Effects of Conditional Discrimination Training on Object Identification: Implications for Selective Stimulus Control

By

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Carolyn S. Ryan

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In the present research, the degree of stimulus control exerted by each of the two dimensions (color and shape) of compound stimuli was studied in two experiments with undergraduate college students. A between-groups design with three consecutive experimental phases was used in each experiment. Phases 1 and 2 were training phases; Phase 1 consisted of single stimulus discrimination training and Phase 2 consisted of compound stimulus discrimination training. Phase 3 was testing in which stimuli were presented to assess the degree to which responding corresponded to the Phase 2 training. In Experiment 1, congruence of reinforcement contingencies between training phases was manipulated for a target dimension in a graded manner-- 100%, 25%, or 0%. There was a systematic decrease in the level of Phase-2-consistent responding in the presence of the target dimension corresponding to the decreases in the level of congruence present during Phase 2. In Experiment 2, training history for the non-target dimension was altered in order to influence the extent to which the

non-target dimension exerts stimulus control. The three experimental conditions under which the Phase 1 training history for the non-target dimension was manipulated were: (a) Correlated with reinforcement, as in Experiment 1, (b) Absent, or (c) Not Correlated consistently with reinforcement. Under the Absent condition, the non-target dimension was not presented in Phase 1. Under the Not Correlated condition, inconsistent prior training for the non-target dimension was presented. The identical manipulation of the congruence of the reinforcement contingencies for the target dimension used in Experiment 1 was used in Experiment 2. There was an effect of the manipulation of the prior training history for the non-target dimension on the level of Phase-2-consistent responding in the presence of the target dimension. Correlated prior training compared to Absent and Not Correlated prior training for the non-target dimension led to greater competition, indicated by high Phase-2-consistent responding in the presence of the non-target dimension and reduced target performance.

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Dedicated to my loving parents,

Joan and John Ryan

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Effects of Conditional Discrimination Training on Object Identification: Implications for Selective Stimulus Control

The present report describes two studies in which the degree of stimulus control obtained by each of the two dimensions of a visual compound antecedent stimulus was studied. Differential control by one or more of the relevant dimensions of a stimulus has been reported in the research literature on *attention* or *selective attention* (Catania, 1998; Hunt & Fitzgerald, 1973; Mackintosh, 1965, 1973, 1975; Ray, 1972; Reynolds, 1961; Skinner, 1938, 1953; Sutherland & Mackintosh, 1971). In previous research studies investigating differential control by one or more stimulus dimensions of a compound stimulus, the term *attention* was intended as a construct to explain instances of differential control and to label those instances (e.g., Allen & Fuqua, 1985; Born & Peterson, 1969; Huguenin & Touchette, 1980; Hunt & Fitzgerald, 1973; Johnson & Cumming, 1968; Ray, 1969). An alternative approach is adopted in the present report in which the term *selective stimulus control* describes differential control by stimulus dimensions, without relying on a construct such as attention.

Numerous experimental demonstrations of selective stimulus control have been described for a variety of settings and species. Across these demonstrations, influences such as individuals' preferences, automaticity,

described as fluent responses to stimuli, and other organismic variables were hypothesized to account for occurrences of selective stimulus control (Besner, 2001; Cortis-Park & Mason, 1982; Ray, 1969, 1972; Seamon, et al., 1997). In prior studies that examined selective stimulus control phenomena (Allen & Fuqua, 1985; Born & Peterson, 1969; D'Amato & Fazzaro, 1966; Huguenin & Touchette, 1980; Hunt & Fitzgerald, 1973; Johnson & Cumming, 1968; Pisacreta, 1983; Ray, 1969; Wilkie & Masson, 1976), the relevant characteristics or dimensions of compound stimuli were first presented separately and trained with reinforcement. Then the relevant dimensions of the compound stimuli were presented simultaneously with identical onset, duration, and offset in a successive experimental phase. After discriminative performance was acquired, differential responding in the presence of each of the stimulus dimensions presented separately was measured during a third phase. Differential responding during testing that favored one trained stimulus dimension over another was taken as evidence for selective stimulus control following compound stimulus discrimination training.

Experimental Background

A well-known experimental demonstration of selective stimulus control was reported by Reynolds (1961). Two pigeons were trained to discriminate between two compound stimuli composed of color and shape stimulus dimensions. Discriminative performance was demonstrated by pigeons' pecking in the presence of the compound S+ that was positively correlated with reinforcement, and not pecking (or pecking minimally) in the presence of the compound S- that was correlated with extinction. Control by each stimulus dimension of the multidimensional compound S+ and compound S- was then measured during a testing procedure in which each value of the two stimulus dimensions was presented separately under extinction. Selective stimulus control was indicated by differential rates of responding between values of either dimension. Each pigeon showed differential responding in the presence of a different stimulus dimension - shape controlled one pigeon's behavior and color controlled the other pigeon's behavior. Each pigeon showed non-differential and near-zero rates of responding in the presence of the other stimulus dimension.

The manipulation of training and testing procedures has been shown to influence the occurrence of selective stimulus control. Degree of congruence between the reinforcement contingencies in effect across training phases is

one such manipulation. Following this paradigm, Huguenin and Touchette (1980) and Ray (1969) examined selective stimulus control using a conflict-compound discrimination procedure in humans with mental retardation and rhesus monkeys, respectively. The conflict-compound stimulus discrimination procedure is a conditional discrimination procedure with two or more alternative responses that correspond to two or more stimulus dimensions of a compound stimulus. Under conflict conditions, the correct response for one of the dimensions conflicts with the correct response for the other dimension(s). The conflict-compound procedure was used in all experimental phases. Phase 1 of both of their studies consisted of single-stimulus discrimination training for two stimuli from two different stimulus dimensions (color and shape). Color discrimination training preceded shape discrimination training. Response A was correct for one value of each of the two stimulus dimensions. Response B was correct for the other value of each of the stimulus dimensions. Conflict-compound stimulus discrimination training occurred in Phase 2 in which compound stimuli, each composed of one value from each stimulus dimension, were presented. For the *non-target dimension*, the reinforcement contingency was congruent with (identical to) the contingency in Phase 1. For the *target dimension*, the reinforcement contingency was incongruent with (opposite of) the contingency in Phase 1.

Compound stimuli were presented in a random order and response accuracy was assessed during training. A performance criterion was used to determine completion of training.

Evidence for selective stimulus control was sought during a subsequent testing procedure (Phase 3) in which each value of the two stimulus dimensions and each of the trained compound stimuli were presented separately. Responses were reinforced in accord with the reinforcement contingencies in effect during Phase 2. Phase 3 performance was measured as the proportion of Phase-2-consistent responding, defined as responding compatible with the reinforcement contingency in effect during Phase 2. As expected, participants continued to show Phase-2-consistent responding in the presence of the non-target stimulus values for which training in Phases 2 and 3 was consistent with the Phase 1 reinforcement contingencies. In comparison to the levels of Phase-2-consistent responding in the presence of the non-target dimension, lower levels of Phase-2-consistent responding were found in the presence of the target dimension for which the Phase 2 contingency was incongruent with Phase 1. The differential levels of Phase-2-consistent responding between the non-target and target dimensions were taken as evidence for selective stimulus control.

Critique and Present Application

The training procedure used by Huguenin and Touchette (1980) and Ray (1969) manipulated the congruence of reinforcement contingencies between training phases. A shortcoming of their research was the failure to conduct a within-subject control condition in which both training dimensions were trained congruently between training phases. A similar procedure using congruent training for both training dimensions would be a useful comparison for the procedure described above so as to draw a conclusion about the effects of prior training history on selective performance. Congruent training only would provide evidence of performance unadulterated by reversed reinforcement contingencies for one of the training dimensions.

An additional limitation was the presence of a reinforcement contingency during testing that may have influenced the results in the previous research (Huguenin & Touchette, 1980; Ray, 1969). In the Huguenin and Touchette study, the reinforcement contingency during testing was identical to that during compound stimulus training (Phase 2). The reinforcement contingency used during testing could allow for additional learning or new learning of the Phase 2 relations. Their testing strategy does not allow for a proper evaluation of the effects of prior training on responding. The relatively low percentages of Phase-2-consistent responding

were shown in the presence of the target dimension for three out of eight participants, compared to the percentages of Phase-2-consistent responding in the presence of the non-target dimension. These data revealed evidence of selective stimulus control by the non-target dimension, but the effect was not strong and Phase-2-consistent responding was quite variable across participants.

Stronger evidence of selective stimulus control was shown by Huguenin and Touchette (1980) in their follow-up condition, Experiment 2. In Phase 3 of that experiment, non-differential reinforcement was used instead of differential reinforcement during testing. Huguenin and Touchette argued that, in comparison to the differential reinforcement procedure used in Experiment 1, non-differential reinforcement during testing would reduce the probability of establishing new stimulus control in this phase, thus increasing the likelihood of responding based on prior differential reinforcement history. Most participants showed evidence of selective stimulus control indicated by low percentages of Phase-2-consistent responding in the presence of the target dimension, compared to the higher percentages of Phase-2-consistent responding in the presence of the non-target dimension.

Huguenin and Touchette (1980) used differential or non-differential reinforcement during testing in order to maintain performance without the

side effects commonly associated with extinction procedures, such as bursting and aggression. They found evidence for selective stimulus control that differed under the two testing procedures, neither of which employed extinction. In their study, however, several participants showed little or no convincing evidence of selective stimulus control. It is proposed that testing under extinction may provide stronger evidence for selective stimulus control because differential or non-differential reinforcement schedules could serve to maintain previous learning or allow new learning to occur. New learning may occur under the non-differential reinforcement condition if responses not previously reinforced were then reinforced during testing.

The present study is an adaptation and extension of the research conducted by Huguenin and Touchette (1980) and Ray (1969). One objective was to test the generality of the effects shown by those researchers by evaluating selective stimulus control in undergraduate students rather than monkeys or adults with mental retardation. The present study also extended the testing parameters used such that there were no consequences for responding. The generalization decrement between training and testing will be as minimal as possible by eliminating the consequences for responding during testing.

Experiment 1 of the present study manipulated congruence of reinforcement contingencies with prior training in a graded manner. For the *non-target dimension*, congruence was 100% between training phases across all groups. For the other stimulus dimension, congruence was 100%, 25%, or 0% between training phases, depending upon group assignment.

As an extension of the previous research, Experiment 1 used three levels of congruence of reinforcement contingencies for the *target dimension* between training phases. The manipulation of congruence of reinforcement contingencies was comparable to that conducted by Huguenin and Touchette (1980) and Ray (1969). In Phase 1 (single-stimulus discrimination training), Groups 1, 4, and 5 were trained to use one assigned name for each of the two values of the two stimulus dimensions (color and shape). For Group 1 (*Congruent target training condition*), the Phase 2 compound-stimulus reinforcement contingencies were congruent with Phase 1 reinforcement contingencies on 100% of the trials for both stimulus dimensions. For Groups 4 and 5 (*Incongruent target training condition*), for the target dimension, the reversed reinforcement contingencies were in effect in Phase 2; therefore, the reinforcement contingencies for the target dimension were congruent with the Phase 1 reinforcement contingencies on 0% of the trials.

An additional level of congruence of reinforcement contingencies was included in the present study. For Groups 2 and 3 (*Partially Congruent target training condition*), the reinforcement contingencies for the target dimension were congruent with the Phase 1 reinforcement contingencies on 25% of trials in Phase 2. This manipulation was accomplished by using a different Phase 1 training procedure for the target dimension for Groups 2 and 3, in comparison to the procedure used for the other groups. Unlike the Phase 1 training procedure for Groups 1, 4, and 5 and that used by Huguenin and Touchette (1980) and Ray (1969), the reinforcement contingencies for naming the discriminative stimuli were non-perfect for Groups 2 and 3. For a given stimulus value of the target dimension, one name was assigned on 75% of the trials and the other name was assigned on 25% of the trials. In Phase 2, the reinforcement contingencies for the target dimension were congruent with Phase 1 reinforcement contingencies on 25% of trials.

A unique feedback-fading procedure was used in Phase 2 of the present study. In Phase 2, accuracy feedback was provided and faded across trials until responding was maintained with no feedback. Feedback was completely eliminated prior to Phase 3.

In addition to the trained single stimuli and compound stimuli presented in Phase 3, untrained compound stimuli were used. Untrained compound

stimuli were created from the color and shape stimuli previously presented. Presentation of untrained compound stimuli provided for an additional assay of selective stimulus control by the non-target dimension in Experiment 1.

Theoretical Background

The effects of the manipulation of the congruence of reinforcement contingencies for the target dimension between training phases on responding in the presence of the target dimension can be predicted using theories of discriminative performance. Several theories of discriminative performance have been proposed to account for the nature of the learning process during discrimination procedures. Two contrasting theories were continuity and noncontinuity theories. Consistent with continuity theory, Spence (1936, 1953) theorized that there are three stages of discrimination learning. First, excitation occurs in the presence of the stimulus associated with reinforcement (S+). Second, inhibition occurs in the presence of the stimulus associated with extinction (S-). Third, excitation and inhibition in the presence of those cues generalize to other stimuli. The net result of excitation and inhibition produces the observed response outcome that reflects the relation between excitatory and inhibitory control of behavior. Spence's theory describes discriminative performance as a gradual process of acquisition.

Discriminative performance in the present research may be understood according to continuity theory. Performance in the presence of the target stimuli during testing may reflect the balance of excitatory and inhibitory control associated with reversing the reinforcement contingencies between phases for those stimuli. The net effect on responding would be shown as different levels of responding under each of the target training conditions. Continuity theory predicts that for the groups exposed to reversal (Incongruent target training condition) or partial reversal (Partially Congruent target training condition) training in the presence of the target dimension, a relatively low probability of Phase-2-consistent responding is expected compared to the group exposed to consistent (Congruent target training condition) training. Participants would only gradually learn the new contingency in Phase 2 for the target dimension. For the Partially Congruent target training condition, excitatory control by the partially correlated values of the target dimension in Phase 1 may occur and new learning in Phase 2 may take place for the target (25%-congruent) training dimension. In comparison, for the Incongruent target training condition, some new learning in Phase 2 may occur, but the level of learning may be incomplete for the target (0%-congruent) training dimension.

In contrast to the continuity theory, Krechevsky's (1932) and Lashley's (1929, 1942) non-continuity theory of discrimination learning anticipates sudden changes in discriminative performance. Discriminative performance shown as differential responding is assumed to reflect hypothesis testing, indicated by alternate patterns of behavior. According to the non-continuity theory, an organism learns to respond differentially according to patterns of behavior for the relevant stimulus dimension. Once learned, these patterns of behavior would continue despite changes in training contingencies. In regard to the present study non-continuity theory predicts that no new learning of the Phase 2 contingencies will occur for the target dimension under the Incongruent target training conditions. During testing, compared to high levels of Phase-2-consistent responding in the presence of the non-target dimension, minimal or zero levels of Phase-2-consistent responding in the presence of the target dimension would be obtained for the Incongruent target training conditions.

Performance in the presence of the untrained compound stimuli may provide evidence supporting the stimulus-element approach or the configural cue approach to stimulus control (Domjan, 2003; Pearce 1987, 1994). Under the stimulus element approach, stimulus elements within a compound stimulus would retain control of behavior demonstrated when they are

presented separately. The prediction of the stimulus-element approach would match the prediction of the continuity theories. Responding in the presence of untrained compound stimuli would be based on previous training for one or both of the training dimensions (non-target or target) that comprise the untrained compound stimuli. A contrasting approach is the configural-cue approach that specifies that compound stimuli would be treated as unique arrangements and not the combination of elements that comprise the compound stimuli (Pearce 1987, 1994). According to the configural-cue approach, performance in the presence of the compound stimuli would be explained by differences in generalization decrement. Responding in the presence of untrained compound stimuli would not be based on previous training for the stimulus elements that compose the compound stimuli. Unsystematic performance may be found based on the lack of prior training with these stimuli (Pearce 1987, 1994). The present study investigated whether responding in the presence of the untrained compound stimuli was consistent with either of the two approaches described above.

The present study was an adaptation and extension of the previous research conducted by Huguenin and Touchette (1980) and Ray (1969). Experiment 1 involved the manipulation of the target training history in a graded manner to assess the effect of target training on Phase-2-consistent

responding. Experiment 2 replicated and extended the findings from Experiment 1 with the additional manipulation of non-target training history.

EXPERIMENT 1

In Experiment 1, all participants were exposed to training with a *non-target dimension* for which the reinforcement contingencies were 100% congruent between training phases. In addition, the degree of congruence of the reinforcement contingencies for the *target dimension* was manipulated across groups. Phase-2-consistent responding in the presence of the target dimension was assessed under the congruent and incongruent training conditions. It was expected that the levels of responding would be higher under the congruent training condition compared to the incongruent training conditions.

Method

Participants for Experiment 1

Thirty-seven female and 13 male university undergraduate students, ranging from 18-49 years old, participated to fulfill a requirement of their introductory psychology course. They were recruited by means of a sign-up sheet posted in the Psychology department. Each participant was assigned to one of the five groups using a block randomization procedure (block size = 5); each group had 10 participants.

Apparatus, Setting, and Stimuli for Experiment 1

Participants were tested individually in a room measuring 2.95 m x 1.42 m. They were seated in a chair of adjustable height, located in front of a computer monitor and a computer mouse manipulandum. The height of the chair was adjusted as necessary to ensure the participant's comfort. The computer mouse was placed on the left or right side of the computer monitor, based on the participant's handedness, and was used to record responding.

Stimulus features presented during the experiment are presented in Tables 1, 2, and 3. Computer-generated stimuli created using Microsoft Paint™ were presented in the center of the monitor (diagonal measure = 39 cm) of a Dell Dimension L 500c Celeron™-based computer. Two achromatic, standard geometric 2-dimensional shapes were used (e.g., triangle and diamond). In addition, two 2-dimensional color stimuli (e.g., red and blue) were presented as a random-appearing curved form; the form was identical for the two primary colors (See Figure 1). Color stimuli were equal in luminance (27.1 cd/m^2). The stimuli fit within a gray background rectangular area of the computer measuring 12 cm x 7 cm on the computer screen.

Two 3-letter, consonant-vowel-consonant nonsense syllables (trigrams) were used as names for the stimuli presented during the experiment. The trigrams were low in association (Glaze, 1928; Hilgard, 1951; Ryan, 2002).

Two stimuli, one stimulus from each stimulus dimension (color and shape), were associated with a given name (Table 1). The assignment of names to stimuli was balanced across participants in Phase 1. For different participants, BUP could be assigned as the name for the blue or red stimulus, and for the diamond or triangle. Figure 1 is a schematic representation of a single stimulus trial. On each trial, both names (BUP and VEC) were displayed 3 cm under the bottom edge of the rectangular area of the image.

During practice trials before the experimental trials, the following stimuli were presented: two different shapes (rhombus and square), two different colors (green and yellow), and two different trigrams (GIF and NOL). These stimuli were not presented during the experiment. The practice stimuli were created in the identical manner as the experimental stimuli.

Table 1

Stimulus Features Presented In Experiments 1 and 2

Stimulus Features			
Name	Color[a]	Shape[b]	Line Orientation[c]
BUP	Blue	Diamond	Horizontal
VEC	Red	Triangle	Vertical

[a]Color dimension was used in Experiments 1 and 2.

[b]Shape dimension was used in Experiments 1 and 2.

[c]Line orientation dimension was used in Experiment 2.

Table 2

Sample of the Session Structure for Group 1 in Experiment 1

Experimental Phase	Stimulus	Name	Presence of Feedback
Phase 1			
	Blue	BUP	Yes[a]
	Diamond	BUP	Yes
	Red	VEC	Yes
	Triangle	VEC	Yes
Phase 2			
	Blue/Diamond	BUP	Yes→ No[b]
	Red/Triangle	VEC	Yes→ No
Phase 3			
	Blue		No[c]
	Diamond		No
	Red		No
	Triangle		No
	Blue/Diamond		No
	Blue/Triangle		No
	Red/Diamond		No
	Red/Triangle		No

[a]Feedback was presented immediately following each response.
[b]Feedback was presented immediately following each response and was systematically decreased in probability of occurrence to 50% and 0%.
[c]No feedback was presented in Phase 3.

Table 3

Stimuli Presented to all Experiment 1 Participants during Phase 3 (Testing)

Stimulus	
Single Stimulus Values	Compound Stimuli
Blue	Blue/Diamond (Trained)
Red	Red/Triangle (Trained)
Diamond	Blue/Triangle (Untrained)
Triangle	Red/Diamond (Untrained)

Note. Participants in all groups were exposed to the same stimulus conditions in Phase 3, without the feedback procedure provided for 80 trials. Ten trials of each stimulus were presented. Compound stimuli were trained or untrained according to Phase 2 training.

Figure 1.

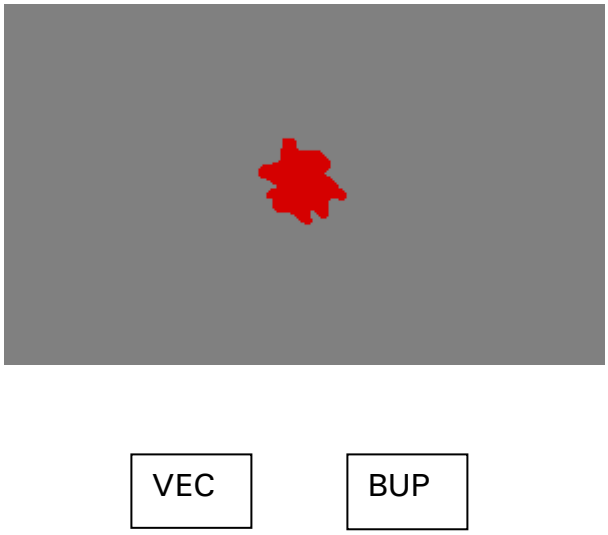


Figure 1. A schematic representation (not to scale) of a sample experimental trial presented on the computer screen during the experiment for a single stimulus. The image itself appeared in the center of the computer screen and the two names appeared centered under the image. The names included one assigned name and one unassigned name for the image presented.

Procedures for Experiment 1

A between-groups experimental design was used. Prior to the experimental session, each participant read and signed an informed consent document, and was then escorted into the experimental room.

Motivational system. Participants were given the opportunity to earn backup reinforcers (i.e., small snacks, soft drinks, or small office supplies), based on the number of points earned during an experimental session. Standardized instructions about availability and opportunity to earn points exchangeable for the backup reinforcers were verbally presented before and after the experimental session, as shown in Appendix A. Each participant was also told that s/he could earn tickets for a lottery drawing based on the total number of points earned during the experimental session. The experimenter provided the verbal description as she pointed to both a printed menu and the tangible items that matched the verbal description. The storage containers for the items were labeled to specify the point values assigned to a given item type. The lottery tickets and a lottery box were displayed and described.

Instructions. After the motivational system was described, standardized instructions (see Appendix B) describing the experimental procedures were presented on the computer screen and verbally. Additional

instructions were presented on the computer screen at several intervals during the session.

Prior to each experimental phase, the participant read instructions printed on the computer monitor (Appendix B). Instructions specified: (a) the occurrence of stimuli on the computer screen, (b) how to indicate a response, (c) that only one response per trial was allowed, (d) the consequences for responding, and (e) how to initiate a trial. The participant was asked to repeat the description of the trials prior to Phase 1. Then the participant answered questions that the experimenter posed regarding the instructions (Appendix C) before the experiment began. Each question was presented in successive order and the participant's response to each question was indicated on a recording sheet. If the participant answered a question correctly, the next question was presented. When the participant answered incorrectly, the experimenter immediately provided the correct answer and the question was presented again until the participant answered correctly. The identical procedure as mentioned above was followed until the participant correctly answered all questions in succession without correction. If the participant made any errors in answering the set of questions, the experimenter instructed the participant to read the instructions again, prompted the correct response, and repeated the questions using the identical procedure.

Experimental trials. After the participant accurately described the procedure, a schematic representation of a trial was presented on a piece of paper (Figure 1). On each trial, an image with two names printed in capital letters centered horizontally below the image was presented on the computer screen. The response options were the two names, consisting of one correct (assigned) name and one incorrect (distractor) name. The distractor name was the assigned name for another stimulus. The left-to-right position of the names on the computer screen was randomized across trials in 4-trial blocks.

In each of the three phases, the participants were instructed to respond immediately following a stimulus presentation by using a computer mouse manipulandum to indicate one correct name from the two names presented on the computer screen. The participants were required to place the mouse cursor on the correct name and click the left mouse button. In Phases 1 and 2, a correct response was defined as indicating the assigned name following the presentation of a stimulus on the computer screen. An incorrect response was defined as indicating the other name. Correct and incorrect responses were not defined for Phase 3. After a response was made, the computer indicated performance feedback as described below. The participant initiated subsequent trials by selecting the 'next' button on the computer screen using the mouse manipulandum (Figure 2).

Figure 2.

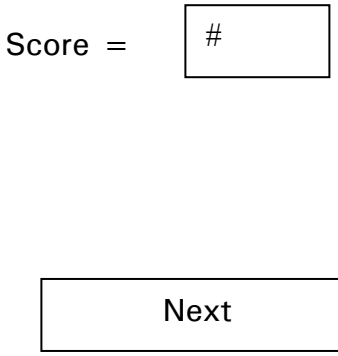


Figure 2. A schematic representation (not to scale) of the screen indicating a participant's score or earned points on feedback trials only, located above the 'next' button. The 'next' button was used to initiate the following trial.

Eight practice trials were presented with the purpose of providing examples of the visual display of trials, with and without performance feedback described below, for four single stimuli in a manner comparable to the method of presentation to be used in the experiment. On the first four practice trials, the experimenter modeled and described responding in a standardized manner for all participants (Appendix C). Practice stimuli and response names were different from those used during the experimental trials. After the practice trials, the experimenter allowed further questions and reviewed the participant's task; the experimenter then left the room. The first experimental trial began after the participant pressed the enter key on the computer keyboard.

Experimental Phases for Experiment 1

The three consecutive experimental phases were presented without a time limit for completion. Completion of Phases 1 and 2 was based on performance criteria mentioned below. In Phase 3, a fixed number of trials was presented, regardless of participant's performance. An example of the session structure for one group is presented in Table 2.

Phase 1. Color and shape discrimination training was conducted by presenting each of the four single stimulus values (two values of each of the

two stimulus dimensions) using a block randomization procedure (block size = 4).

Discrimination training differed across groups as described below and in Tables 4, 5, 6, 7, and 8. Groups 1, 4, and 5 were exposed to training in which one name (e.g., BUP) was always assigned for one shape value and one color value; the other name (e.g., VEC) was always assigned for the other shape and color values (Tables 4, 7, and 8, respectively). The assigned name for each color and shape pair of values was counterbalanced within the group so that half of the participants were trained to use one name and the other half of the participants were trained to use the other name. Groups 2 and 3 were exposed to training in which one of the two names was assigned for one of the two values of one (non-target) training dimension (color and shape, respectively); the other name was assigned for the other value (Tables 5 and 6, respectively). For each of the two values of the other (target) training dimension (shape and color, respectively), one name was assigned as correct on 75% of the trials and the other name was assigned as correct on 25% of the trials.

Table 4

Example of Stimuli and Assigned Names Used with Group 1, Experiment 1

Group 1: Congruent		
Phase 1: Single Dimension Stimuli	**Assigned Name**	**Phase 2: Compound Stimuli**
Red Triangle	VEC	Red/Triangle
Blue Diamond	BUP	Blue/Diamond

Note. The trigrams indicated under the assigned name heading indicate the correct assigned name for each of the four stimulus values in Phase 1 training and each of the two compound stimuli in Phase 2 training.

Table 5

Example of Stimuli and Assigned Names Used with Group 2, Experiment 1

Group 2: Partially Congruent (Shape as Target dimension)		
Phase 1:		**Phase 2:**
Single Dimension Stimuli	**Assigned Name**	**Compound Stimuli**
Red	VEC	Red/Triangle
Blue	BUP	Blue/Diamond
Triangle	VEC 25% of trials BUP 75% of trials	
Diamond	BUP 25% of trials VEC 75% of trials	

Note. The trigrams indicated under the assigned name heading indicate the correct assigned name for each of the four stimulus values in Phase 1 training and each of the two compound stimuli in Phase 2 training. For Group 2, each of the shape stimulus values has two names in Phase 1. In Phase 2, the assigned name for each compound stimulus was the same name trained in Phase 1 for the color stimulus element of the compound. That name was correlated with reinforcement on 25% of the trials in Phase 1 in the presence of the shape stimulus element of the compound.

Table 6

Example of Stimuli and Assigned Names Used with Group 3, Experiment 1

Group 3: Partially Congruent (Color as Target dimension)		
Phase 1:		**Phase 2:**
Single Dimension Stimuli	**Assigned Name**	**Compound Stimuli**
Triangle	VEC	Red/Triangle
Diamond	BUP	Blue/Diamond
Red	VEC 25% of trials BUP 75% of trials	
Blue	BUP 25% of trials VEC 75% of trials	

Note. The trigrams indicated under the assigned name heading indicate the correct assigned name for each of the four stimulus values in Phase 1 training and each of the two compound stimuli in Phase 2 training. For Group 3, each of the color stimulus values had two names in Phase 1. In Phase 2, the assigned name for each compound stimulus was the same name trained in Phase 1 for the shape stimulus value of the compound. That name was correlated with reinforcement on 25% of the trials in Phase 1 in the presence of the color stimulus value of the compound.

Table 7

Example of Stimuli and Assigned Names Used with Group 4, Experiment 1

Group 4: Incongruent (Shape as Target dimension)		
Phase 1: **Single Dimension Stimuli**	**Assigned Name**	**Phase 2:** **Compound Stimuli**
Red Diamond	VEC	Red/Triangle
Blue Triangle	BUP	Blue/Diamond

Note. The trigrams indicated under the assigned name heading indicate the correct assigned name for each of the four stimulus values in Phase 1 training and each of the two compound stimuli in Phase 2 training.

Table 8

Example of Stimuli and Assigned Trigrams Used with Group 5, Experiment 1

Group 5: Incongruent (Color as Target dimension)		
Phase 1: Single Dimension Stimuli	**Assigned Name**	**Phase 2: Compound Stimuli**
Blue	VEC	Red/Triangle
Triangle		
Red	BUP	Blue/Diamond
Diamond		

Note. The trigrams indicated under the assigned name heading indicate the correct assigned name for each of the four stimulus values in Phase 1 training and each of the two compound stimuli in Phase 2 training.

Performance feedback immediately followed each response in Phase 1. Feedback was indicated at the center of the computer screen below the image as a flashing 'correct' or 'incorrect' rectangular box, each measuring approximately 2 cm x 10 cm, indicating a correct or incorrect response, respectively. Immediately following a response, one of two different 2.5 s-audio stimuli indicated a 'correct' or 'incorrect' response. After feedback was presented, a new screen indicated the participant's accumulated earned points in the center of the screen above the 'next' button (Figure 2). A point was earned for each correct response; no points were earned for an incorrect response. Advancement from Phase 1 to Phase 2 was based on a performance criterion of 100% accuracy for one stimulus dimension across four consecutive, four-trial blocks (for a minimum of 16 trials). For Group 1, the performance criterion was based on one arbitrarily chosen stimulus dimension (color or shape) that was counterbalanced across Group 1 participants; each participant was randomly assigned to a stimulus dimension prior to the experimental trials. For Groups 2, 3, 4, and 5, the performance criterion was based on accuracy for the non-target dimension only.

Phase 2. In Phase 2, compound stimulus discrimination training occurred. Two compound stimuli were presented that were created using one value from each of the two stimulus dimensions. In creating the compound

stimuli, the two values were superimposed, such as ‘Red/Triangle’. The color stimulus appeared centered within the geometric shape (see Figure 3) in order to maintain the features of each stimulus. For each group, the order of presentation of each of the first two compound stimuli was balanced across participants. The method of compound stimulus presentation in Phase 2 was block randomized; each four-trial block presented each stimulus twice in a random order.

Figure 3.

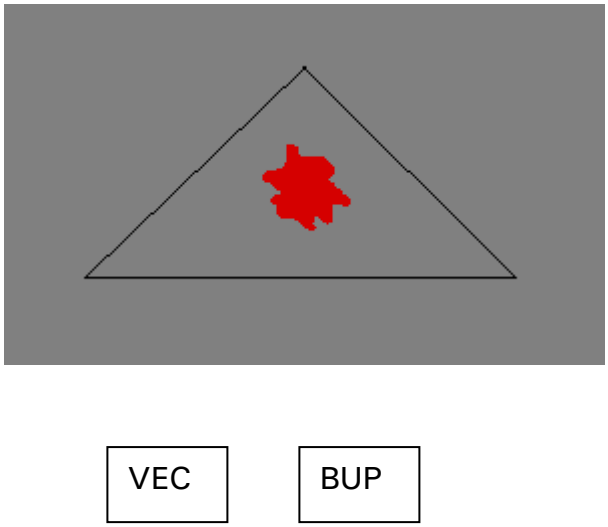


Figure 3. A schematic representation (not to scale) of a sample experimental trial presented on the computer screen during the experiment for a compound stimulus. The image itself appeared in the center of the computer screen and the two names appeared centered under the image. The names included one assigned name and one unassigned name for the image presented.

Phase 2 training was identical for all participants across all groups (see Tables 4, 5, 6, 7, and 8). In Phase 2, the reinforcement contingencies with respect to each compound stimulus were congruent with prior training for at least one of the stimulus dimensions (the non-target stimuli) of the compound stimulus.

On feedback trials, participants were presented with feedback in the identical manner as in Phase 1; however, during Phase 2, the probability of feedback was systematically decreased across trials from 100% to 50% and 0%, based on a performance criterion. Under each level of feedback, a performance criterion of 100% accuracy for each of the compound stimuli was required for a specified minimum number of four-trial blocks, as follows: three consecutive blocks under the 100% feedback condition (12 trials), two consecutive blocks under the 50% feedback condition (4 trials), and one block under the 0% feedback condition. Although points continued to accrue for correct responses, even when feedback was not presented, cumulative earned points appeared on the screen only on trials during which feedback was presented. Participants were informed of this procedure prior to beginning Phase 2.

For Group 1 (*Congruent* target training condition) the Phase 2 reinforcement contingencies were identical to those of Phase 1 for the non-

target and target stimulus values of each compound stimulus (Table 4). For this group, the contingencies for responding in the presence of both single stimulus values that were presented in the compound stimuli were congruent with the Phase 1 contingency for each value. For Groups 2, 3, 4, and 5, the reinforcement contingencies with respect to the non-target stimulus values of the compound stimuli were identical to those of Phase 1. For Groups 2 and 3 (*Partially Congruent* target training condition), the correct name in Phase 2 was the name assigned to the non-target stimulus value in Phase 1 and the name assigned to the target stimulus value on 25% of the trials. For Groups 4 and 5 (*Incongruent* target training condition), the Phase 2 reinforcement contingencies were identical to those of Phase 1 for the non-target stimulus values of each compound stimulus; the correct name was the alternative name for the target stimulus values.

Advancement from Phase 2 to Phase 3 was based on the performance criteria described above for the successive decreases in levels of feedback.

Phase 3. In Phase 3, the effects of prior reinforcement history on responding were measured. Ten trials of each of eight stimuli (80 total trials), including the four single stimulus values and four compound stimuli (trained and untrained) listed in Table 3, were presented without feedback. Stimuli are shown in Table 3. Stimuli were presented in a block-randomization sequence

with one presentation of each single stimulus and compound stimulus within each block. During Phase 3, the response options (VEC and BUP) appeared equally often on each side (left and right) constrained by random assignment. A random number table was used to assign the response options (VEC and BUP) and side-order (left and right) appearance for each stimulus in each 4-trial block.

All participants were presented with 80 points, although points were not displayed on screen. Participants were notified at the end of Phase 3 of the number of points received.

Debriefing for Experiment 1

At the end of the experimental session a message on the computer screen prompted the participant to call the experimenter. The experimenter verified the number of earned points by viewing the data file from the computer, and said, "You earned (#) points." After the total number of earned points was determined, the exchange system for backup reinforcers and lottery tickets was then conducted (see Appendix A for the Motivational System Script). Lottery ticket stubs were placed in the lottery box after the participant's assigned ticket numbers were recorded. The point-exchange menu was repeated and the participant chose and earned the item(s) s/he preferred.

In addition, the experimenter conducted a standardized debriefing interview in which each participant was asked about her/his method for responding during the experiment. Verbal statements and questions were presented as shown in Appendix C. If the participant did not state answers to the questions, verbal prompts were used. The participant's verbal responses to each question were recorded on a recording sheet by the experimenter. After this interview was conducted, the experimenter expressed her appreciation for the person's participation and presented the credit slip earned for participation.

Data Analysis for Experiment 1

Data from each trial were used to assess accuracy, total points earned, and total trials required to meet the performance criterion for each phase. In Phases 1 and 2, a correct response was defined as the name that was assigned to the particular stimulus presented; an incorrect response was the assigned name for another stimulus. For Phase 3, the proportion of Phase-2-consistent responding for a given stimulus was calculated as the frequency of the name assigned in Phase 2 divided by the total number of presentations of that stimulus (10 trials). The alpha level for statistical analyses was .05.

Results

Selective stimulus control was assessed in Phase 3 (Testing) by comparing the pattern of responses across groups in the presence of the test single stimuli and compound stimuli.

Single Stimuli

***Phase-2-consistent responding*.** Figure 4 shows the mean proportion of Phase-2-consistent responding in the presence of the single stimulus values in Phase 3. Data for one group are presented on each panel. The open bars indicate data for the non-target dimension (color for Groups 2 and 4; shape for Groups 3 and 5); the filled bars indicate data for the target dimension (shape for Groups 2 and 4; color for Groups 3 and 5). The error bars refer to the standard error of the mean. For Group 1, training for each of the stimulus dimensions was congruent across phases. Based on visual inspection, the mean proportion of Phase-2-consistent responding for the non-target stimuli appears high for all groups; the mean proportion of Phase-2-consistent responding for the target stimuli varied across Groups 2, 3, 4, and 5.

To examine differences in the mean proportion of Phase-2-consistent responding among Groups 2, 3, 4, and 5 and to determine whether participants responded differentially according to the training dimensions

(non-target, target), a target condition (2) x stimulus dimension assigned as the target dimension (2) x training history (2) mixed-factorial design analysis of variance (ANOVA) was conducted. The ANOVA was defined according to the following factors: target training condition (Partially Congruent, Incongruent) x stimulus dimension assigned as the target dimension (color, shape) x training history (non-target, target). Group 1 was not included because the training for both dimensions was the same across phases. Results showed a significant main effect of target training condition, F (1, 36) = 3.56, p = .050, a significant main effect of training history, F (1, 36) = 133.05, p < .001, and a significant target training condition x training history interaction effect, F (1, 36) = 4.59, p = .039. The effect of training history differed depending on the group assignment. The following effects were not significant: main effect of stimulus dimension [F (1, 36) = 1.04, p = .314]; target training condition x stimulus dimension interaction effect [F (1, 36) = .532, p = .471]; training history x stimulus dimension [F (1, 36) = 3.98, p = .065]; training history x target training condition x stimulus dimension interaction effect [F (1, 36) = .020, p = .887].

To examine the differences in mean proportion of Phase-2-consistent responding for Group 1 in which the contingencies of reinforcement between training phases were congruent for the stimulus dimension assigned as target

dimension (color, shape), an independent samples t-test was conducted. There was no significant difference in the mean proportion of Phase-2-consistent responding between the two stimulus dimensions, t (18) = 1.05, p = .307.

Figure 4. Mean proportion of Phase-2-consistent responding for Groups 1, 2, 3, 4, and 5 in the presence of the non-target and target single stimulus values presented during Phase 3 (Testing). Stimulus values are presented along the abscissa as capital letters (Red, R; Blue, B; Triangle, T; Diamond, D). The error bars refer to the standard error of the mean. Groups 2 and 3 were exposed to the Partially Congruent target training condition. Groups 4 and 5 were exposed to the Incongruent target training condition. For Groups 2, 3, 4, and 5, the stimulus dimension indicated in parentheses refers to the target dimension.

Figure 4.

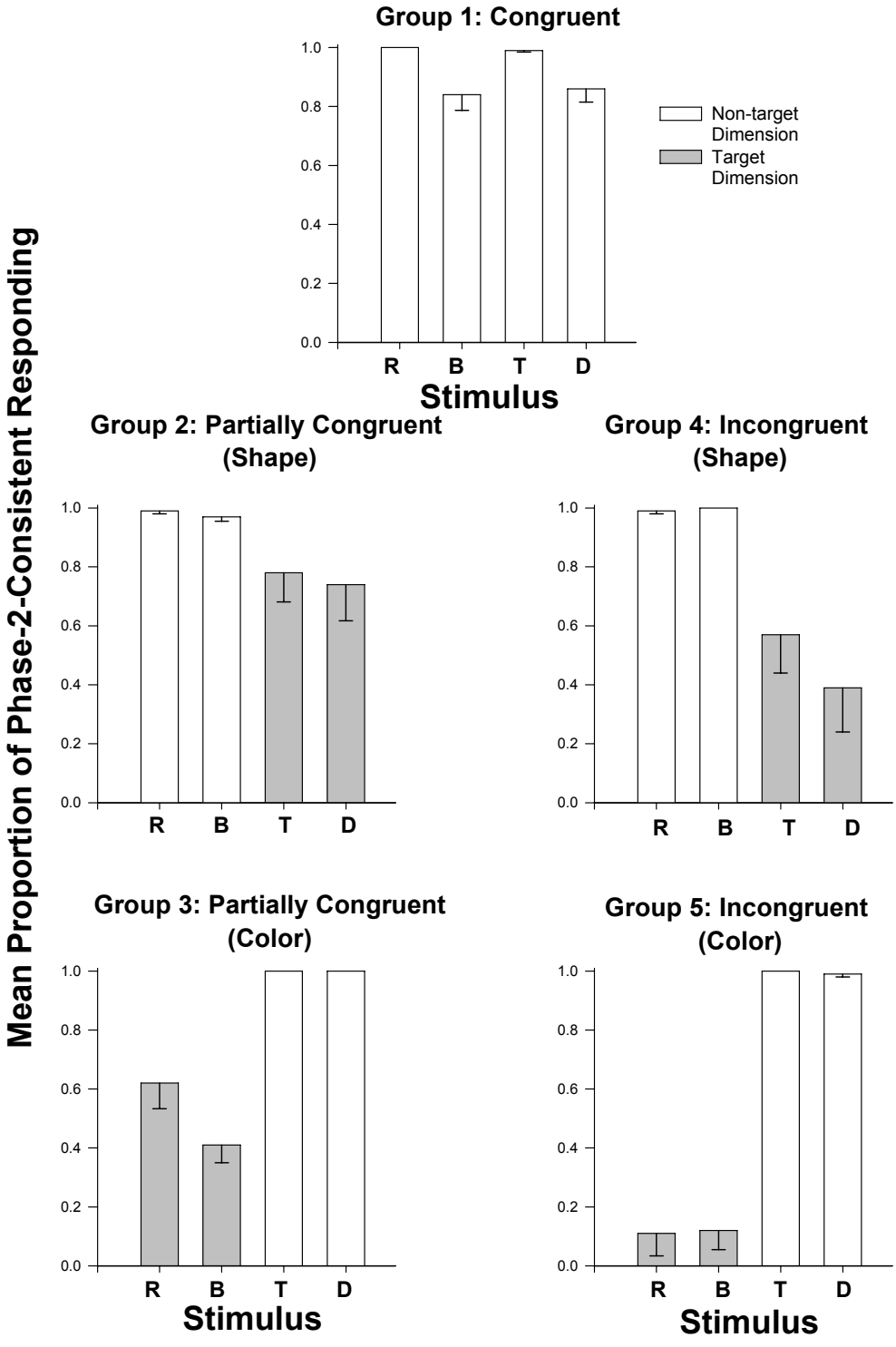

Group 1: Congruent
Group 2: Partially Congruent (Shape)
Group 3: Partially Congruent (Color)
Group 4: Incongruent (Shape)
Group 5: Incongruent (Color)
Mean Proportion of Phase-2-Consistent Responding
1.0
0.8
0.6
0.4
0.2
0.0
R
B
T
D
Stimulus
Non-target Dimension
Target Dimension

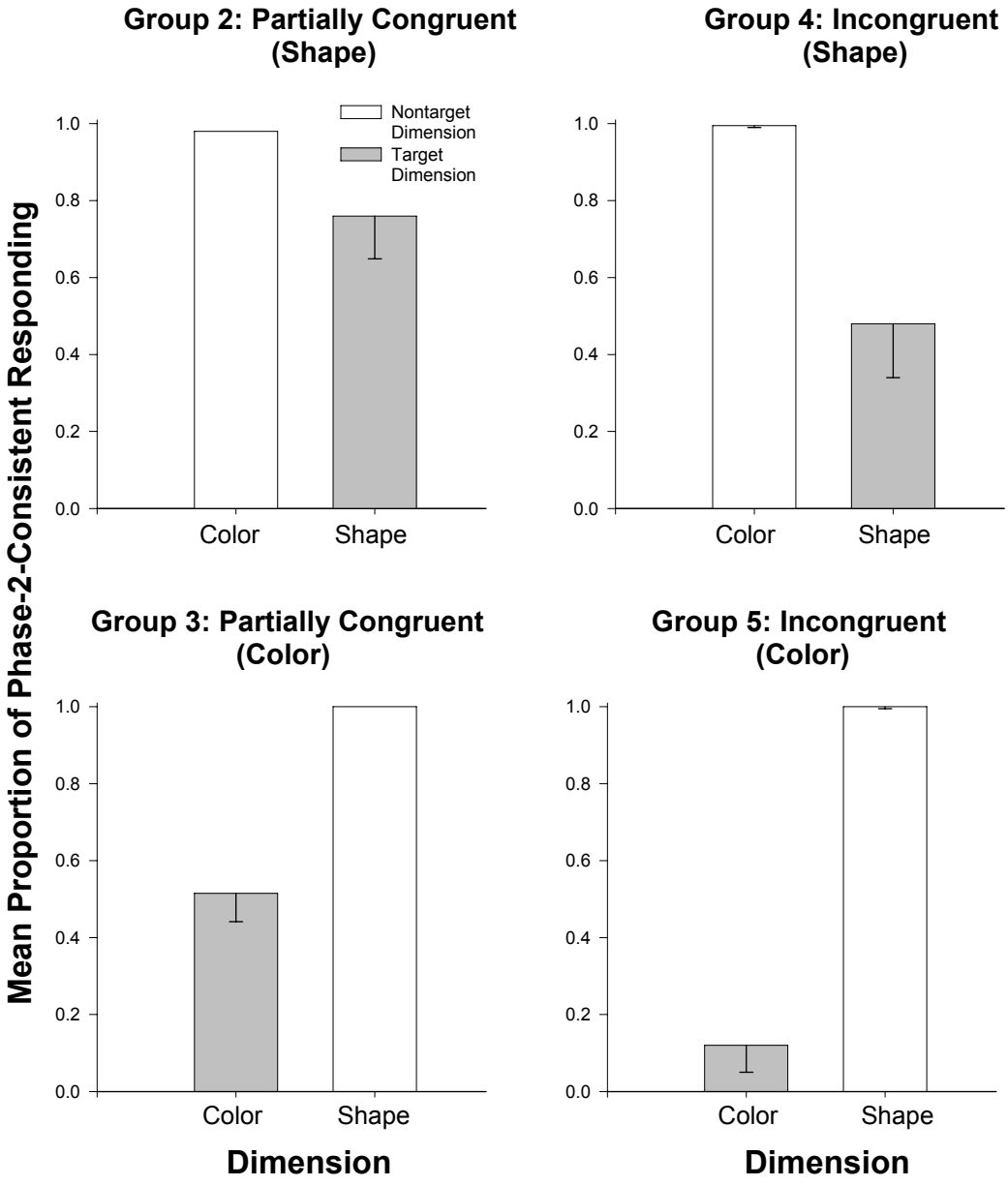
Figure 5 shows the mean proportion of Phase-2-consistent responding for the two stimulus values of a given dimension combined for each training dimension (non-target and target) for the Partially Congruent and Incongruent target training conditions. These values were combined based on the nonsignificant main effect of stimulus dimension and related interaction effects described above. It appears that the mean proportion of Phase-2-consistent responding in the presence of the target dimension for the Partially Congruent target training condition was higher than that of the Incongruent target training condition for comparable groups (Groups 2 vs. 4 and 3 vs. 5). To assess the extent to which the degree of mean proportion of Phase-2-consistent responding in the presence of the target dimension varied according to target training condition, a target training condition (2) x training dimension (2) ANOVA was conducted. Results of the ANOVA revealed a significant effect of target training condition, F (1, 36) = 4.40, p = 0.043. The mean proportion of Phase-2-consistent responding in the presence of the target dimension was higher in the presence of the Partially Congruent target training condition (M = 0.625) compared to the Incongruent target training condition (M = 0.315). The mean proportion of Phase-2-consistent responding was not significantly different for the training dimensions, F (1,

36) = 3.24, p = 0.080, and the target training condition x training dimension interaction was not significant, F (1, 36) = .656, p = 0.202.

Figure 6 shows the mean proportion of Phase-2-consistent responding for the non-target and target dimensions across the target training conditions. The data were combined across target training conditions due to the nonsignificant target training condition x training dimension interaction described above. The data for Group 1 were combined for non-target and target dimensions because the reinforcement contingencies were identical between phases. For Group 1, there was no manipulation of training history; one dimension was assigned as the non-target dimension and the other dimension was assigned as the target dimension. The mean proportion of Phase-2-consistent responding appears to decrease systematically with the decrease in the degree of congruence of reinforcement contingencies between Phase 1 and Phase 2 for the target dimension. In order to assess the differences in mean proportion of Phase-2-consistent responding across target training conditions in the presence of the target dimension, a one-way ANOVA was conducted. The Group 1 combined data were included in the analysis. There was a significant difference in the level of mean proportion of Phase-2-consistent responding across target training conditions, F (2, 47) = 47.04, $p < .001$.

Figure 5. Mean proportion of Phase-2-consistent responding for Groups 2, 3, 4, and 5 in the presence of the non-target and target dimensions for the single stimulus values presented during Phase 3 (Testing). The error bars refer to the standard error of the mean. Groups 2 and 3 were exposed to the Partially Congruent target training condition. Groups 4 and 5 were exposed to the Incongruent target training condition. For Groups 2, 3, 4, and 5, the stimulus dimension indicated in parentheses refers to the target dimension.

Figure 5.


Group 2: Partially Congruent (Shape)
Group 4: Incongruent (Shape)
Group 3: Partially Congruent (Color)
Group 5: Incongruent (Color)
Nontarget Dimension
Target Dimension
Mean Proportion of Phase-2-Consistent Responding
1.0
0.8
0.6
0.4
0.2
0.0
Color
Shape
Dimension

According to post-hoc tests, there was a significant difference in the mean proportion of Phase-2-consistent responding in the presence of the target dimension between the Congruent (M = 0.923) and Partially Congruent (M = 0.625) target training conditions. In addition, there was a significant difference in the mean proportion of Phase-2-consistent responding in the presence of the target dimension between the Partially Congruent (M = 0.625) and Incongruent (M = 0.315) target training conditions.

As displayed in Figure 6, high levels of Phase-2–consistent responding were obtained in the presence of the non-target dimension. A one-way ANOVA on the effect of target training condition on Phase-2-consistent responding for the non-target dimension was not significant, F (2, 47) = .156, p = .856.

Figure 6.

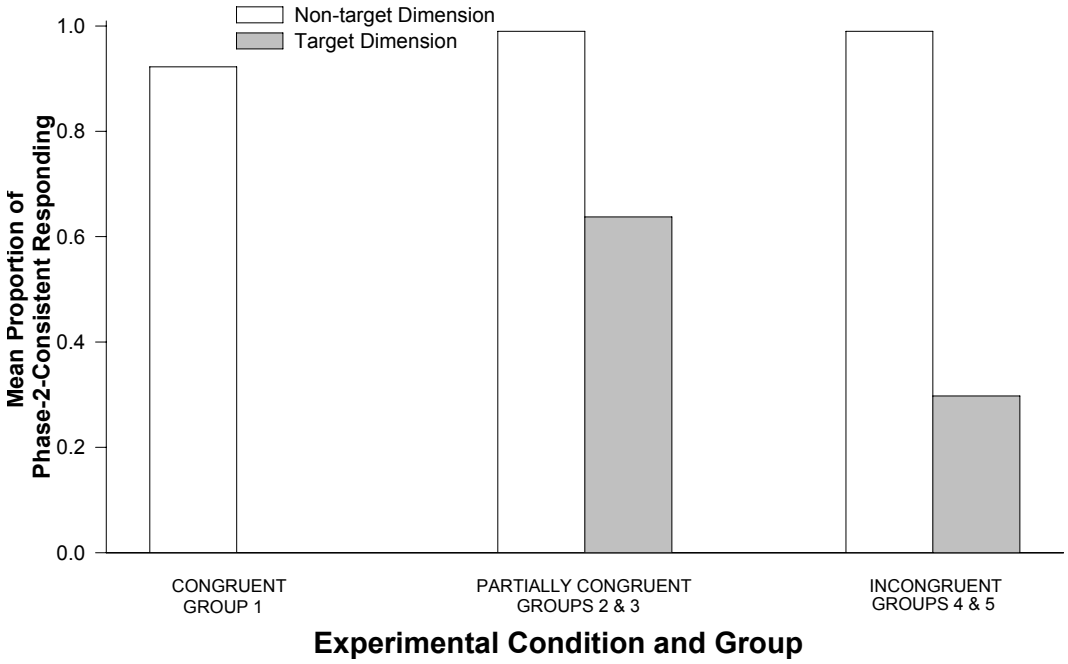


Figure 6. Mean proportion of Phase-2-consistent responding for each of the five groups in the presence of the non-target and target dimensions for the single stimulus values presented during Phase 3 (Testing). For Group 1, the single bar refers to the average of mean proportion of Phase-2-consistent responding in the presence of the color and shape stimulus dimensions.

***Response latency*.** Figure 7 shows the mean response latency (ms) in the presence of the single stimulus values in Phase 3. The figure format is similar to Figure 4. The mean response latency (ms) in the presence of the non-target and target dimension stimuli appears to be similar for most of the groups, with the exception of Group 3. For Group 3, the mean response latency (ms) in the presence of the target dimension stimuli are somewhat higher than that of the non-target dimension stimuli. A mixed-factorial design 2 x 2 x 2 analysis of variance (ANOVA) was conducted using the following factors: target training condition (Partially Congruent, Incongruent) x stimulus dimension assigned as the target dimension (color, shape) x training history (non-target, target) with 10 participants in each group, to examine differences in mean response latency (ms) among Groups 2 – 5 and to determine whether participants responded differentially according to the training dimensions. The ANOVA revealed no significant main effects or interaction effects, F (1, 36) $\leq$ 2.095, ns.

Figure 7. Mean response latency (ms) for Groups 1, 2, 3, 4, and 5 in the presence of the non-target and target single stimulus values presented during Phase 3 (Testing). Stimulus values are presented along the abscissa as capital letters (Red, R; Blue, B; Triangle, T; Diamond, D). The error bars refer to the standard error of the mean. Groups 2 and 3 were exposed to the Partially Congruent target training condition. Groups 4 and 5 were exposed to the Incongruent target training condition. For Groups 2, 3, 4, and 5, the stimulus dimension indicated in parentheses refers to the target dimension.

Figure 7.

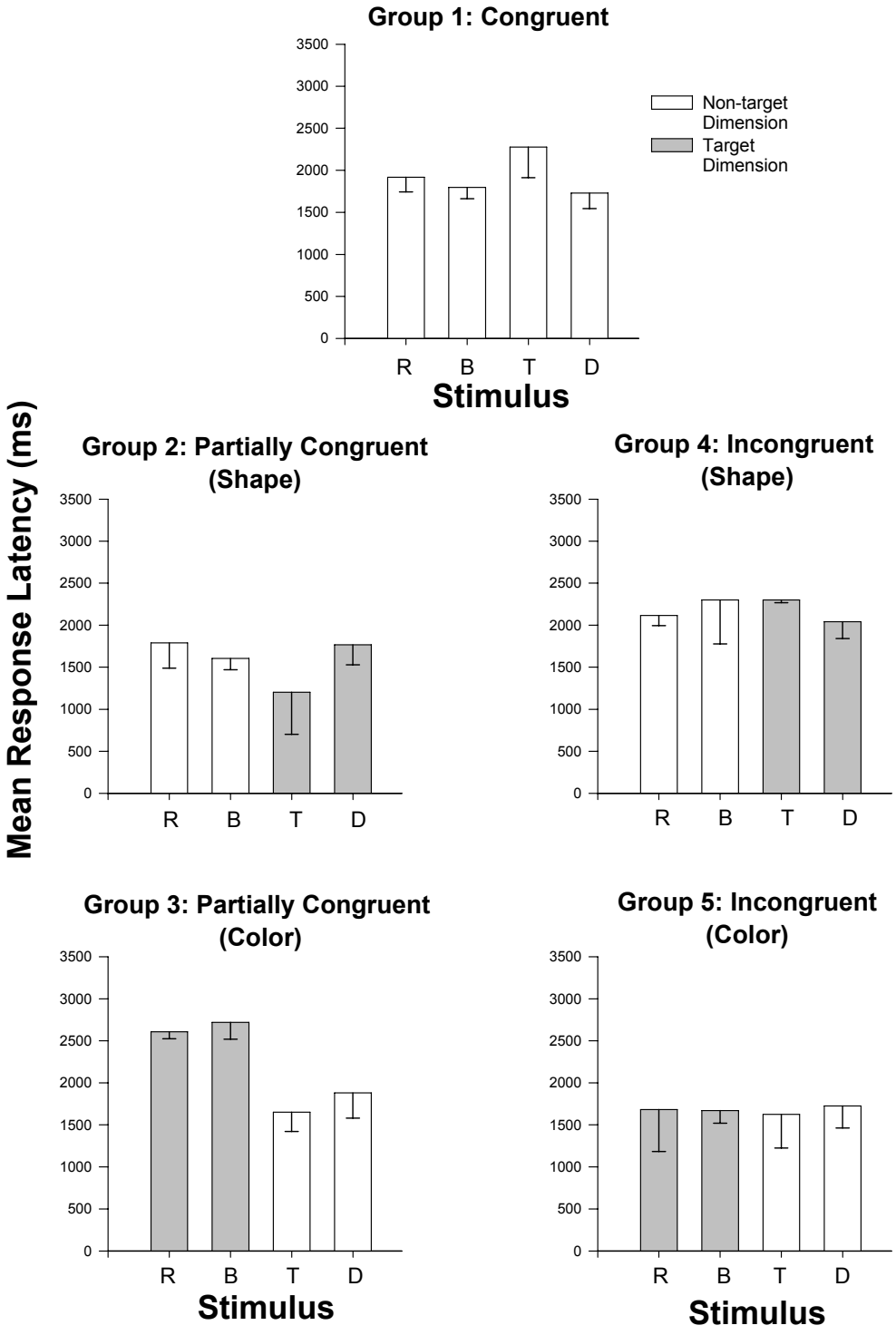
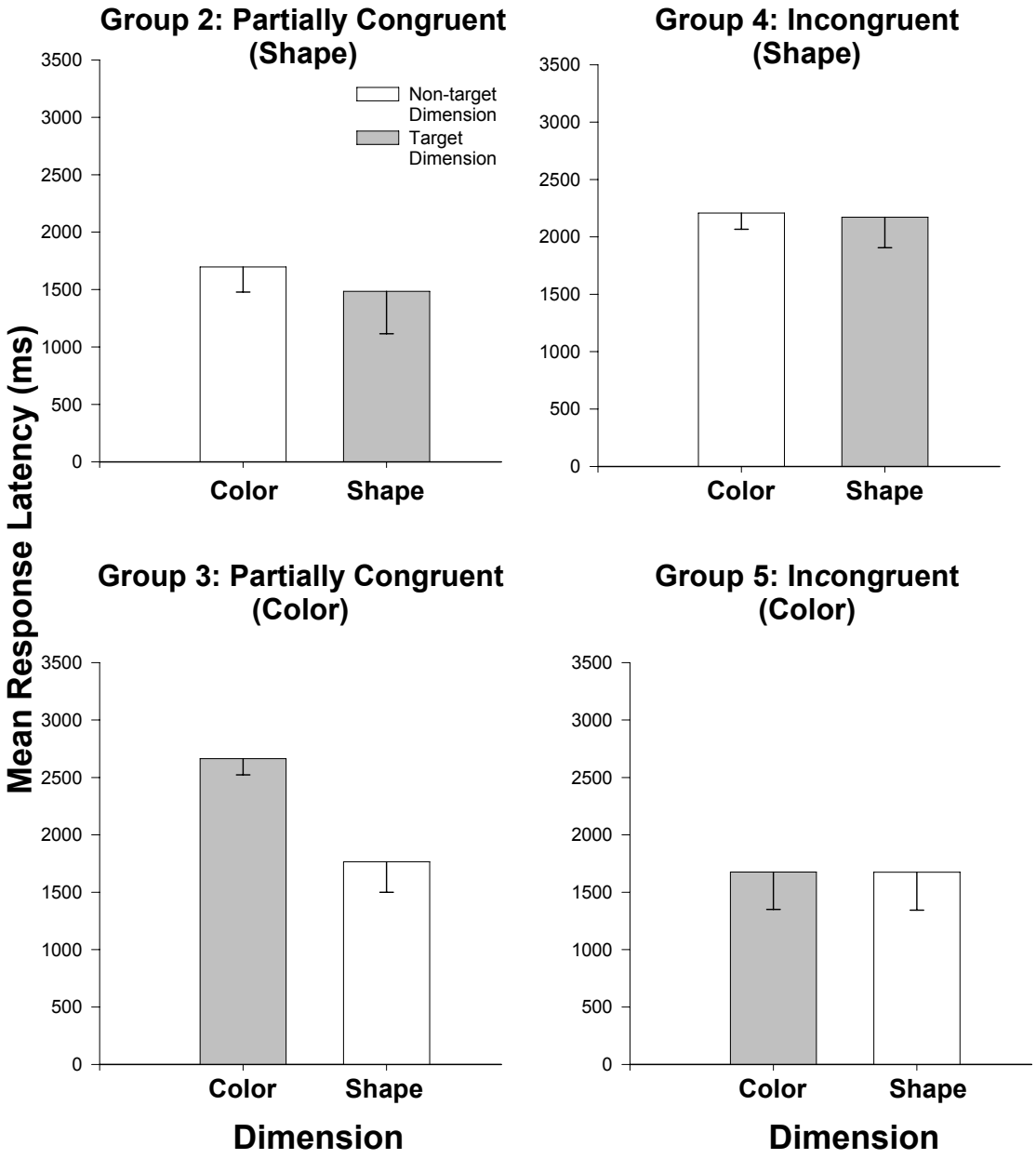

Group 1: Congruent
Non-target Dimension
Target Dimension
Mean Response Latency (ms)
Group 2: Partially Congruent (Shape)
Group 4: Incongruent (Shape)
Group 3: Partially Congruent (Color)
Group 5: Incongruent (Color)
3500
3000
2500
2000
1500
1000
500
0
R
B
T
D
Stimulus

Figure 8 shows the mean response latency (ms) for the training dimensions (non-target and target) under the Partially Congruent and Incongruent target training conditions. These mean response latency values were combined across stimulus values for each group based on the nonsignificant main effect of stimulus dimension and related interaction effects described above. Compared to the other groups, Group 3 appears to show evidence of a training effect, as shown by the greater level of mean response latency (ms) in the presence of the target dimension compared to that of the non-target dimension. A target training condition (2) x training dimension (2) ANOVA was conducted. There were no significant effects on response latency (ms) of target training condition, F (1, 36) = .017, p = .897, or training dimension, F (1, 36) = .520, p = .475. The target training condition x training dimension interaction was not significant, F (1, 36) = 2.49, p = .123.

Figure 8. Mean response latency (ms) for Groups 2, 3, 4, and 5 in the presence of the non-target and target dimensions for the single stimulus values presented during Phase 3 (Testing). The error bars refer to the standard error of the mean. Groups 2 and 3 were exposed to the Partially Congruent target training condition. Groups 4 and 5 were exposed to the Incongruent target training condition. The stimulus dimension indicated in parentheses refers to the target dimension.

Figure 8.


Group 2: Partially Congruent (Shape)
Non-target Dimension
Target Dimension
Group 4: Incongruent (Shape)
Group 3: Partially Congruent (Color)
Group 5: Incongruent (Color)
Mean Response Latency (ms)
3500
3000
2500
2000
1500
1000
500
0
Color
Shape
Dimension

Compound Stimuli

Phase-2-consistent responding. Figure 9 shows the mean proportion of Phase-2-consistent responding for each group in the presence of the compound stimuli. For each group panel, the mean proportion of Phase-2-consistent responding in the presence of the trained compound stimuli are presented in the two left-side columns; the mean proportion of Phase-2-consistent responding in the presence of the untrained compound stimuli are presented in the two right-side columns.

In the presence of the untrained compound stimuli, Phase-2-consistent responding was defined according to the response in Phase 2 that was assigned for the non-target dimension, only. For example, if color was the non-target dimension (Group 4) and Red was called VEC in Phase 1 and 2, then in the presence of the Red/Diamond untrained compound stimulus, VEC would be the Phase-2-consistent response.

The mean proportion of Phase-2-consistent responding in the presence of the **trained compound stimuli** appears high with minimal variability across groups. To assess differences across the target training conditions (Congruent, Partially Congruent, and Incongruent) in mean proportion of Phase-2-consistent responding in the presence of the trained compound stimuli, a one-way ANOVA was conducted. There were no significant

differences found across target training condition, F (2, 47) = .302, p = .741.

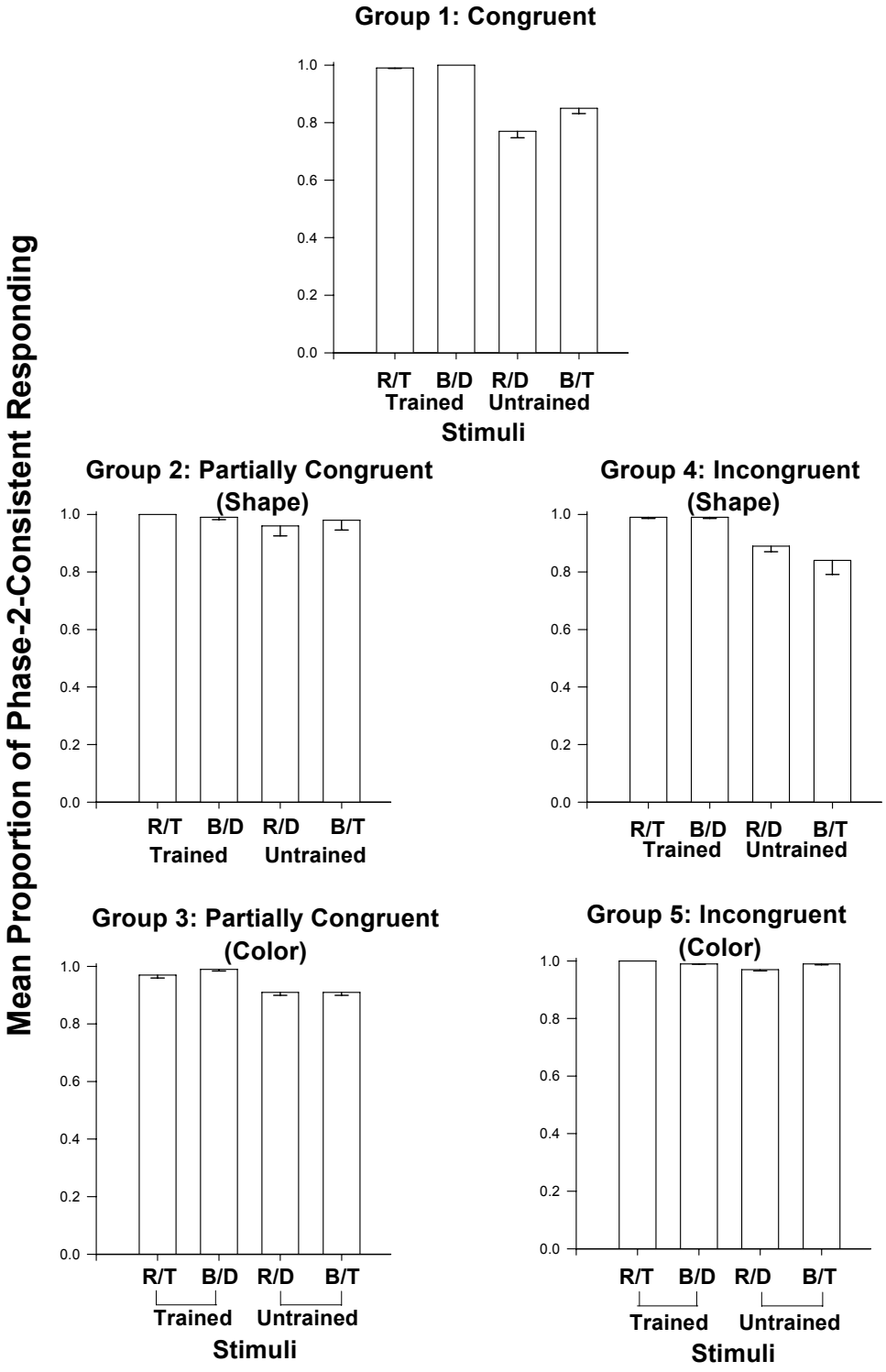
The mean proportion of Phase-2-consistent responding in the presence of the **untrained compound stimuli** also appears high with little variability across groups. To assess differences across the target training conditions (Congruent, Partially Congruent, and Incongruent) in mean proportion of Phase-2-consistent responding in the presence of the untrained compound stimuli, a one-way ANOVA was conducted. There were differences in mean proportion of Phase 2 consistent responding across target training conditions for untrained compound stimuli F (2, 47) = 9.95, p $<$.001. Tukey post-hoc tests revealed that the mean proportion of Phase-2-consistent responding for the Congruent target training condition (M = 0.92) was significantly lower than those of the Partially Congruent (M = 0.99) and Incongruent (M = 0.98) target training conditions.

For each group, a dependent measures t-test was used to assess the differences in mean proportion of Phase-2-consistent responding according to the compound stimulus (trained or untrained) with 10 participants per group. For Group 1, the mean proportion of Phase-2-consistent responding significantly differed in the presence of the trained and untrained compound stimuli, t (9) = 2.512, p = .033. For Group 4, the mean proportion of Phase-

2-consistent responding significantly differed in the presence of the trained and untrained compound stimuli, t (9) = .667, p = .035. There were no significant effects found for Groups 2, 3, and 5 [t (9) = .421, p = 1.00; t (9) = 1.00, p = .343; t (9) = 1.00, p = .434, respectively].

Figure 9. Mean proportion of Phase-2-consistent responding for Groups 1, 2, 3, 4, and 5 in the presence of the trained and untrained compound stimuli presented during Phase 3 (Testing). Compound stimuli are presented along the abscissa as capital letters (Red/Triangle, R/T; Blue/Diamond, B/D; Red/Diamond, R/D; Blue/Triangle, B/T). The trained compounds are R/T and B/D (left-side bars). The untrained compounds are R/D and B/T (right-side bars). The error bars refer to the standard error of the mean. Groups 2 and 3 were exposed to the Partially Congruent target training condition. Groups 4 and 5 were exposed to the Incongruent target training condition. For Groups 2, 3, 4, and 5, the stimulus dimension indicated in parentheses refers to the target dimension.

Figure 9.


Group 1: Congruent
Group 2: Partially Congruent (Shape)
Group 4: Incongruent (Shape)
Group 3: Partially Congruent (Color)
Group 5: Incongruent (Color)
Mean Proportion of Phase-2-Consistent Responding
1.0
0.8
0.6
0.4
0.2
0.0
R/T
B/D
R/D
B/T
Trained
Untrained
Stimuli

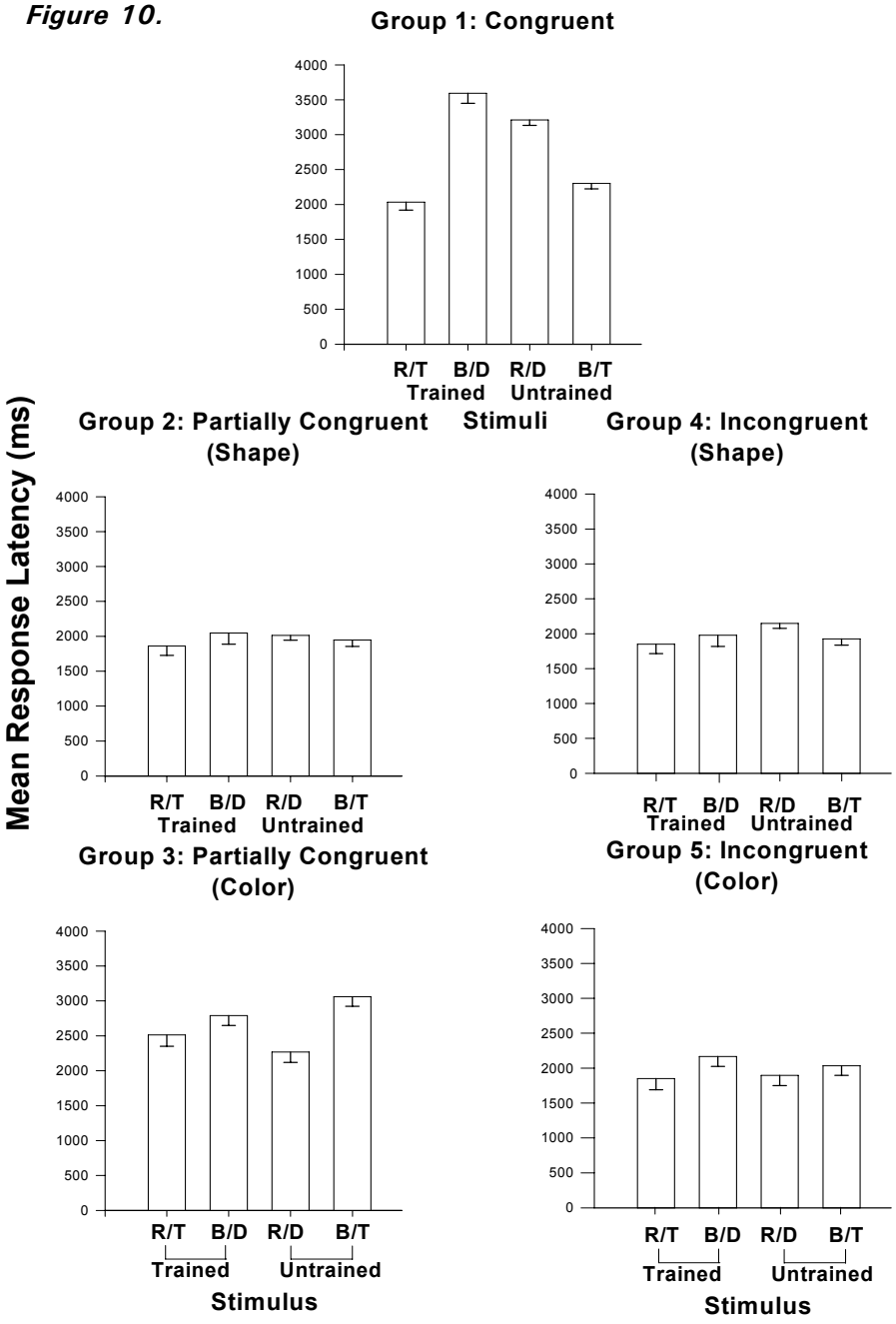
***Response latency*.** Figure 10 shows the mean response latency (ms) in the presence of the compound stimuli presented in Phase 3. The figure format is similar to that of Figure 9. To assess differences across the target training conditions (Congruent, Partially Congruent, and Incongruent) in mean response latency (ms) in the presence of the trained compound stimuli, a one-way ANOVA was conducted. There were no significant differences found across target training conditions, F (2, 47) = 2.368, p = .741.

In comparing the data for the **untrained compound stimuli** across groups, the mean response latency (ms) in the presence of the Red/Diamond compound stimulus was not different from that of the Blue/Triangle compound stimulus. The mean response latency (ms) is greater in the presence Blue/Triangle compound stimulus for Groups 3 and 5 compared to that of the Red/Diamond compound stimulus, but this difference was not significant. There were differences in mean response latency (ms) across target training conditions for untrained compound stimuli, F (2, 47) = 3.378, p = .043. Tukey post-hoc tests revealed that the mean response latency (ms) for the Congruent target training condition (M = 2223.80) was significantly higher than that of the Incongruent target training condition (M = 1708.40).

For each group, a dependent measures t-test was used to assess the differences in mean response latency (ms) according to the compound stimulus (trained or untrained) with 10 participants per group. There were no significant effects found for Groups 1, 2, 3, 4, or 5 [t (9) = .798, p = .445; t (9) = 1.45, p = .888; t (9) = .392, p = .704; t (9) = 1.407, p = .088, t (9) = 1.056, p = .318, respectively].

Figure 10. Mean response latency (ms) for Groups 1, 2, 3, 4, and 5 in the presence of the presence of the trained and untrained compound stimuli presented during Phase 3 (Testing). Compound stimuli are presented along the abscissa as capital letters (Red/Triangle, R/T; Blue/Diamond, B/D; Red/Diamond, R/D; Blue/Triangle, B/T). The trained compounds are R/T and B/D (left-side bars). The untrained compounds are R/D and B/T (right-side bars). The error bars refer to the standard error of the mean. Groups 2 and 3 were exposed to the Partially Congruent target training condition. Groups 4 and 5 were exposed to the Incongruent target training condition. For Groups 2, 3, 4, and 5, the stimulus dimension indicated in parentheses refers to the target dimension.

Figure 10.


Group 1: Congruent
Group 2: Partially Congruent (Shape)
Group 3: Partially Congruent (Color)
Group 4: Incongruent (Shape)
Group 5: Incongruent (Color)
Mean Response Latency (ms)
4000
3500
3000
2500
2000
1500
1000
500
0
R/T
B/D
R/D
B/T
Trained
Untrained
Stimuli
Stimulus

Trials to Criterion

The mean number of trials to meet the Phase 1 and Phase 2 performance criterion is presented in Figure 11. Across all groups, the performance criterion for Phase 1 was based on accurate performance on the non-target dimension, only. From Figure 11, Group 5 shows the highest mean number of trials to criterion, compared to the other groups. In order to assess the differences in the number of trials required to meet the Phase 1 criterion, a one-way ANOVA was conducted across groups (5), that indicated a significant effect of group, F (4, 45) = 3.55, p = .013. Tukey post-hoc tests revealed that the mean trials to criterion required for Group 1 (M = 18.40) was significantly lower than that of the Group 5 (M = 37.20), and that the mean trials to criterion required for Group 4 (M = 19.20) was significantly lower than that of Group 5 (M = 37.20).

The figure shows more consistency in mean number of trials required to meet the Phase 2 contingencies across groups in comparison to Phase 1. A one-way ANOVA was conducted across groups (5) to assess the differences in the number of trials required to meet the Phase 2 criterion. A nonsignificant effect of group was found, F (4, 45) = 1.12, p = .360.

Figure 11.

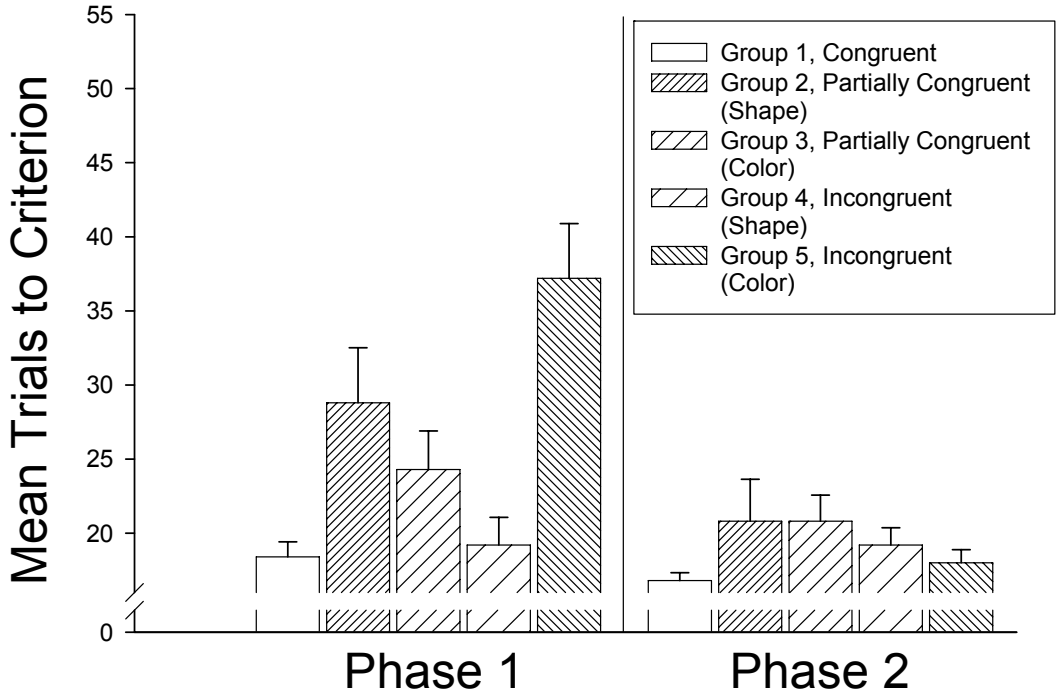


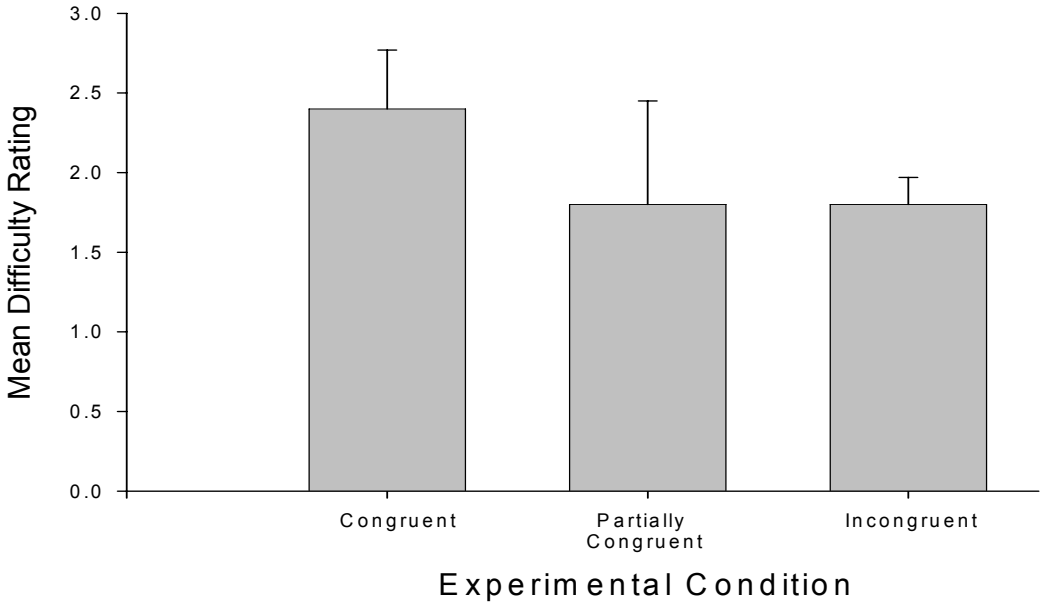
Figure 11. Mean trials to meet the Phase 1 and 2 criteria in Experiment 1 across the groups: Congruent target training condition (Group 1), Partially Congruent target training condition (Groups 2 and 3), and Incongruent target training condition (Groups 4 and 5). The error bars indicate the standard error of the mean.

Difficulty Ratings

Figure 12 presents the findings from the debriefing question of the debriefing interview (Appendix C) requesting participants to rate their perceived level of difficulty experienced during the experiment. According to Figure 12, there appear to be high levels of variability across conditions. A one-way ANOVA of difficulty ratings across target training conditions was conducted to determine whether participants responded differentially according to the target training conditions. The analysis revealed a nonsignificant effect of target training condition, F (2, 47) = 2.459, p = .096.

Figure 12. Mean ratings of experiment difficulty according to the debriefing survey in Experiment 1. The rating scale values are: 0, not difficult at all; 1, very easy; 2, slightly easy; 3, moderately difficult; or 4, very difficult. The error bars refer to the standard error of the mean. The target training conditions and corresponding groups are: Congruent target training condition (Group 1), Partially Congruent target training condition (Groups 2 and 3), and Incongruent target training condition (Groups 4 and 5).

Figure 12.


3.0
2.5
2.0
1.5
1.0
0.5
0.0
Mean Difficulty Rating
Congruent
Partially Congruent
Incongruent
Experimental Condition

Discussion

The present results showed a systematic decrease in the level of mean proportion of Phase-2-consistent responding in the presence of the target stimuli during testing across the Congruent, Partially Congruent and Incongruent target training conditions. These findings replicated the previous research (Huguenin and Touchette, 1980) on selective stimulus control using a conditional discrimination procedure with two levels of the congruence (congruent and incongruent) of the reinforcement contingencies between training phases. The findings of Experiment 1 extend the research on selective stimulus control to a third level (25%) of congruence between training phases. The demonstration of a functional relation between congruence of reinforcement contingencies across training phases using the conflict-compound stimulus discrimination paradigm provides a contribution to the literature by showing a graded effect of congruence on selective stimulus control.

The Experiment 1 results can be evaluated in terms of the continuity theory that predicts that for the Incongruent and Partially Congruent target training groups a relatively low probability of Phase-2-consistent responding is expected compared to the Congruent group in the presence of the target dimension. In accord with that prediction, the groups exposed to the

Incongruent and the Partially Congruent conditions showed a relatively low probability of Phase-2-consistent responding in the presence of the target dimension compared to the Congruent target training condition. It may be inferred that the participants in the Partially Congruent and Incongruent conditions gradually learned the new contingencies in Phase 2 for the target dimension. Some new learning of the Phase 2 contingencies for the target dimension occurred for the Incongruent condition, but the level of learning was lower than that of the Partially Congruent condition. These different levels of Phase-2-consistent responding in the presence of the target dimension for the Partially Congruent and Incongruent target training conditions lend support for the continuity theory.

The present results can also be evaluated in terms of the predictions of the noncontinuity theory. The noncontinuity theory predicts that for the Incongruent target training groups near-zero levels of Phase-2-consistent responding were expected in the presence of the target dimension. The present findings do not correspond to the predictions of the noncontinuity theory in that groups exposed to the Incongruent condition showed elevated (non-zero) levels of Phase-2-consistent responding in the presence of the target dimension.

According to the selective stimulus control account, it can be speculated that the non-target training dimension present during Phase 2 training selectively controlled performance, thereby diminishing control by the target training dimension. As a result, participants showed little acquisition of the new stimulus-response relation programmed for the target training dimension in Phase 2. Huguenin and Touchette interpreted their findings in terms of selective attention to the non-target dimension; Ray interpreted her findings as ignoring the target dimension. According to both interpretations, the new stimulus-response contingency implemented for the target training dimension was not acquired under the Incongruent target training condition.

There is an alternative interpretation to Huguenin and Touchette's and Ray's interpretations that specifies that learning based on the new stimulus-response contingency for the target training dimension *does* occur during Phase 2. The 'learning acquisition' interpretation assumes that during Phase 2 training, for the conditions other than Congruent, the new Phase 2 contingency for the target training dimension in the presence of the compound stimuli is learned to some extent. The learning acquisition interpretation is in line with Spence (1936) and continuity theory, indicating the gradual learning of the contingencies for the target dimension. The learning acquisition interpretation is different from the noncontinuity theory

because according to noncontinuity theory, no new learning of the contingencies for the target dimension would occur.

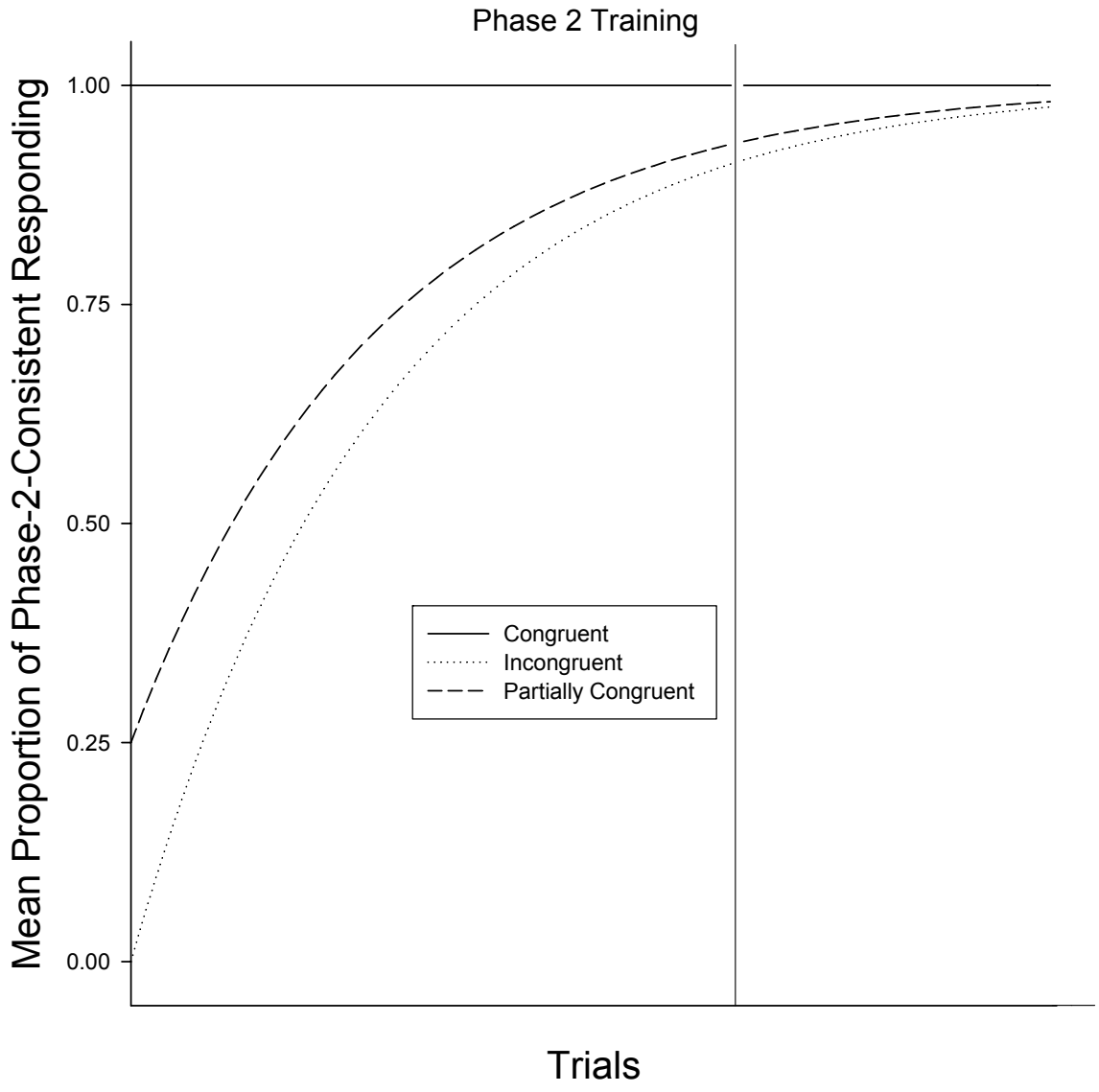
A visual display of hypothetical performance that corresponds to the learning acquisition interpretation is shown in Figure 13. Figure 13 displays performance in the presence of the target stimulus during Phase 2 for the three conditions. The initial level of Phase-2-consistent responding represents the level of Phase-2-consistent responding immediately following Phase 1 training. As displayed in Figure 13, the initial level of performance for the Congruent and Partially Congruent conditions would be higher than that of the Incongruent condition. For the congruent condition, the initial level would approximate 100%. For the other two conditions, Partially Congruent and Incongruent, the initial levels would approximate the levels according to the Phase 1 training conditions, 25% and 0%, respectively. Although acquisition was not directly measured in Phase 2 for the target training dimension in Experiment 1, the learning acquisition account assumes that learning would be acquired for the Incongruent condition, as shown in the figure by the increase in proportion of phase-2 consistent responding. Owing to the different levels of responding for the three conditions projected for the onset of phase 2, differential levels of performance would be also be expected at the end of phase 2 (indicated by the vertical line in Figure 13), with the

highest level for the Congruent Condition and the lowest level for the Incongruent Condition.

In the present study, the graded effect of congruence may indicate partial learning of the new contingency in Phase 2 or partial interference of new learning for the target dimension by the non-target dimension, or both. For the Congruent and the Partially Congruent target training conditions, in contrast to the Incongruent target training condition, Phase 1 provided participants with a history of reinforcement for the new stimulus-response relation programmed in Phase 2. The level of acquisition for the Partially Congruent condition is based on the training history presented to those participants prior to Phase 2; whereas, the participants in the Incongruent condition had no prior training.

Figure 13. Mean proportion of Phase-2-consistent responding in the presence of the target training dimension presented during Phase 2 across trials for the target training conditions of Experiment 2. Data are hypothetical. The vertical line refers to the end of the Phase 2 training procedure according to the criterion for completion. In the event of further training, data are hypothesized to gradually increase over trials.

Figure 13.


Phase 2 Training
Mean Proportion of Phase-2-Consistent Responding
1.00
0.75
0.50
0.25
0.00
Congruent
Incongruent
Partially Congruent
Trials

EXPERIMENT 2

The present experiment attempts to distinguish between the two alternate interpretations of the results of Experiment 1, selective stimulus control and learning acquisition, by manipulating the level of within-compound competition in Phase 2. Support for selective stimulus control would occur if the mean level of Phase-2-consistent responding is lower for the group trained as in Experiment 1 versus for the groups in which the target stimulus values are compounded with novel stimuli or irrelevant stimuli in Phase 2. This prediction is based on the degree of competition between cues across non-target training conditions. Responding in the presence of the target dimension in the group trained as in Experiment 1 is expected to be low compared to the other conditions because of the high level of competition between cues. In contrast, compound stimulus training that produces relatively similar results across non-target training conditions would indicate the need for an explanation of Experiment 1 findings that does not rely on selective stimulus control. On the other hand, support for the learning acquisition interpretation would occur if differential levels of acquisition of the altered stimulus-response relation in Phase 2 are demonstrated as a function of the non-target training condition. According to the learning acquisition

interpretation, no differences in responding in the presence of the target dimension under a given target condition would be expected.

Experiment 2 extended the Experiment 1 manipulation of target training conditions to include a manipulation of the Phase 1 training contingencies of the non-target training dimension. The target stimulus values were compounded with: (a) stimuli consistently correlated with reinforcement, as in Experiment 1, (b) novel stimuli, or (c) stimuli not consistently correlated with reinforcement (irrelevant stimuli). Compared to the conditions presented in Experiment 1 in which the target stimuli were compounded with correlated non-target stimuli only, the purpose of using target stimuli compounded with novel or irrelevant stimuli in Experiment 2 was to reduce the competition between cues. For all non-target training conditions, the reinforcement contingencies for responding for the target stimulus values in Phase 2 were congruent, partially congruent, or incongruent with their Phase 1 training.

Method

Participants in Experiment 2

One hundred fifty university undergraduate students, ranging from 18-47 years old (94 were female and 56 were male) participated to fulfill a requirement of their introductory psychology course. Ten students were randomly assigned to each of the 15 groups described below. The method of recruitment was identical to that of Experiment 1.

Procedures of Experiment 2

The apparatus, setting, stimuli (color and shape), motivational system, instructions, experimental-trial format, Phase 2 feedback format, Phase 2 performance criterion, debriefing procedure, and data analysis procedures from Experiment 1 were used in Experiment 2. Phase 3 testing differed from Experiment 1 Phase 3 testing as described below. The stimulus dimensions used in Experiment 2 were: ***color***, ***shape***, and ***line orientation*** (see Table 1). The color and shape dimensions were the same as those used in Experiment 1. The line orientation dimension was composed of black lines presented within a rectangular space measuring 12 cm x 7 cm on the computer screen. The rectangular space was identical to that of the other stimuli. Two values of line orientation were presented—horizontal and vertical.

Experimental Design of Experiment 2

In Experiment 2, training history was manipulated for both the non-target and target dimensions using a non-target training condition x target training condition x stimulus dimension assigned as the target dimension (color, shape) x training history (non-target, target) mixed factorial design with 10 subjects per group. Table 9 displays the structure for Experiment 2. There were three levels of training history for the non-target dimension, labeled *Correlated, Absent,* and *Not Correlated,* based on manipulation of Phase 1 reinforcement contingencies for the non-target dimension, and three levels of training for the target dimension—*Congruent*, *Partially Congruent*, and *Incongruent*, as in Experiment 1.

Non-target training conditions. The Correlated non-target training condition corresponds to the training conditions of Experiment 1. Under the Absent non-target training condition, there was one target dimension trained in Phase 1 and Phase 2; the non-target dimension trained in Phase 1 was different from the non-target dimension used in Phase 2. Under the Not Correlated non-target training condition, the two responses for the non-target dimension were assigned as correct for half the trials in Phase 1

Structure for Experiment 2

Condition		Group	Experimental Phases			
			Phase 1: Single Stimulus Discrimination Training	Phase 2: Compound Stimulus Discrimination Training	Relation between Contingencies for Naming in Phase 1 and Phase 2	Phase 3: Testing
Correlated Experiments 1 and 2	**Congruent**	**1**	***NT*** 100% ***T*** 100 %	***NT*** 100% ***T*** 100 %	***nt*** CONGRUENT ***t*** CONGRUENT	**10 Trials of each Stimulus** ***Experiment 1:*** Trained and Untrained Stimuli ***Experiment 2***: Trained Stimuli only
	Partially Congruent	**2 & 3**	***NT*** 100% ***T*** 25% / 75%	***NT*** 100% ***T*** 100 %	***nt*** CONGRUENT ***t*** PARTIAL	
	Incongruent	**4 & 5**	***NT*** 100% ***T*** 100 %	***NT*** 100% ***T*** 100 %	***nt*** CONGRUENT ***t*** INCONGRUENT	
Absent Experiment 2	**Congruent**	**6**	***NT*** 100% ***T*** 100 %	***NT*** 100% ***T*** 100 %	****nt*** NOVEL ***t*** CONGRUENT	
	Partially Congruent	**7& 8**	***NT*** 100% ***T*** 25% / 75%	***NT*** 100% ***T*** 100 %	****nt*** NOVEL ***t*** PARTIAL	
	Incongruent	**9 & 10**	***NT*** 100% ***T*** 100 %	***NT*** 100% ***T*** 100 %	****nt*** NOVEL ***t*** INCONGRUENT	
Not Correlated Experiment 2	**Congruent**	**11**	***NT*** 50% ***T*** 100 %	***NT*** 100% ***T*** 100 %	**+*nt*** IRRELEVANT ***t*** CONGRUENT	
	Partially Congruent	**12 & 13**	***NT*** 50% ***T*** 25% / 75%	***NT*** 100% ***T*** 100 %	**+*nt*** IRRELEVANT ***t*** PARTIAL	
	Incongruent	**14 & 15**	***NT*** 50% ***T*** 100 %	***NT*** 100% ***T*** 100 %	**+*nt*** IRRELEVANT ***t*** INCONGRUENT	

Table 9 continued

Note. The two training dimensions studied are non-target dimension, *NT,* and target dimension, *T*. Each dimension has two individual values, which are non-target stimulus, *nt,* and target stimulus, *t*.

Experimental Phase Description.

Phase 1 refers to single stimulus discrimination training for each of the two values of two dimensions, non-target dimension (*NT*) and target dimension (*T*).

Phase 2 refers to the manipulation of congruence of the contingency of reinforcement between Phase 1 and Phase 2 for each of the two target stimulus values (*t*).

Stimulus-Response-Reinforcer Contingency.

Subscripts.

100%: For each value of a given training dimension, a given response is assigned as the correct response on 100% of the trials.

50%: For each value of a given training dimension, a given response is assigned as the correct response on 50% of the trials.

25%/75%: For each value of a given training dimension, one response is assigned as the correct response on 75% of the trials, and the other response is assigned as the correct response on 25% of the trials.

Relation between Phase 1 and Phase 2 Contingencies for the Non-target Dimension.

Subscripts.

****NOVEL:*** The non-target dimension is novel. The reinforcement contingency in effect for the two novel stimulus values in Phase 2 is new; there is no training in Phase 1 for the novel stimulus values.

Table 9 continued

+***IRRELEVANT:*** The reinforcement contingency in effect for a non-target stimulus value in Phase 2 is congruent with that of Phase 1 for the non-target stimulus value on 50% of the trials; i.e., the assigned response in Phase 2 for a given target stimulus value in Phase 2 is the same as the assigned response for that stimulus value in Phase 1 on half of the Phase 1 trials.

CONGRUENT: The reinforcement contingency in effect for a target stimulus value in Phase 2 is congruent with that of Phase 1 on 100% of the trials; i.e., the assigned response in Phase 2 for a given target stimulus value in Phase 2 is the same as the assigned response in Phase 1 for each target stimulus value.

Relation between Phase 1 and Phase 2 Reinforcement Contingencies for the Target Dimension.

Subscripts.

CONGRUENT: The reinforcement contingency in effect for a target stimulus value in Phase 2 is congruent with that of Phase 1 on 100% of the trials; i.e., the assigned response in Phase 2 for a given target stimulus value in Phase 2 is the same as the assigned response in Phase 1 for each target stimulus value.

PARTIAL (PARTIALLY CONGRUENT): The reinforcement contingency in effect for a target stimulus value in Phase 2 is congruent with that of Phase 1 on 25% of the trials; i.e., the assigned response in Phase 2 for a given target stimulus value in Phase 2 is the same as the assigned response for that stimulus value in Phase 1 on 25% of the Phase 1 trials.

INCONGRUENT: The reinforcement contingency in effect for a target stimulus value in Phase 2 is congruent with that of Phase 1 on 0% of the trials; i.e., the assigned response in Phase 2 for a given target stimulus value in Phase 2 is different from the assigned response for that stimulus value in Phase 1 on all Phase 1 trials.

Target training conditions. As in Experiment 1, congruence of the target dimension training in Phase 1 with that in Phase 2 was manipulated. Training history for the target dimension was Congruent, Incongruent, or Partially Congruent between training phases.

Phase 1. In Phase 1 (single-stimulus discrimination training), training was presented for the non-target and target dimensions. Color and shape were used as the training dimensions for both the target and non-target stimuli for the Correlated (Groups 1 - 5) and the Not Correlated (Groups 11 - 15) conditions. Under the Absent condition (Groups 6 - 10), color or shape were used for the target dimension, while line orientation rather than color or shape was used for the non-target dimension.

For the non-target dimension, the relation between stimulus value and identity of the correct response varied across conditions. For the Correlated (Groups 1 – 5) and Absent (Groups 6 - 10) conditions, a consistent relation was arranged, such that for a given stimulus, a given response was correct on all trials (as in Experiment 1). For the Not Correlated (Groups 11 - 15) condition, reinforcement for the non-target dimension (color or shape), was independent of the stimulus presented. For a given stimulus value of the non-target dimension, one of the two response alternatives was randomly

assigned as correct on half of the trials, whereas the other response was assigned as correct on the other half of the trials.

Training for the target dimension was manipulated as in Experiment 1 under the Congruent, Partially Congruent, and Incongruent conditions. Under the Congruent (Groups 1, 6, and 11) and Incongruent (Groups 4, 5, 9, 10, 14, and 15) conditions, participants were exposed to training in which one name (e.g., BUP) was always assigned for one shape value and one color value; the other name (e.g., VEC) was always assigned for the other shape and color values. For the Partially Congruent condition (Groups 2, 3, 7, 8, 12, and 13), participants were exposed to target training in which one name was assigned as correct on 75% of the trials and the other name was assigned as correct on 25% of the trials for each of the targets.

The performance criterion for progression from Phase 1 to Phase 2 for the Correlated and the Absent non-target training conditions was 100% accuracy for one dimension across four consecutive, four-trial blocks. For the Correlated condition, under the Congruent condition (Group 1), the performance criterion was based on one arbitrarily chosen dimension (color or shape) that was counterbalanced across participants; prior to the experimental trials, each participant was randomly assigned to one dimension. Under the Absent condition, for the Partially Congruent (Groups 7

and 8) and the Incongruent (Groups 9 and 10) conditions, the performance criterion was based on the non-target dimension only.

The performance criterion for progression from Phase 1 to Phase 2 for the Not Correlated condition differed across the target training conditions. For the Congruent and Incongruent conditions (Groups 11, 14, and 15), the performance criterion was 100% accuracy for the target dimension across four consecutive, four-trial blocks. For the Partially Congruent conditions (Groups 12 and 13), Phase 1 ceased after a total number of completed experimental trials; the number of Phase 1 trials was identical to that of the respective participants in Groups 2 and 3.

Phase 2. The Phase 2 stimuli and contingencies were identical across training conditions; however, the relation between the Phase 1 and Phase 2 reinforcement contingencies for the target dimension differed among groups, as in Experiment 1. In addition, for the Absent non-target condition, the non-target stimulus dimension used in Phase 2 (color or shape) differed from that used in Phase 1 (line orientation)

As in Experiment 1, the stimulus-response relation for the Congruent condition was the same between Phases 1 and 2. For the Partially-Congruent and Incongruent conditions, the reinforcement contingencies with respect to the non-target stimulus values of the compound stimuli were identical to

those of Phase 1. For the Partially Congruent condition, the correct name in Phase 2 was the name assigned to the target stimulus value on 25% of the trials. For the Incongruent condition, the Phase 2 reinforcement contingencies, the correct name was the alternative name for the target stimulus values.

Under the Absent condition (Groups 6 – 10), the Phase 2 compound stimuli consisted of the target stimulus values superimposed with stimuli from a novel dimension (either color or shape) that was *not* presented in Phase 1. For the Absent condition, the Phase 2 reinforcement contingencies were identical to those of the Correlated condition for the target stimulus values of each compound stimulus. For the Not Correlated condition (Groups 11 - 15), participants experienced Phase 2 reinforcement contingencies for the non-target dimension that were not relevant to those of Phase 1 for each compound stimulus.

Phase 3. In Phase 3, testing was conducted under conditions in which points continued to be each of the stimulus dimensions presented in Phase 2, both presented singly and in compound. Ten trials of each of six stimuli (60 total trials), including the four single stimulus values and two trained compound stimuli listed in Table 3, were presented without feedback. Stimuli were presented in a block-randomization sequence with one presentation of

each single stimulus and compound stimulus within each block. During Phase 3, the response options (VEC and BUP) appeared equally often on each side (left and right) constrained by random assignment. A random-number table was used to assign the response options (VEC and BUP) and side-order (left and right) appearance for each stimulus in each 4-trial block.

All participants were presented with 60 points, although points were not displayed on screen. Participants were notified at the end of Phase 3 of the number of points received.

Results and Discussion

Experiment 2 assessed the degree to which performance was influenced by the manipulation of non-target training conditions (Correlated, Absent, Not Correlated) across target training conditions (Congruent, Partially Congruent, Incongruent). A non-target training condition x target training condition x stimulus dimension assigned as the target dimension (color, shape) x training history (non-target, target) mixed factorial ANOVA was conducted to assess the effects on mean Phase-2-consistent responding of the non-target training condition, target training condition, stimulus dimension assigned as the target dimension (color, shape), and training history (non-target, target). All groups were included in the analysis. For Group 1, half of the participants were exposed to color as the target dimension and half of the participants were exposed to shape as the target dimension. In addition, for Group 1, one dimension was assigned as the non-target dimension and the other dimension was assigned as the target dimension. The analysis showed significant main effects of non-target training condition, target training condition, and training history. The following interactions were significant: non-target training condition x target training condition, non-target training condition x training history, target training condition x training history, and non-target training condition x target training condition x training history (see

Table 10). Appendix G presents the 3 x 2 x 2 x 2 mixed factorial ANOVA without the Congruent target training condition (Group 1). This test was conducted without Group 1 because there was no manipulation of training history. The findings did not differ substantially from the ANOVA presented above. The non-target training condition x target training condition x training history interaction indicates that responding for the non-target and target training conditions varied depending on training history. Because there were no interactions involving stimulus dimension, data were pooled across dimension in subsequent analyses.

Figure 14 displays the mean proportion of Phase-2-consistent responding according to the manipulation of non-target and target training. Results for the three non-target training conditions (Correlated, Absent, and Not Correlated) are shown in the three respective rows of panels, and results for the three target training conditions (Congruent, Partially Congruent, and Incongruent) are shown in the three respective columns of panels. Consistent with the results of the ANOVA described above, showing that stimulus dimension (color and shape) does not interact with the other factors, the data were collapsed across comparable groups that differed only in the stimulus dimensions used for the non-target and target stimuli. Data for the non-target and target training histories are plotted separately in all panels of Figure 14,

except those for Group 1. For Group 1, the data were combined because training was identical across dimensions and responding was not significantly different for the two dimensions. The data for the individual groups are presented in Appendixes D, E, and F.

The figure shows that the mean proportion of Phase-2-consistent responding for the target stimuli varied considerably as a function of target training condition (Congruent, Partially Congruent, and Incongruent), as was the case in Experiment 1, and also with non-target training (Correlated, Absent, and Not Correlated). Performance to the non-target stimuli varied primarily with non-target training condition.

Responding on the target dimension. To confirm that responding on the target dimension (dark bars) varied according to the level of the non-target and target training condition, a non-target training condition (3) x target training condition (3) factorial ANOVA was conducted. There were significant main effects of non-target and target training conditions, and the non-target training condition x target training condition interaction was significant (see Table 11). Owing to the significant interaction, the influence of target training on target responding is assessed separately for each of the non-target training conditions in the following analyses.

The upper row of panels of Figure 14 shows the effects of target training condition for the groups exposed to Correlated non-target training condition. These groups constitute a direct replication of Experiment 1 (see Figure 6). The results of Experiment 2 appear to be similar to those of Experiment 1. The differences in responding were assessed using a 1-way ANOVA ($n = 50$), $F(2, 47) = 70.634$, $p < .001$. As in Experiment 1, the level of responding under the Congruent target training condition is higher than under the other two target training conditions. According to Tukey post-hoc tests, responding under the Congruent target training condition ($M = 0.910$; $SD = 0.032$) was significantly higher than under the Partially Congruent ($M = 0.425$; $SD = 0.119$) and Incongruent ($M = 0.355$; $SD = 0.156$) target training conditions. The levels from the Partially Congruent target training condition are slightly higher than that of the Incongruent target training condition; however, that difference is not as pronounced as that of Experiment 1. The difference between the Partially Congruent and Incongruent training conditions was not significant.

Table 10

Summary of the Mixed Design Non-target Training Condition (3) x Target Training Condition (3) x Stimulus Dimension (2) x Training History (2) Analysis of Variance (ANOVA) for Phase-2-Consistent Responding in Experiment 2

Source	***df***	***F***	***p***
Between-subjects effects			
Non-target Training Condition (N)	2	168.086	< .001
Target Training Condition (T)	2	131.242	< .001
Stimulus Dimension (S)	1	2.898	.076
N x T	4	8.974	< .001
N x S	2	.062	.940
T x S	2	2.003	.067
N x T x S	4	1.292	.082
Error	132	(.006)	
Within-subjects effects			
Training History (H)	1	136.774	< .001
N x H	2	300.591	< .001
T x H	2	103.570	< .001
S x H	1	2.607	.073
N x T x H	4	8.736	< .001
N x H x S	2	.565	.570
T x S x H	2	2.055	.058
N x T x S x H	4	1.370	.248
Error	132	(.009)	

Note. The values enclosed in parentheses represent the mean square error.

Figure 14. Mean proportion of Phase-2-consistent responding in the presence of the non-target and target training dimensions presented during Phase 3 (Testing) for the non-target training conditions and target training conditions of Experiment 2. Stimuli from the non-target training dimension (NT) are presented as open bars; stimuli from the target training dimension (T) are presented as dark bars. The panels display the non-target training conditions horizontally and the target training conditions vertically. The bar presented for Group 1 under the Correlated non-target training condition, Congruent target training condition represents the combined mean proportion of Phase-2-consistent responding in the presence of the two dimensions trained identically between phases. The Correlated training condition groups (Groups 1, 2, 3, 4, and 5) are represented horizontally in the top row of three panels. The Absent training condition groups (Groups 6, 7, 8, 9, and 10) are represented in the middle row of three panels. The Not Correlated training condition groups (Groups 11, 12, 13, 14, and 15) are represented in the bottom row of three panels. The Congruent training condition groups (Groups 1, 6, and 11) are represented vertically in the left-most column of three panels. The Partially Congruent training condition groups (Groups 2, 3, 7, 8, 12 and 13) are represented vertically in the middle row of three panels. The

Incongruent training condition groups (Groups 4, 5, 9, 10, 14, and 15) are represented vertically in the right-most column of three panels.

Figure 14.

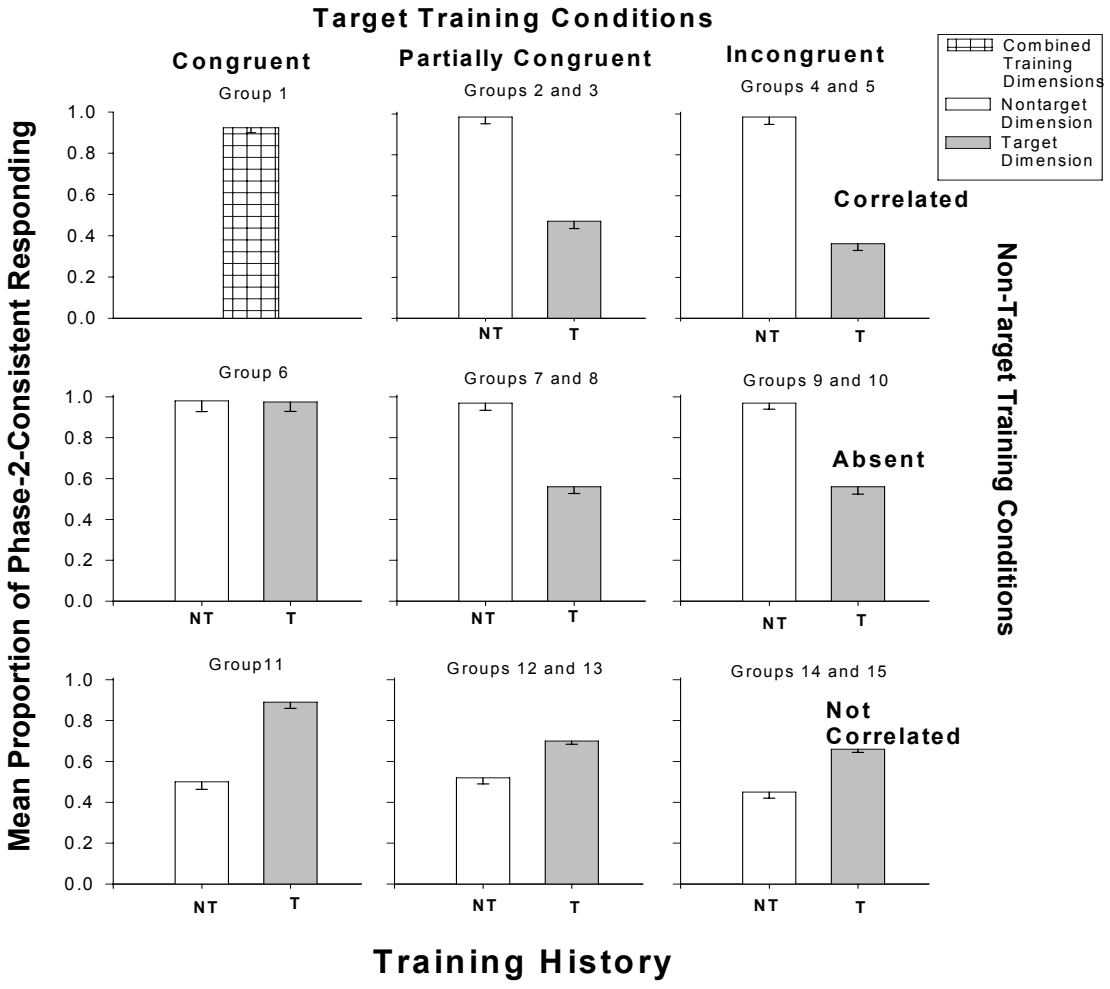

Target Training Conditions
Congruent
Partially Congruent
Incongruent
Combined Training Dimensions
Nontarget Dimension
Target Dimension
Group 1
Groups 2 and 3
Groups 4 and 5
Correlated
Group 6
Groups 7 and 8
Groups 9 and 10
Absent
Group11
Groups 12 and 13
Groups 14 and 15
Not Correlated
NT
T
1.0
0.8
0.6
0.4
0.2
0.0
Mean Proportion of Phase-2-Consistent Responding
Non-Target Training Conditions
Training History

Table 11

Summary of the Mixed Design Non-target Training Condition (3) x Target Training Condition (3) Analysis of Variance (ANOVA) for Phase-2-Consistent Responding in the Presence of the Target Training Dimension in Experiment 2

Source	***df***	***F***	***p***
Non-target Training Condition (N)	2	27.124	<.001
Target Training Condition (T)	2	128.790	<.001
N x T	4	9.837	<.001
Error	141	(.013)	

Note. The value enclosed in parentheses represents the mean square for error.

Under the Absent and Not Correlated non-target training conditions, target levels for the Congruent target training condition were higher than those of the Partially Congruent and Incongruent target training conditions (middle and bottom rows of panels, respectively); however, target responding for the Partially Congruent and Incongruent target training conditions were relatively similar. One-way ANOVAs for the Absent [F (2, 47) = 109.020, p < .001] and Not-Correlated [F (2, 47) = 7.326, p = .002] training conditions showed a significant main effect of target training condition. For the Absent training condition according to the post-hoc tests showed that responding for the Congruent training condition (M = 0.975; SD = 0.026) was significantly higher than responding for the Partially Congruent (M = 0.555; SD = 0.067) and Incongruent (M = 0.525; SD = 0.112) training conditions. A similar finding was shown for the Not Correlated training condition, that is, responding under the Congruent training condition (M = 0.855; SD = 0.104) was significantly higher than responding under the Partially Congruent (M = 0.703; SD = 0.135) and Incongruent (M = 0.667; SD = 0.143) training conditions. For both the Absent and Not Correlated training conditions, the differences between the Partially Congruent and Incongruent training conditions were not significant.

The left column of panels of Figure 14 shows the effects on target responding of the non-target training conditions for the groups exposed to the Congruent target training condition. These groups were exposed to contingencies for the target dimension that were identical between training phases. The level of responding under the Absent non-target training condition is higher than those under the Correlated and Not Correlated non-target training conditions. The differences in responding were assessed using a 1-way ANOVA, F (2, 27) = 8.66, p = .001. Post-hoc tests indicated that responding under the Absent (M = 0.975; SD = 0.023) training condition was significantly higher than the Not Correlated (M = 0.855; SD = 0.021) training condition. For the Absent and Not Correlated control groups, lack of prior exposure to the non-target dimension in Phase 1 seems to lead to higher levels of responding. Responding from the Absent and Not Correlated groups was not different from the Correlated condition (M = 0.910; SD = 0.032)

Under the Partially Congruent and Incongruent target training conditions (middle and right columns); target data appeared to differ significantly across the three levels of non-target training. The one-way ANOVAs for the Partially Congruent and Incongruent training conditions showed a significant main effect of non-target training condition, F (2, 57) = 31.422, $p < .001$, and F (2, 57) = 24.542, $p < .001$, respectively. Post-

hoc tests for the Partially Congruent training condition showed that the Not Correlated non-target training condition (M = 0.703; SD = 0.135) was significantly higher than the Absent (M = 0.555; SD = 0.067) and Correlated (M = 0.425; SD = 0.118) non-target training conditions. The difference between the Absent and Correlated training conditions was also significant. The same pattern was shown for the Incongruent training condition in post-hoc tests in which responding under the Not Correlated training condition (M = 0.660; SD = 0.143) was significantly higher than the Absent (M = 0.525; SD = 0.112) and Correlated (M = 0.355; SD = 0.155) training conditions. The difference between the Absent and Correlated training conditions was also significant.

In order to assess the differences in the mean proportion of Phase-2-consistent responding between the Partially Congruent and Incongruent target conditions, a non-target training condition (3) x target training conditions (2) ANOVA was conducted. There were significant main effects of the non-target training condition, F (2, 114 = 54. 210, $p < .001$, and target training condition, F (1, 114) = 4. 324, $p = .040$. These findings support the Experiment 1 findings that the mean proportion of Phase-2-consistent responding for the Partially Congruent condition was higher than that of the Incongruent condition.

The effect of the non-target training manipulation in Phase 1 that can be described in terms of a manipulation of competition between dimensions was shown by the differences in the levels of responding in the presence of the target dimension. For the Absent training condition, elimination of the prior training for the non-target dimension led to higher levels of target responding in Phase 2 compared to those of the Correlated training condition. Under the Not Correlated condition, higher levels of target responding were shown compared to those of the Correlated and Absent training conditions.

Non-target responding. Non-target level of responding (Figure 14, open bars) was high under the Correlated and Absent non-target training conditions. According to a non-target training condition (3) x target training condition (3) factorial ANOVA, there was a main effect of non-target training condition, but no significant main effect of target training condition or non-target training condition x target training condition interaction effect (see Table 12). According to post-hoc tests, the non-target response levels under the Not Correlated training condition (M = 0.482; SD = 0.009) was significantly lower than those of the Correlated (M = 0.957; SD = 0.008) and Absent (M = 0.953; SD = 0.008) training conditions. There was no significant difference in non-target responding between the Correlated and Absent training conditions.

The non-target training conditions differed in terms of the Phase 1 training for the non-target dimension. For the Correlated non-target training condition, the non-target stimuli were consistently correlated with reinforcement. For the Absent non-target training condition, the non-target stimuli were not presented in Phase 1 and were only presented in Phase 2 in compound form with the target stimuli. In that condition, Phase 3 responding represents level of Phase 2 acquisition of responding to the non-target stimuli. Responding was close to identical in the Absent condition compared to the Correlated condition, despite the lack of non-target prior training in Phase 1 for the Absent condition. The similarities in these levels suggest rapid acquisition of new stimulus-response relations in Phase 2. The differences in responding in the presence of the non-target dimension between the two control conditions (Absent and Not Correlated non-target conditions) may be understood in terms of the differences in Phase 1 training for the non-target dimension. The data in the presence of the non-target dimension indicate that new learning under the Absent condition occurs quite readily in the context of the compound stimuli compared to the learning of the changed contingencies under the Not Correlated condition. For the Not Correlated condition, the non-target stimuli were inconsistently correlated with reinforcement in Phase 1 followed by consistent training in Phase 2 in

compound form. Prior inconsistent training appears to retard acquisition for the non-target dimension in Phase 2.

Table 12

Summary of the Mixed Design Non-target Training Condition (3) x Target Training Condition (3) Analysis of Variance (ANOVA) for Phase-2-Consistent Responding in the Presence of the Non-target Training Dimension in Experiment 2

Source	***df***	***F***	***p***
Non-target Training Condition (N)	2	1094.068	$<.001$
Target Training Condition (T)	2	.683	.507
N x T	4	.337	.853
Error	141	(.013)	

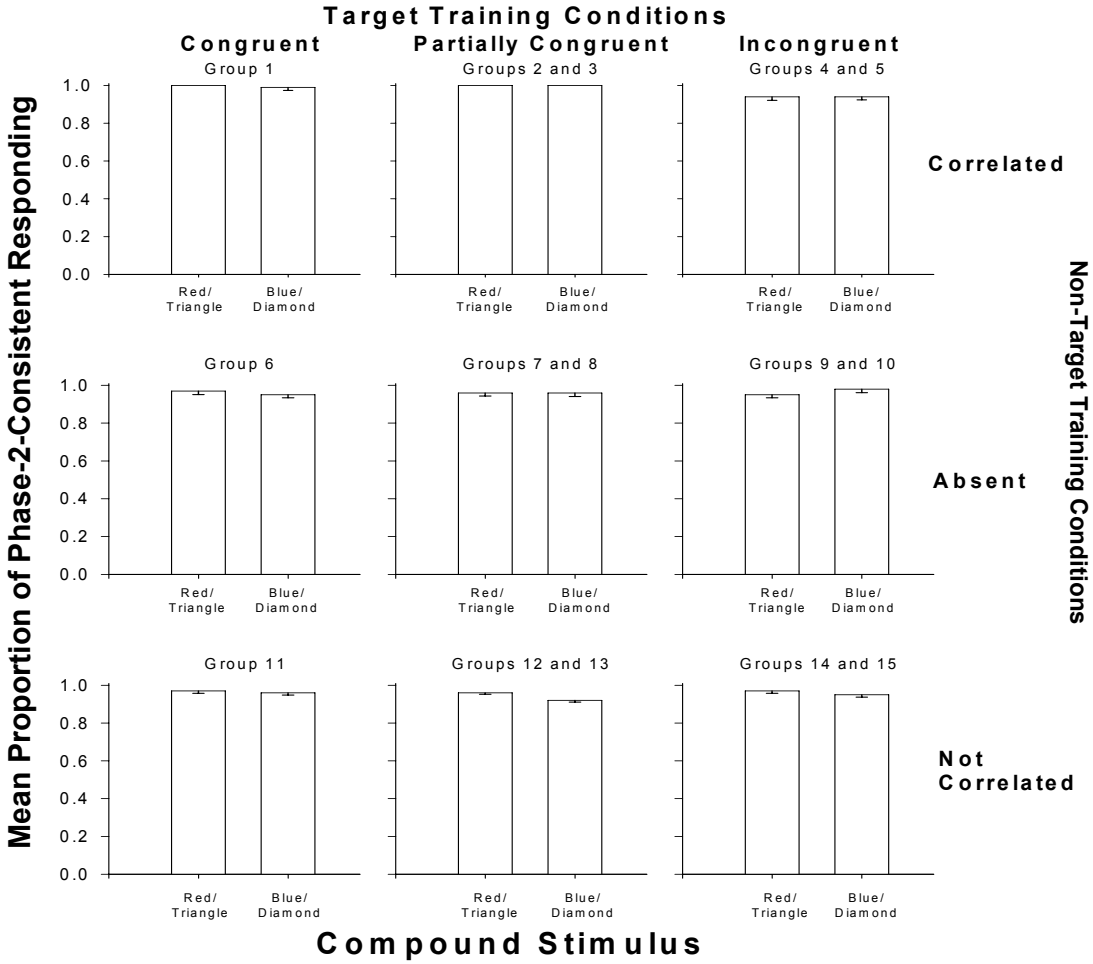
Note. The value enclosed in parentheses represents the mean square error.

Compound Stimuli

Figure 15 shows the mean proportion of Phase-2-consistent responding across non-target and target training conditions in the presence of the compound stimuli presented in Phase 3 (Testing). A high level of the mean proportion of Phase-2-consistent responding under all conditions was demonstrated in the presence of the two compound stimuli. The apparent lack of differences in responding in the presence of the two compound stimuli across training conditions was supported by a mixed factorial design non-target training condition (3) x target training conditions (3) x compound stimulus (2) ANOVA of the mean proportion of Phase-2-consistent responding. The ANOVA revealed no significant main effects of non-target training condition or target training condition and no significant interaction effects. Prior to Phase 3, the two compound stimuli were trained in the same manner across all non-target and target training conditions. High levels of responding during testing are accounted for based on the immediately prior training and exposure to training in Phase 2.

Figure 15. Mean proportion of Phase-2-consistent responding in the presence of the compound stimuli, Red/Triangle and Blue/Diamond, presented during Phase 3 (Testing) for the non-target training conditions and the target training conditions of Experiment 2. The panels display the non-target training conditions horizontally and the target training conditions vertically. The error bars refer to the standard of the error of the mean values. The Correlated non-target training condition groups (Groups 1, 2, 3, 4, and 5) are represented horizontally in the three top panels. The Absent non-target training condition groups (Groups 6, 7, 8, 9, and 10) are represented in the three center panels. The Not Correlated non-target training condition groups (Groups 11, 12, 13, 14, and 15) are represented in the three bottom panels. The Congruent target training condition groups (Groups 1, 6, and 11) are represented vertically in the three left-most panels. The Partially Congruent target training condition groups (Groups 2, 3, 7, 8, 12 and 13) are represented vertically in the three center panels. The Incongruent target training condition groups (Groups 4, 5, 9, 10, 14, and 15) are represented vertically in the three right-most panels.

Figure 15.


Target Training Conditions
Congruent
Partially Congruent
Incongruent
Group 1
Groups 2 and 3
Groups 4 and 5
Group 6
Groups 7 and 8
Groups 9 and 10
Group 11
Groups 12 and 13
Groups 14 and 15
Correlated
Absent
Not Correlated
Non-Target Training Conditions
Mean Proportion of Phase-2-Consistent Responding
1.0
0.8
0.6
0.4
0.2
0.0
Red/ Triangle
Blue/ Diamond
Compound Stimulus

Trials to Criterion

The mean number of trials required for the acquisition of the Phase 1 and Phase 2 performance criterion is presented in Figure 16. The Phase 1 mean trials to criterion were assessed for differences across groups (15) using a one-way ANOVA, that indicated a significant effect of group, F (14, 45) = 3.00, $p < .001$. Results of Tukey post-hoc analyses revealed significant differences between Group 7 and each of Groups 1, 2, 4, and 12, and between Group 8 and each of Groups 1, 2, 4, and 12. No other differences were found. In Phase 1 as displayed in the first (left-most) set of bars, the mean trials to criterion for Groups 7 and 8 (Absent non–target training condition, Partially Congruent target training condition) are higher than the other groups, especially Groups 1, 2, 4, and 12. Exposure to line orientation as the dimension for which the accuracy criterion was determined for Groups 7 and 8 under the Partially Congruent conditions contributed to the high number of trials required in Phase 1 compared to Groups 1, 2, 4, and 12.

In Phase 2 (second, right-most set of bars), despite the apparent higher mean trials to criterion for Group 12 (Not Correlated non-target training condition, Partially Congruent target training condition) compared to the other

groups, a one-way ANOVA indicated no significant effect of group, F (4, 45) = 1.50, p = .12.

Difficulty Ratings

Figure 17 presents the findings from the question of the debriefing interview (Appendix C) requesting participants to rate their perceived level of difficulty experienced during Experiment 2. The figure shows the lowest mean rating for Group 1 (Correlated non-target training condition, Congruent target training condition). In comparing the mean ratings for each of the three non-target training conditions (Correlated, Absent, and Not Correlated) under the three non-target training conditions (Congruent, Partially Congruent, and Incongruent), the figure shows the lowest mean rating for the Congruent training condition. According to the non-target training condition (3) x target training condition (3) ANOVA on mean difficulty ratings, a significant main effect of non-target training condition, F (2, 141) = 11.791, p < .001, and a significant main effect of target training condition, F (2, 141) = 6.378, p = .002 were found. The non-target training condition x target training condition interaction was significant, F (4, 141) = 2.712, p = .032. Across the non-target training conditions, mean difficulty ratings of the experiment was significantly higher under the Partially Congruent condition compared to the other conditions, except under the Correlated non-target training condition.

Figure 16.

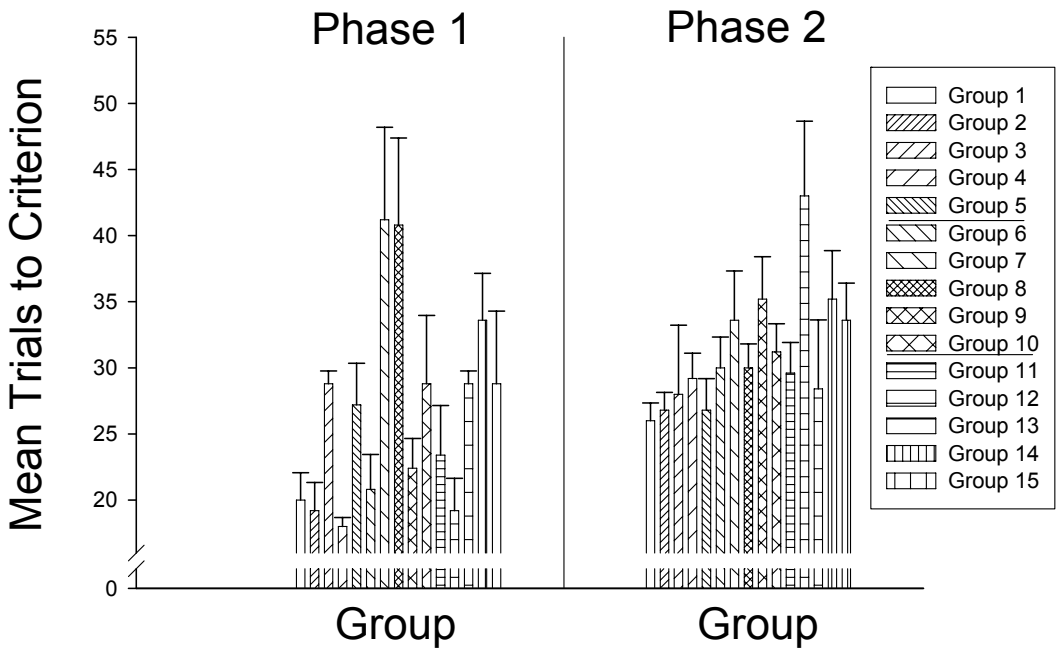
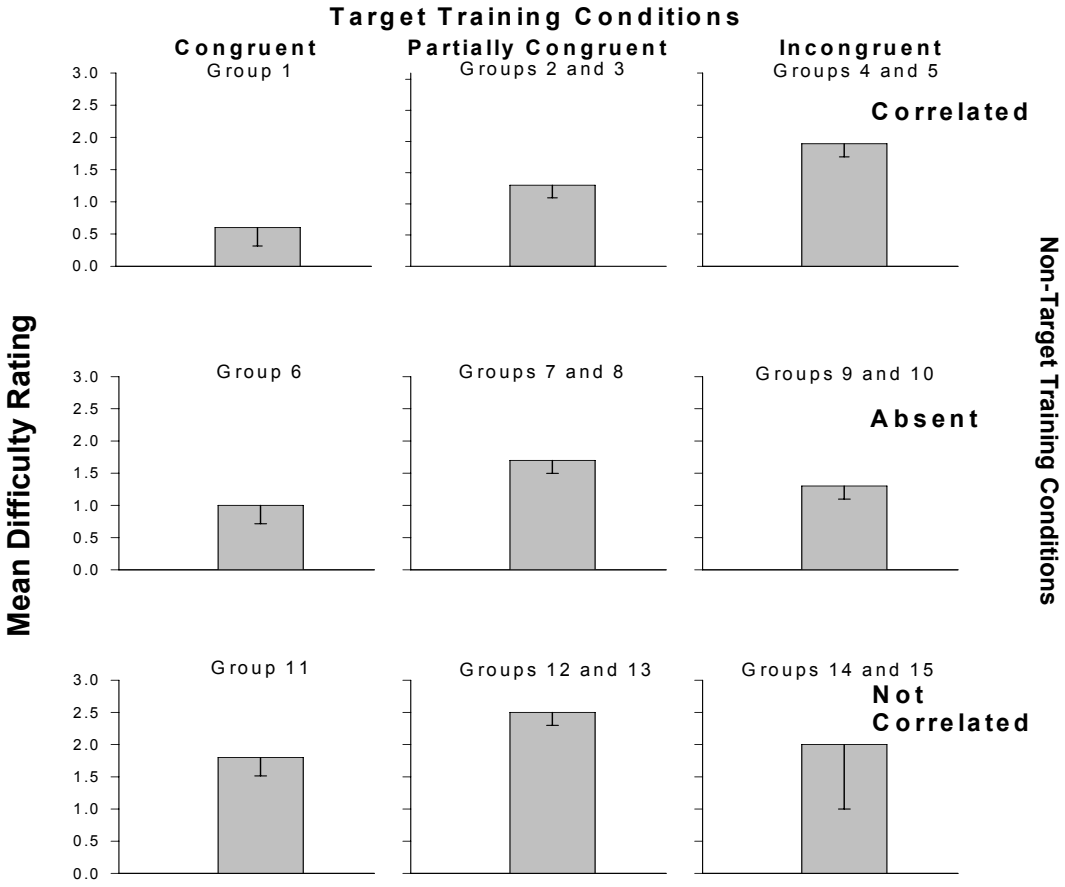


Figure 16. Mean trials to meet the Phase 1 and Phase 2 criteria in Experiment 2 across groups: the Correlated non-target training condition groups (Groups 1, 2, 3, 4, and 5), the Absent non-target training condition groups (Groups 6, 7, 8, 9, and 10), the Not Correlated non-target training condition groups (Groups 11, 12, 13, 14, and 15). The error bars indicate the standard error of the mean.

Across target training conditions, lower levels of Phase-2-consistent responding for the non-target dimension were associated with significantly higher ratings of difficulty, especially under the Partially Congruent target training condition. The ease with which participants perceived the completion of the experiment is attributed to the consistency of training for the non-target and target conditions.

Figure 17. Mean ratings of experiment difficulty according to the debriefing survey in Experiment 2. The rating scale values were: 0, not difficult at all; 1, very easy; 2, slightly easy; 3, moderately difficult; or 4, very difficult. The error bars refer to the standard error of the mean. The panels display the non-target training conditions horizontally and the target training conditions vertically. The Correlated non-target training condition groups (Groups 1, 2, 3, 4, and 5) are represented horizontally in the top row of three panels. The Absent non-target training condition groups (Groups 6, 7, 8, 9, and 10) are represented in the middle row of three panels. The Not Correlated non-target training condition groups (Groups 11, 12, 13, 14, and 15) are represented in the bottom row of three panels. The Congruent target training condition groups (Groups 1, 6, and 11) are represented vertically in the left-most column of three panels. The Partially Congruent target training condition groups (Groups 2, 3, 7, 8, 12 and 13) are represented vertically in the middle row of three panels. The Incongruent target training condition groups (Groups 4, 5, 9, 10, 14, and 15) are represented vertically in the right-most column of three panels.

Figure 17.


Target Training Conditions
Congruent
Partially Congruent
Incongruent
Group 1
Groups 2 and 3
Groups 4 and 5
Correlated
Group 6
Groups 7 and 8
Groups 9 and 10
Absent
Group 11
Groups 12 and 13
Groups 14 and 15
Not Correlated
Mean Difficulty Rating
Non-Target Training Conditions
3.0
2.5
2.0
1.5
1.0
0.5
0.0

Conclusion

Experiment 2 used two methods of reducing competition between stimuli in Phase 2 by manipulating non-target prior history, which had dramatically different effects on performance. Highly correlated non-target stimuli in prior training interfered with the acquisition of control by the target stimuli. The reduction of competition between stimuli improved control by the target dimension. Consistent prior training compared to inconsistent and no prior training for the non-target dimension led to greater competition, indicated by high non-target levels of responding and reduced target performance.

General Discussion

The present study extended the previous research in selective stimulus control conducted by Huguenin and Touchette (1980) and Ray (1969) using a between-groups conditional discrimination procedure. The aforementioned researchers used two values of congruence of reinforcement contingencies between training phases for one dimension, the target dimension. The two values of congruence for the target dimension were 100% and 0%. The present study included a third value (25%) of the congruence variable. Experiment 1 provided evidence for a graded effect on target responding of the target training manipulation across training conditions.

Experiment 2 was a systematic replication of Experiment 1. Experiment 2 included the target training manipulation, as in Experiment 1. In addition, Experiment 2 included a manipulation of prior non-target training history. Three qualitatively different prior non-target training conditions were used in Experiment 2. One non-target condition (Correlated condition) was identical to the training conditions of Experiment 1; two control conditions (Absent and Not Correlated conditions) were used to reduce competition by the non-target dimension in Phase 2. Under the competition condition in which consistent non-target training was presented, levels of target responding were lower than that of the control conditions. This effect was

most pronounced when comparing target responding for the Correlated non-target training condition to target responding for the Not Correlated non-target training condition.

The results of Experiment 1 indicating a graded effect of target training conditions on target responding can be understood in terms of the selective stimulus control approach. The selective stimulus control interpretation implies less learning of the modified contingencies in Phase 2 for the target dimension compared to the learning of the unmodified contingencies. According to the selective stimulus control interpretation, participants could continue to respond according to the Phase 1 contingencies instead of the Phase 2 contingencies in Phase 2. Phase 3 performance reflects responding according to the Phase 1 contingencies.

The alternative approach to discriminative performance in the current study is the learning acquisition interpretation that implies that learning the reversed contingencies for the target dimension occurs in Phase 2 in a gradual manner over trials. The learning acquisition interpretation can be used to interpret the present findings and those of Huguenin and Touchette's (1980) and Ray's (1969) findings. According to the learning acquisition interpretation, Phase 3 performance reflects learning the new Phase 2 contingency for the target dimension. In the present study, similar levels of

responding under the modified contingencies for the target dimension would occur across the levels of non-target prior training.

According to the manipulation of the non-target training in Experiment 2 across target training conditions, target responding was influenced by prior training history for the non-target dimension. Compared to the Absent and Not Correlated conditions, consistent prior non-target training led to the lowest target responding. For the Absent and Not Correlated conditions, inconsistent non-target training led to higher levels of target responding compared to that of the absent non-target training condition. The extent to which responding occurs according to the modified contingencies in Phase 2 was influenced by prior training for the non-target stimulus—an outcome that is not predicted by the learning acquisition interpretation The current findings indicate that responding according to the modified contingencies is impeded under the condition in which correlated non-target training was used.

The present results can be evaluated in terms of continuity and noncontinuity theories. Continuity theory predicts different levels of Phase-2-consistent responding in the presence of the target dimension under the Incongruent and Partially Congruent conditions. A graded effect of the target training manipulation was found across the target training conditions in Experiment 1. The results from Experiment 1 are in line with continuity

theory. Alternatively, the noncontinuity theory predicts minimal levels of Phase-2-consistent responding in the presence of the target dimension under the Incongruent conditions. In Experiment 2, the levels of responding for the Incongruent condition in the presence of the target dimension were greater than zero. Support for the continuity theory was provided in the present study.

In the Incongruent non-target condition, a low level of performance for the non-target stimulus implies a durable effect of inconsistent prior training. Similar findings were shown for response-independent training procedures in Pavlovian conditioning (Gamzu & Williams, 1973) in which a reduction of responding occurred as a result of prior non-differential training.

Appendix A

Motivational System Script

Prior to the experiment. During the session, you will earn points based on your performance. It is important that you respond correctly during the experiment in order to earn the most points and lottery tickets. Every point that you earn during the session can be exchanged at the end of the session for items of your choice, such as small snacks, soft drinks, or small office supplies. In addition, a lottery ticket will be provided for each point earned. At the end of the session, you will be able to select the items that you want based on the points that you earned. The tickets will be torn in half and you will keep one half and I will add the other to a box to be combined with other ticket stubs. When the study is complete and data are being analyzed, lottery tickets will be mixed up and one ticket will be drawn. The winning participant will receive a prize, such as, a computer mouse, or a gift certificate for movies, a local restaurant, the campus bookstore, a computer store, or a local mall. The more tickets you receive, the greater the likelihood that you will win the lottery.

After the experiment. You earned (#) points today. That means that you earned (#) lottery tickets for the lottery drawing to be conducted when the study is complete. As mentioned before the experiment, lottery tickets

will be mixed up and one ticket will be drawn. The winning participant will be notified and will receive a prize. If you wish to be contacted if you are the winner, please provide a reliable method, such as e-mail address, home/work phone number, or home/work mailing address. In addition to the lottery tickets, you may exchange points earned for the following snacks, money, or some combination of both, based on your preference.

Appendix B

Instructions on the Computer Monitor

Prior to Phase 1. Before the experiment starts, some practice trials will be presented. Read the instructions CAREFULLY. When you are finished, the experimenter will ask you about the instructions.

1. On each trial, a stimulus and 2 names will be shown. Each stimulus has an assigned name. Click on the correct name 1 time.
2. The computer will tell you if you are correct or incorrect.
3. A flashing "CORRECT" and a sound happens after a CORRECT response. You EARN 1 point for being CORRECT.
4. A flashing "INCORRECT" and a DIFFERENT sound happens after an INCORRECT response. You DO NOT earn a point for being INCORRECT.
5. Your score will appear shortly after you respond.
6. When you are ready for the next trial, click 'NEXT'.
7. There will be many trials.
8. Sometimes the computer WILL NOT tell you if you are correct.
9. The experimenter will now ask you questions.

After practice trials. You finished the practice trials. Please wait for the experimenter's instructions.

Prior to Phase 2. Read the instructions CAREFULLY.

1. Your task is the same as before.
2. Sometimes, the computer will tell you if you are correct or incorrect.
3. You will continue to earn 1 point for each CORRECT response.
4. Press the ENTER key when you are ready to start.

Prior to Phase 3. Read the instructions CAREFULLY.

1. From now on, the computer WILL NOT tell you if you are correct or incorrect.
2. Points WILL NO LONGER appear, though you WILL continue to earn points.
3. Use what you LEARNED BEFORE to guide your responses.
4. Press the ENTER key when you are ready.

Appendix C

Verbal Statements and Questions Prior to and After the Experimental Session

Prior to the experiment, after reading the instructions presented on the computer screen prior to practice trials. "Before you begin the experiment, there are a few questions that I would like you to answer."

1. What will appear on the computer screen on each trial? Tell me about the stimuli you'll see first.
2. What do you have to do after the stimulus and words are presented?
3. What happens when you make a correct response?
4. How do you earn a point?
5. What will you be able to do with the points?
6. What happens when you make an incorrect response?
7. Do you ever earn a point for an incorrect response?
8. How do you know that you earned a point?
9. Will the computer always indicate whether you are correct and incorrect?
10. When you are correct, will you always see the points you earned?

11. During the experiment, what do you do when you are ready for the next trial?
12. What should you do when instructions appear on the computer screen?
13. Do you have any questions before you begin?

Prior to the experiment, after answering the standard questions above, immediately prior to practice trials. "Before you begin the experiment, there are a few practice trials that I will model for you and then I will have you practice."

1. On this trial, one (color, shape) stimulus appears with two words as response options.
2. I will click on one response option.
3. This response happens to be correct and I received the on-screen feedback and one point.
4. When I'm ready for the next trial, I will click 'next'.
5. (Repeat # 1 and 2 above.) This response happens to be incorrect. I received the on-screen feedback. I did not earn a point.
6. (The experimenter models 4 trials using #1-5 above).
7. Do you have any questions before you begin? Now it's your turn to practice.

8. Do you have any questions before you begin the experiment?

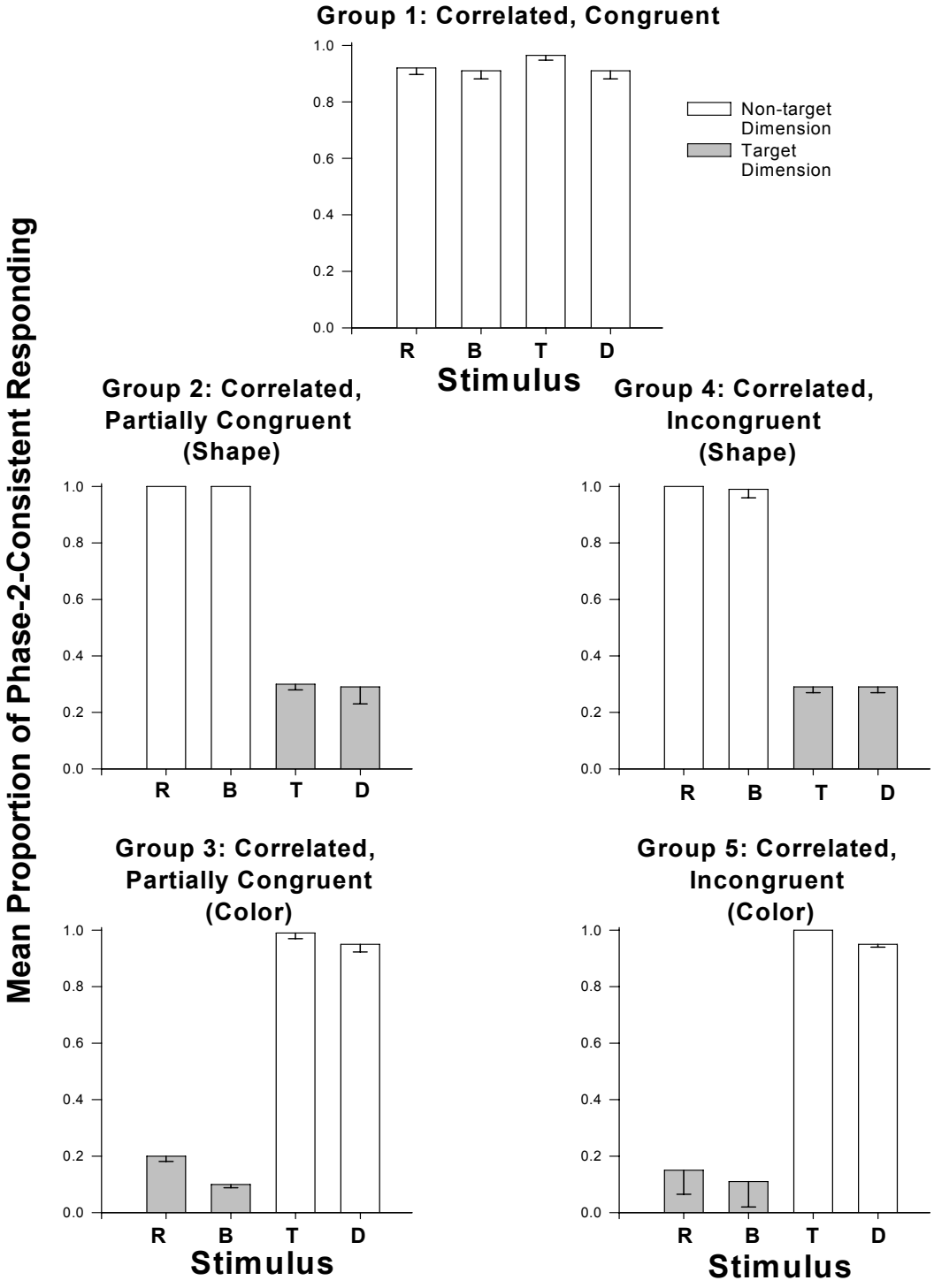
After the experiment. "Before you finish the experiment, there are a few questions that I would like you to answer:"

1. Did you understand your task prior to the beginning of the experiment?
2. Did the practice trials presented before the experiment began help you to understand what appeared on the screen during the experiment?
3. Did you understand your task for each part of the experiment based on the written instructions presented on the computer screen?
4. Please tell me again what you had to do to earn points.
5. What did the stimuli look like, e.g., what were the stimulus dimensions?
6. How did the stimuli differ in different parts of the experiment?
7. On a scale of 0-4, how difficult did you find this experiment (0, not difficult at all; 1, very easy; 2, slightly easy; 3, moderately difficult; or 4, very difficult)?

Appendix D

Figure Appendix D. Mean proportion of Phase-2-consistent responding for the Correlated training condition (Groups 1, 2, 3, 4, and 5) in the presence of the non-target and target single stimulus values presented during Phase 3 (Testing). Stimulus values are presented along the abscissa as capital letters (Red, R; Blue, B; Triangle, T; Diamond, D). The error bars refer to the standard error of the mean. Group 1 was exposed to the Congruent target training condition. Groups 2 and 3 were exposed to the Partially Congruent target training condition. Groups 4 and 5 were exposed to the Incongruent target training condition. For Groups 2, 3, 4, and 5, the stimulus dimension indicated in parentheses refers to the target dimension.

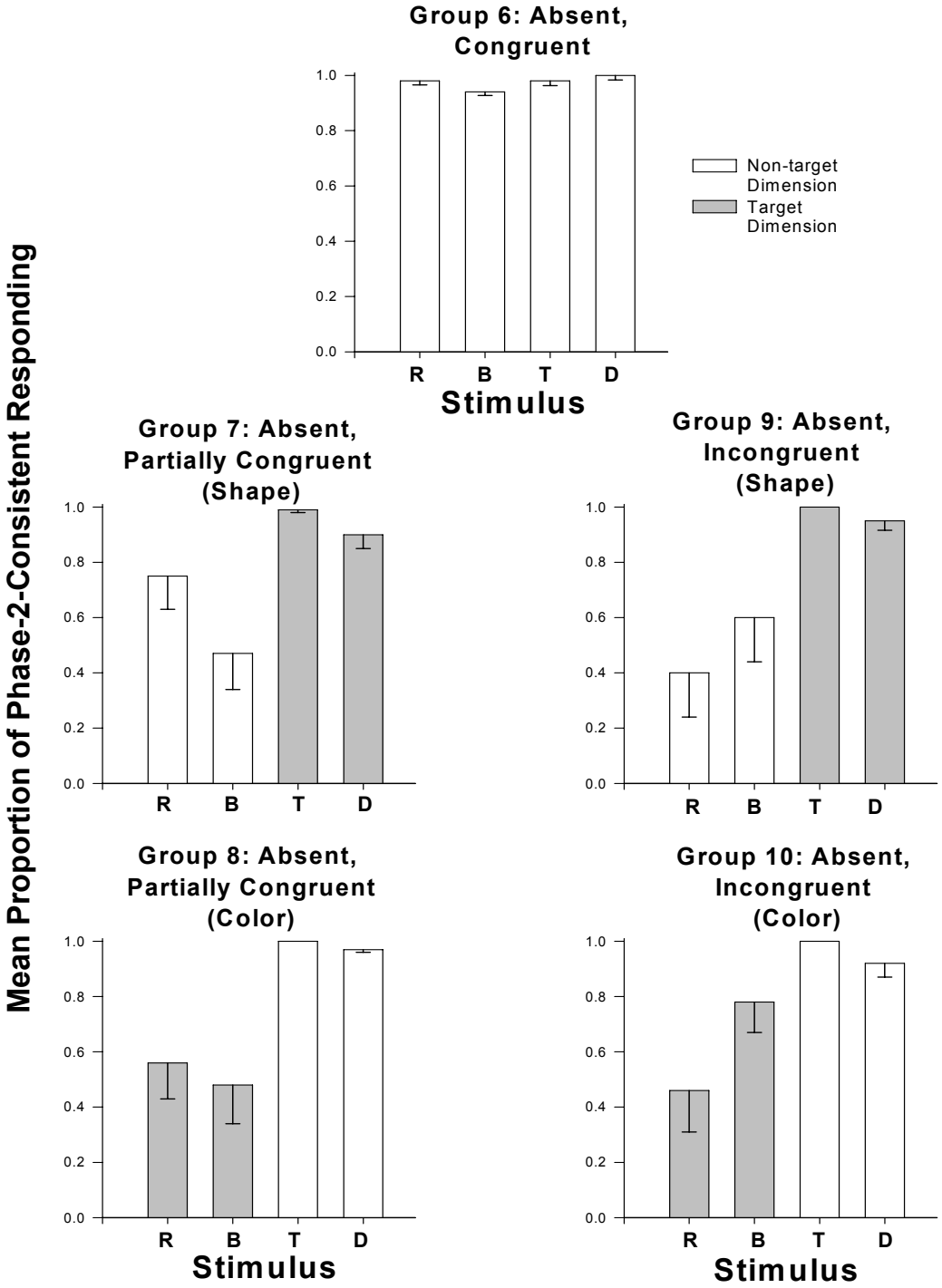
Figure Appendix D.



Appendix E

Figure Appendix E. Mean proportion of Phase-2-consistent responding for the Absent non-target training condition (Groups 6, 7, 8, 9, and 10) in the presence of the non-target and target single stimulus values presented during Phase 3 (Testing). Stimulus values are presented along the abscissa as capital letters (Red, R; Blue, B; Triangle, T; Diamond, D). The error bars refer to the standard error of the mean. Group 6 was exposed to the Congruent target training condition. Groups 7 and 8 were exposed to the Partially Congruent target training condition. Groups 9 and 10 were exposed to the Incongruent target training condition. For Groups 7, 8, 9, and 10, the stimulus dimension indicated in parentheses refers to the target dimension.

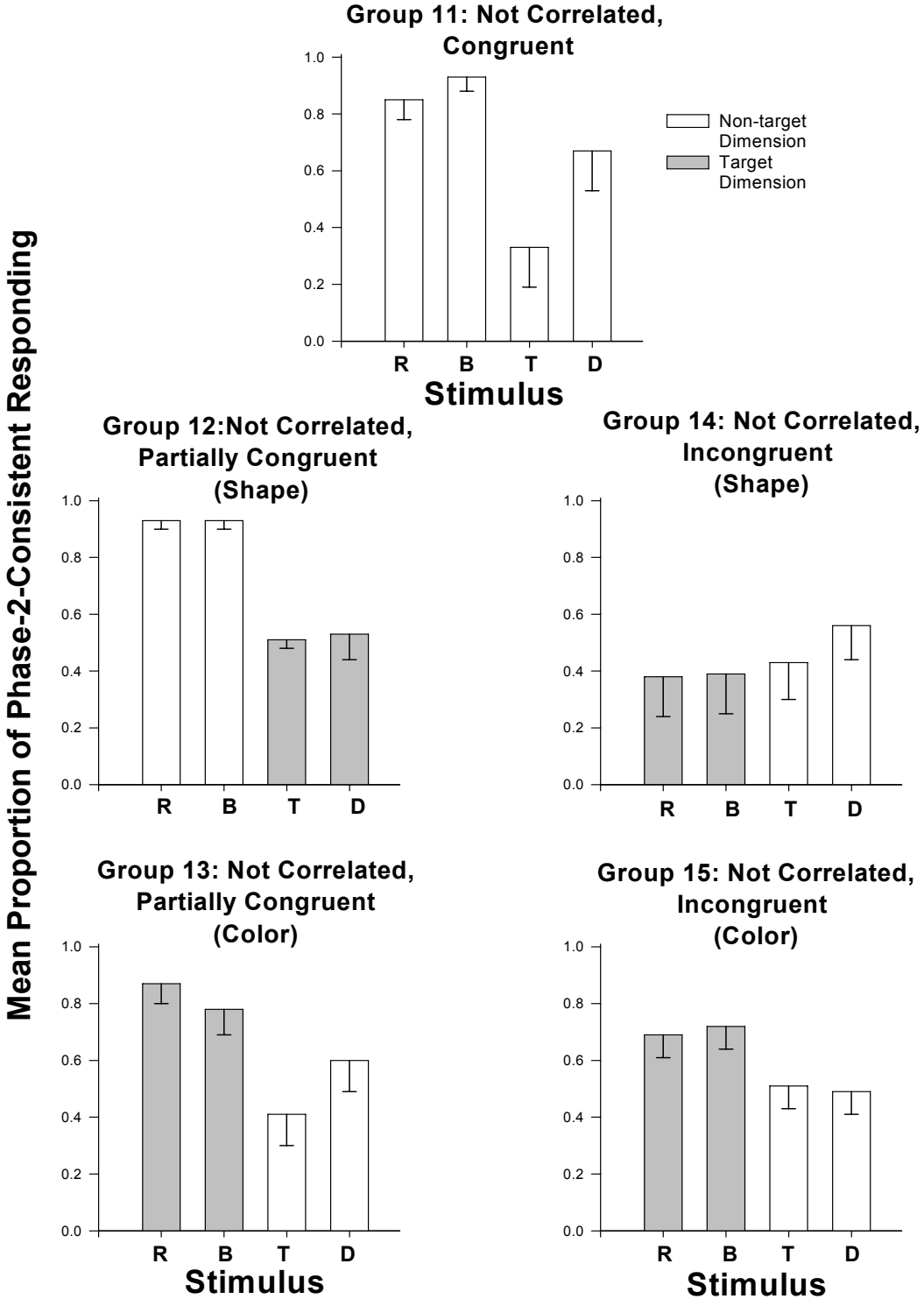
Figure Appendix E.



Appendix F

Figure Appendix F. Mean proportion of Phase-2-consistent responding for the Not Correlated training condition (Groups 11, 12, 13, 14, and 15) in the presence of the non-target and target single stimulus values presented during Phase 3 (Testing). Stimulus values are presented along the abscissa as capital letters (Red, R; Blue, B; Triangle, T; Diamond, D). The error bars refer to the standard error of the mean. Group 11 was exposed to the Congruent target training condition. Groups 12 and 13 were exposed to the Partially Congruent target training condition. Groups 14 and 15 were exposed to the Incongruent target training condition. For Groups 12, 13, 14, and 15, the stimulus dimension indicated in parentheses refers to the target dimension.

Figure Appendix F.



Appendix G

Table for Appendix G

Summary of the Mixed Design Non-target Training Condition (3) x Target Training Condition (2) x Stimulus Dimension (2) x Training History (2) Analysis of Variance (ANOVA) without the Congruent Target Training Condition for Phase-2-Consistent Responding from Experiment 2

Source	***df***	***F***	***p***
Between-subjects effects			
Non-target Training Condition (N)	2	82.283	< .001
Target Training Condition (T)	1	5.378	.022
Stimulus Dimension (S)	1	1.727	.192
N x T	2	.354	.703
N x S	2	.136	.873
T x S	1	.303	.072
N x T x S	2	2.587	.053
Error	108	(.014)	
Within-subjects effects			
Training History (H)	1	162.781	< .001
N x H	1	129.214	< .001
T x H	1	1.623	.205
S x H	1	2.539	.114
N x T x H	2	1.217	.300
T x S x H	1	2.468	.152
N x T x S x H	2	2.223	.103
Error	108	(.052)	

Note. The value enclosed in parentheses represents the mean square error.

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