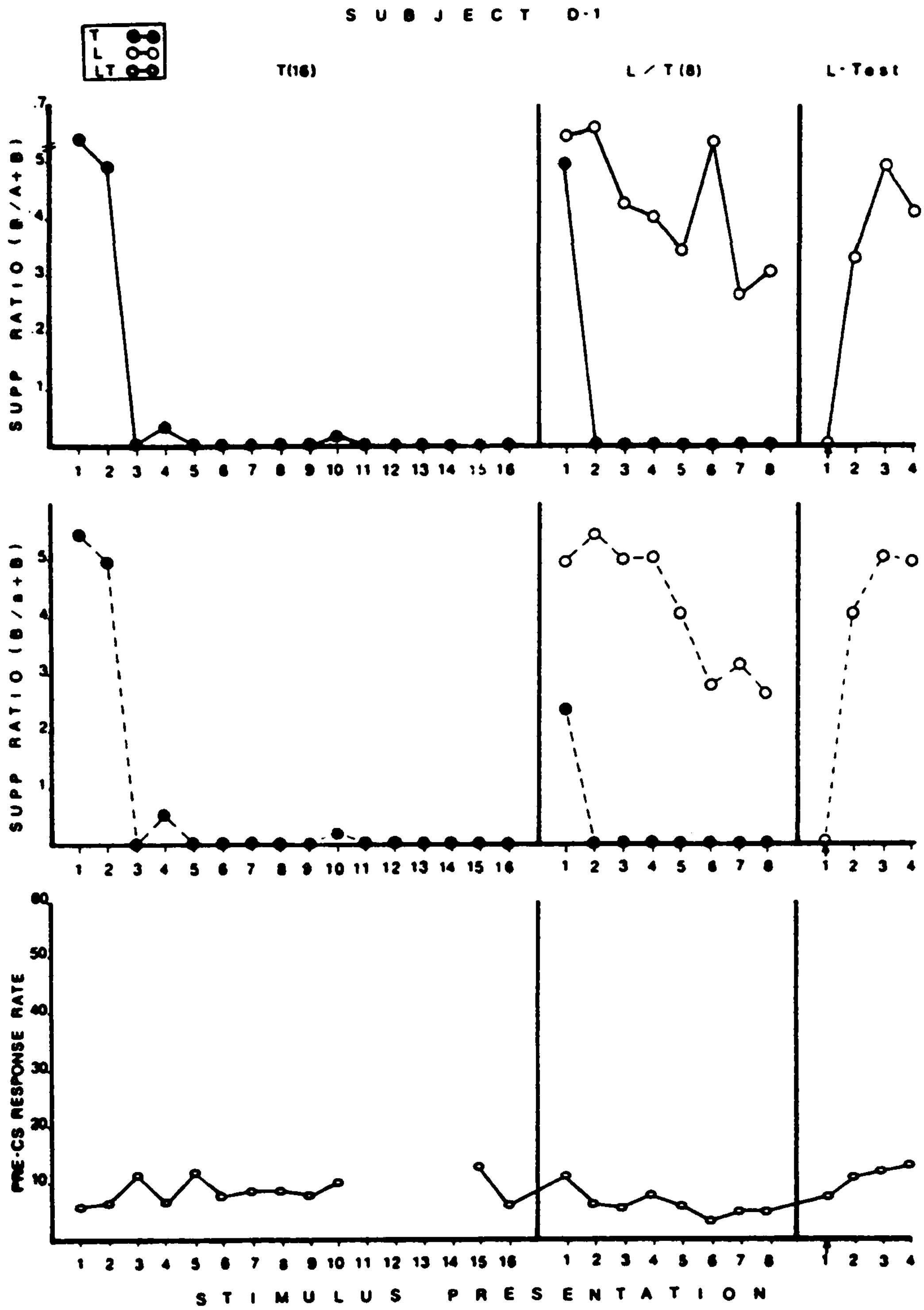

S U B J E C T D-1
T
L
LT
T(16)
L / T (8)
L-Test
SUPP RATIO (B/A+B)
SUPP RATIO (B/a+B)
PRE-CS RESPONSE RATE
STIMULUS PRESENTATION

Figure 9. Suppression ratios and pre-CS response rate as a function of stimulus presentation for subject D-2 in condition L/T.

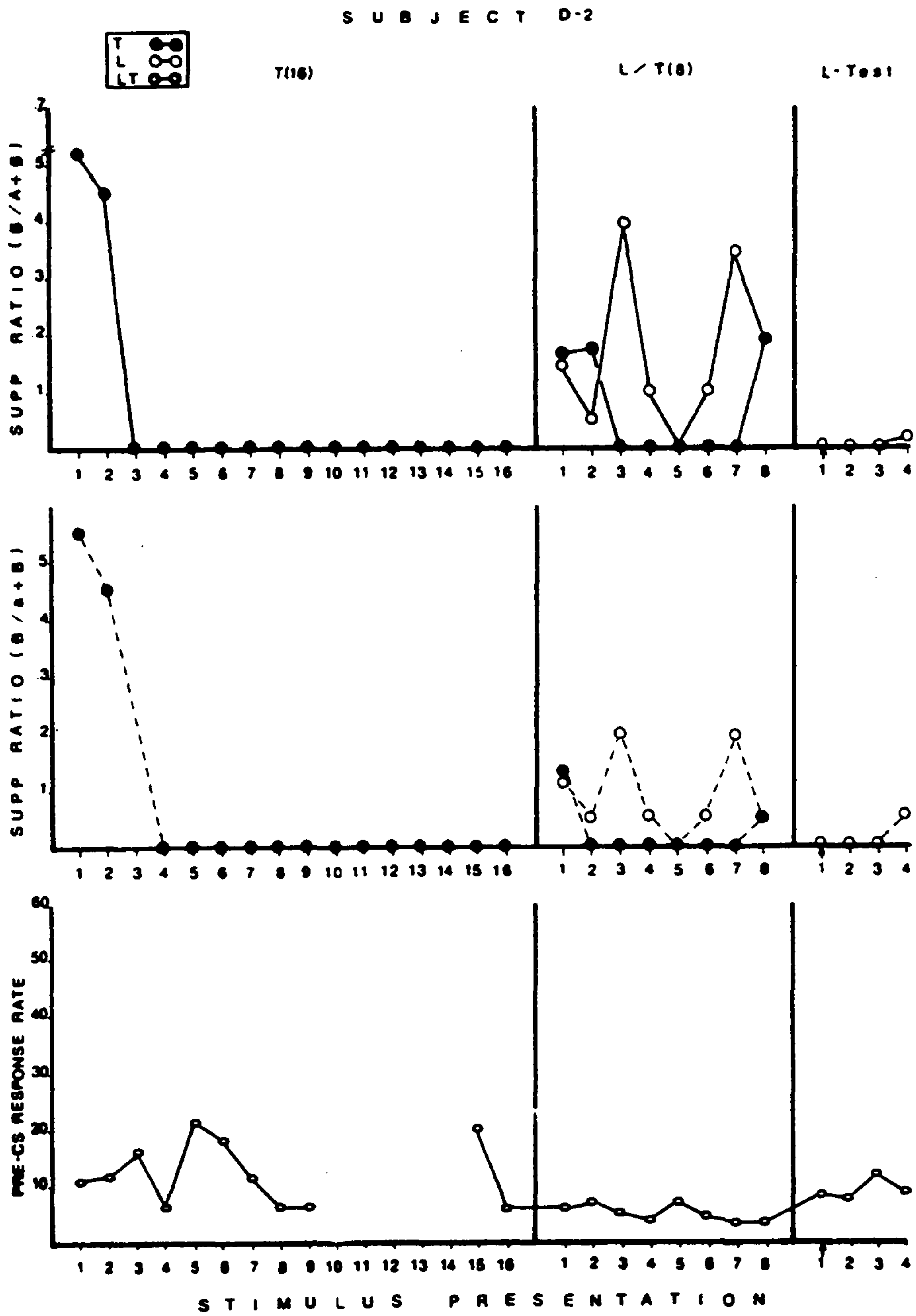
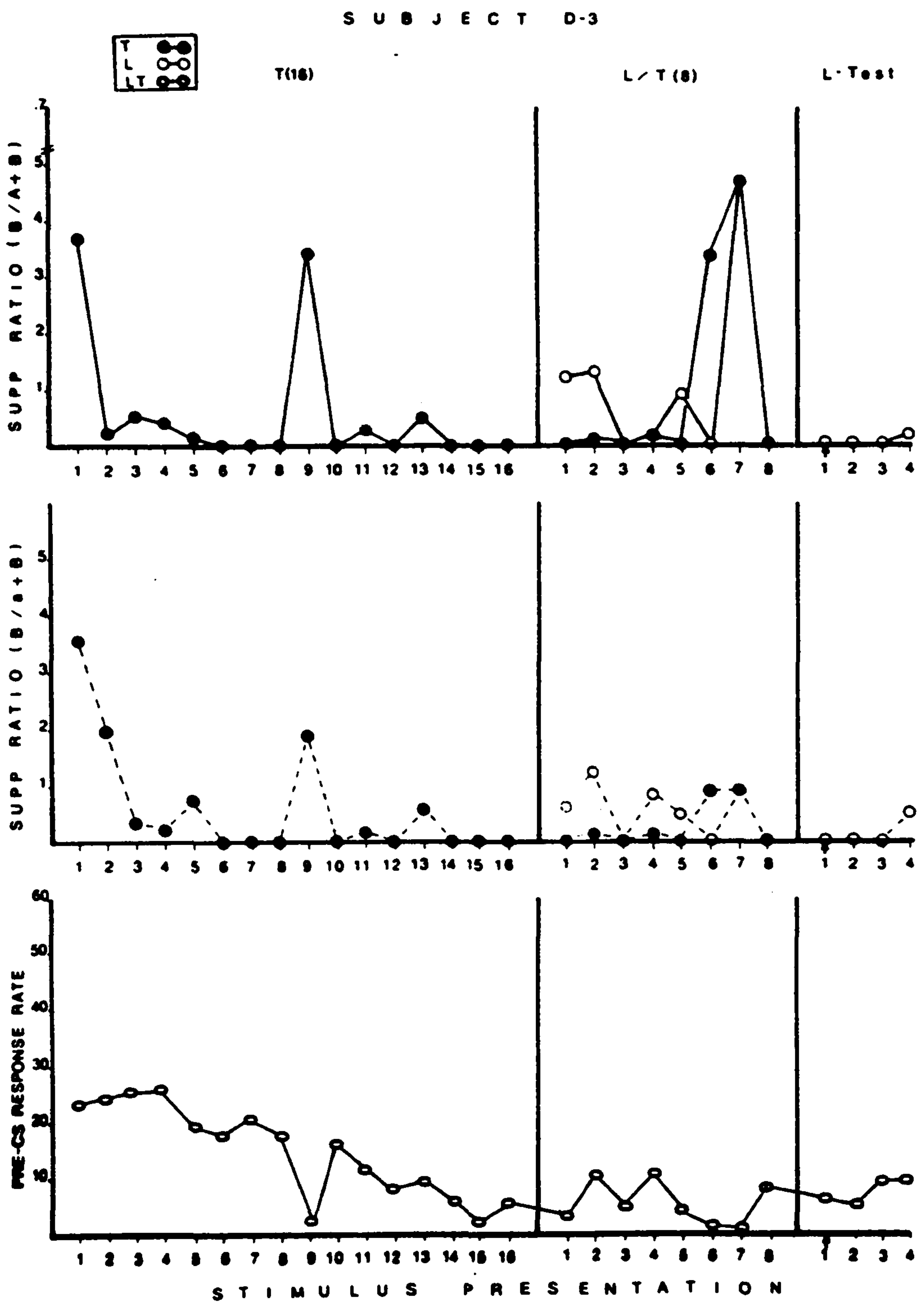

SUBJECT D-2
T
L
LT
T(16)
L/T(8)
L-Test
SUPP RATIO (B/A+B)
SUPP RATIO (B/a+B)
PRE-CS RESPONSE RATE
STIMULUS PRESENTATION

Figure 10. Suppression ratios and pre-CS response rate as a function of stimulus presentation for subject D-3 in condition L/T.


S U B J E C T D-3
T
L
LT
T(16)
L / T (8)
L-Test
SUPP RATIO (B/A+B)
SUPP RATIO (B/a+B)
PRE-CS RESPONSE RATE
S T I M U L U S P R E S E N T A T I O N

with a ratio of .44. Pre-CS rates throughout stimulus presentations for D-1 (Fig. 8) were 6-12, 4-12 (data for trials 11 to 14 were lost), and 10-15, respectively, for each stimulus condition. D-2 (Fig. 9) pre-CS rates were 6-22, 4-9 (data for trials 10-12 were lost), and 11-14. Finally, D-3 (Fig. 10) displayed pre-CS rates for consecutive stimulus presentation conditions of 2-26, 1-14, and 8-12, respectively.

DISCUSSION

The major findings of the present study indicate that the light element (without prior history of conditioning) became an effective CS, when it was presented as one of the successively presented elements in a compound. This conditioning effect was found for all S's in each of the three successive presentation procedures containing a prior conditioned element. Kamin's (1968) observation of stimulus "blocking" was not exhibited with any of the successive compound procedures employed in the present study. In addition, the S's in the LT/L (Group C) successive element procedure displayed greater resistance to extinction for L-Test presentations (without the UCS), as compared to the two other successive or "serial" conditioning procedures. Finally, the B/A+B suppression ratio measure displayed greatest variability within each stimulus presentation phase, when the pre-CS response rate was either above or below the response rate for the entire session. Specifically, this variation was generally characterized by the following covariations between the two suppression ratio measures and the pre-CS response rate: a) When the pre-CS rate of response dropped to within 1-4 responses (in the 30" interval prior to the CS onset), the B/A+B ratio was larger than the B/a+B suppression rate. b) When the pre-CS was larger than the average response rate for the entire session (i.e., the "a" term in the B/a+B ratio), the B/A+B measure was smaller than the ratio exhibited in the B/a+B measure.

The major procedural difference between the present design, and the design employed by both Kamin (1968) and Rescorla and Wagner (1972) was the method of compound presentation--successive in the former, and simultaneous in the latter design. The results of this investigation clearly indicate that the "blocking effect," revealed as a failure of conditioning to the superimposed element, CS_2, relies upon the simultaneous presentation of compound stimulus elements. Given the parameters of CS duration employed in the present study, each of the three successive procedures presenting the light component temporally "offset" from either the light-tone (LT) or tone (T) element(s), evidenced light as an effective CS and "blocking" was not exhibited. The effect of shorter durations of successive element presentations cannot be ascertained from the present study. Further parametric investigation of CS duration in the present design is needed. While the amount of conditioning displayed by S's in each condition was seen to be large (as measured by suppression ratios ranging from .00-.06) for the light element, the S's in the LT/L (Group C) condition displayed greater resistance to extinction during the L-Test procedure than did S's in the other conditions. The temporal proximity of the L component in Group C (LT/L) to the UCS may account for this apparent increase in strength of conditioning.

While the acquisition of conditioned suppression for the L component of the successive compound was presented (Fig. 2-10), it was not possible to assess conditioning to the L element in the simultaneous LT component of the compounds in Group B (L/LT) and C (LT/L). However, it was demonstrated that if any conditioning to the L element in the LT compound did take place, it did not effect the conditioning of the L component--which was temporally "offset" from either LT (in Groups B and C) or T (Group D). Specifically, complete conditioning of the L component (as displayed by a .00 suppression ratio) took place whether or not it was serially presented with LT or T alone. Furthermore, variability of conditioned suppression with successive compounding was not found to be an adequate predictor for the subsequent test of conditionability of the L element. For example, C-2, D-1, and D-2 all displayed considerable variability of conditioned suppression during compound stimulus presentations, yet each of these S's exhibited a suppression ratio of .00 to the first test presentation of the L element.

The prior mentioned problems encountered with the use of absolute measures of suppression, were evidenced in the calculation of the B/A+B ratio. The S's who displayed suppression ratios for the B/A+B measure that were most variable (e.g., C-3, D-2, and D-3) generally exhibited pre-CS response rates that were the most disrupted by the conditioned suppression procedure. Increased suppression ratios for these S's were directly affected by the extreme drops in pre-CS rates, since the ratio is most sensitive to very low pre-CS rates (Shimoff, 1972). The calculation of the B/a+B measure provided identification that the source of the variability was the variable pre-CS rate, and not changes in the CS response rate.

The conditionability of serially presented stimuli (given prior conditioning to one of the elements) seems generally not to fit into the interpretations of stimultaneous compound conditioning described by Kamin (1968, 1969a, 1969b) or Rescorla and Wagner (1972). The "asymptote of learning" hypothesis states that the amount learned on a given trial is a function of the amount already learned, and the "total 'asymptote' CR that the UCS will hold (Rescorla and Wagner, 1972)." While the possibility exists that no further conditioning was taking place during the LT component in Groups B (L/LT) and c (LT/L), the theory does not account for a CR occurring in an interval "adjacent" to the LT component. The conditioning exhibited to the L component in the compound may just as well be explained as an "excitatory" conditioning process, since the L component was either directly followed by the UCS, or was temporally "offset" by another element(s). One might also consider the latter condition a special case of trace conditioning, whereby the usual delay between CS offset and UCS onset is "filled" with an already conditioned element. An earlier question posed in the present investigation sought to study the differential "abilities" of the three successive procedures in conditioning the L (CS_2) element. While relatively equal conditionability between the procedures was evidenced by the .00 ratio for the first L-test presentation, a limitation upon the confidence of such a statement may be made. Perhaps a "celler effect" may have been evidenced using the disruption of lever pressing as the dependent variable for the conditioned suppression procedure. If respondents are involved in the conditioned suppression procedure, they may well continue to show CR's beyond the .00 suppression ratio measure. Perhaps the "lack of lever pressing" that characterizes complete suppression, is not a sensitive enough measure of the conditioning process. Unfortunately, an acceptable delineation of the measurement of respondents in the conditioned suppression procedure has yet to be made (Brady, Kelly, and Plumlee, 1969).

The temporal proximity of the L component in the compound to the UCS, during successive presentations of elements, was generally found to produce suppression ratios that were more resistant to extinction. Further analysis is suggested comparing extinction rates between the L/T condition, and successive presentation of a T/L compound, since the latter condition employs the L component in closer proximity to the UCS. The addition of extended L-Test presentations may provide a quantitative measurement of the above mentioned "cellar effect" for "completely conditioned" stimulus elements.

Earlier mention was made to an "information hypothesis" as an interpretation of compound element conditioning (Egger and Miller, 1962; Kamin, 1968, 1969a). This interpretation cannot be supported in the present design. Given that the tone (T) element has become a "predictor" of the UCS onset (by pairings of the tone with the UCS), then presumably whenever the T element in the compound is temporally closest to the UCS (as in the L/LT or L/T conditions), the L component (which is farther away from the UCS) should be labled a "redundant stimulus"—and should not be conditioned. This was not the case, the L component was "fully conditioned" in each successive procedure, thus an "informationess hypothesis" cannot be confirmed.

While the successive element conditioning procedures have been demonstrated to be effective, many issues require further investigation. Among them are: 1) A parametric investigation of the relationship between CS duration and subsequent conditioning in the serial conditioning procedure. 2) A stimulus test procedure with extended CS presentations to assess rate of extinction and the "cellar effect." 3) A further investigation of the effects of baseline disruption between CS-UCS presentations and subsequent conditioned suppression. These issues are in no way exhaustive as to the concerns in successive compound conditioning. As these issues are dealt with a clearer delineation of the variables controlling serial conditioning in the conditioned suppression process will be evidenced.

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