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Nonidentity Matching-to-Sample with Retarded Adolescents: Stimulus Equivalences and Sample-Comparison Control

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NONIDENTITY MATCHING-TO-SAMPLE WITH RETARDED ADOLESCENTS:
STIMULUS EQUIVALENCES AND SAMPLE-COMPARISON CONTROL

by

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ABSTRACT

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In Experiment 1, four subjects were trained to match two visual samples (A) and their respective nonidentical visual comparisons (B); i.e., A-B matching. During nonreinforced test trials, all subjects demonstrated stimulus equivalences within the context of sample-comparison reversibility (B-A matching): When B stimuli were used as samples, appropriate responding to A comparisons occurred. A-B and B-A matching persisted given novel stimuli as alternate comparisons. However, the novel comparisons were consistently selected in the presence of nonmatching stimuli: i.e., during trials comprised of a novel comparison, an A or B sample from one stimulus class, and an "incorrect" comparison from the other, B or A stimuli respectively. In Experiment 2, three groups of subjects were trained under three different mediated transfer paradigms (e.g., A-B, C-B matching). Tests for reversibility (e.g., B-A, B-C matching) and mediated transfer (e.g., A-C, C-A matching) evinced stimulus equivalences for 11 of

12 subjects. The 11 subjects also matched the mediated equivalences given novel comparisons; whereas, they selected the novel comparisons when combined with nonmatching stimuli. Overall, the demonstrated stimulus equivalences favor a concept learning interpretation of non-identity matching-to-sample. Additionally, the trained and mediated matching relations were comprised of complementary sets of S+ and S- rules: Any stimulus of a given class used as a sample designated both the "correct" and "incorrect" comparisons.

(136 pages)

CHAPTER I

INTRODUCTION

Humans appear uncanny in their ability to behave in novel, seemingly unpredictable ways. The conceptual and language repertoires of humans are especially rich with exemplars. Spoken words, printed words, and pictures or objects bear no physical resemblance to one another, yet these stimuli are potential members of common stimulus classes. Quite often these stimuli become functionally equivalent or interchangeable and used in a variety of contexts. Moreover, stimulus equivalences may be demonstrated even though an explicit training history may not be responsible for their categorization. The symbolic or representational nature of such behavior has eluded explanation in terms of rudimentary processes of discrimination and generalization (Wetherby, 1978). Conceptualizing this phenomenon in terms of stimulus and/or response classes (e.g., Goldiamond, 1962) also appears contraindicated for lack of parsimony (Wetherby, 1978). Hence, the notion of stimulus equivalences has gained prominence in recent literature.

The roots of stimulus equivalence research may be traced to the early writings of the British associationists who noted that if event A (i.e., an "idea") became associated with event B, and event B then became associated with another event, C, then A and C tended to be associated with each other. Considering the void of empirical substantiation for associative learning theory, Ebbinghaus (1913) devised an experimental methodology that went far to advance the science of psychology. Collectively, these developments were the impetus for research in mediated transfer of verbal learning several decades later (e.g., Jenkins, 1963; Jenkins & Palermo, 1964). More recently, operant researchers have embarked on an experimental analysis of stimulus equivalences. This may have an important influence on future directions of operant research seeking to explain and ultimately predict the occurrence of complex, generative behavior. Investigations of stimulus equivalences may help to bridge the conceptual gap that exists between cognitive psychologists and those adhering to an experimental analysis (Sidman, 1979). The present investigation provides data relevant to the description of higher-order stimulus control that characterizes much of human behavior.

Nonidentity matching-to-sample is akin to many of the discriminative behaviors acquired during receptive language learning and symbolic concept formation. The commonality shared by all is that appropriate responding to environmental events is dependent upon the existence of contextual stimuli arbitrarily associated with these events. The nonidentity task is one of three major variants of the basic matching-to-sample procedure. The other two variants are identity matching and oddity-from-sample (Cumming & Berryman, 1965). In contrast to nonidentity matching, during identity matching and oddity, the reinforced sample-comparison relations are based on physical similarity and dissimilarity, respectively. To illustrate, consider the behaviors required during simultaneous nonidentity matching where each of the letter/number designations represent configurally different stimuli. Trials commence with a sample stimulus, either A1 or A2, displayed on the center of three response keys. The subject emits an observing response to the sample key, and with the sample still present, the two side keys are illuminated with the comparisons B1 and B2. In the presence of sample A1, responses to B1 are reinforced; whereas, when A2 is displayed, responses to B2 are reinforced. A response to either comparison concludes a trial, after which all keys are dark for a brief interval. On subsequent trials, presentations of samples vary unpredictably, as well as do the left-right positions of the comparisons. During simultaneous identity matching or oddity, samples A1 and A2 are accompanied by the same two stimuli as comparisons. Thus, when identity matching contingencies are in effect and sample A1 is presented, reinforcement follows responses to A1; and when A2 is the sample, A2 is the reinforced comparison. Under the oddity contingencies, responses to the nonmatching comparisons are reinforced: If sample A1, choose A2; if sample A2, select A1. These procedures are called second-order or conditional discriminations (Cumming & Berryman, 1965) since on any given trial, the correct (the S+) and the incorrect (the S-) comparisons depend upon (i.e., are conditional upon) the particular sample presented. The descriptor "simultaneous" matching or oddity refers to the fact that the sample remains illuminated concurrently with the comparison stimuli.

The issue of central concern here is the nature of the transfer performance of retarded adolescents following various histories of nonidentity matching. Compared to the data base that has been generated from infrahuman laboratories in recent years (see review by Carter & Werner, 1978), relatively little is known about the processes underlying human performance on complex discriminated operants. While terminal matching behavior may be topographically similar across species, the results of several studies suggest that humans respond according to different sets of "rules" (Dixon, 1977; Dixon, 1978; Dixon & Dixon, 1978, Note 1; Dixon & Spradlin, 1976; Lazar, 1977; Levin & Maurer, 1969; Saunders, 1973; Scott, 1964; Sherman, Saunders, & Brigham, 1970; Sidman, 1971; Sidman & Cresson, 1973; Sidman, Cresson, & Willson-Morris, 1974; Spradlin, Cotter, & Baxley, 1973; Spradlin & Dixon, 1976; Wetherby, Karlan, & Spradlin, Note 2). A determination of these rules awaits empirical inquiry and is the subject of the present research.

A-B matching training constitutes the minimal case of nonidentity matching-to-sample. Given that such a task has been acquired, a fundamental question arises: What do humans learn from a conditioning history of this kind? Are simple stimulus-response chains between samples and comparisons learned, or have invariant equivalences been acquired? One kind of stimulus equivalence would be evidenced by the demonstrated "reversibility" or "substitutability" (Dixon & Spradlin, 1976; Spradlin & Dixon, 1976) of the trained A-B task. Accordingly, a probe involving B-A configurations (i.e., former samples are now comparisons and former comparisons are samples) should be matched as accurately as the trained A-B configurations.

The nature of the matching and nonmatching A-B stimuli also requires delineation. Do the A samples instruct the subject as to which of the B comparisons is the S+ on a given trial, and/or do they occasion the B comparison serving as the S-? The former case might be considered indicative of the S+ rule, while the latter is an instance of the S- rule (Berryman, Cumming, Cohen, & Johnson, 1965; Cumming & Berryman, 1961). Contrary to pigeon matching performance (Carter & Werner, 1978), the possibility exists that for humans, both S+ and S- functions are exercised by the sample stimuli in nonidentity matching. Researchers interested in complex human behavior have only recently begun to address this question (Dixon & Dixon, 1978, Note 2). Furthermore, we might ask whether or not the S+ and/or S- rules operate in the equivalent B-A association. If A-B and B-A relations are in fact equivalent, when B is used as a sample, it should exert the same degree and kind of control as sample A.

To extend the stimulus equivalence analysis further, we might attempt to enlarge the A-B stimulus classes to include a third stimulus, C. The construct of stimulus equivalence implies that this third stimulus might gain entry into the class via an association with either A or B. Subsequently, an assessment of equivalence within the class would involve a test for an association between C and the stimulus not directly encountered in the presence of C. For example, following A-B training, a subject might also be taught that when C is the sample, select the B comparison. Without further training, would sample A control comparison C responses? Would C as a sample also control choice of A comparisons? Demonstrated control by stimulus class members not directly trained (e.g., A-C and C-A matching) has been referred to as "mediated" transfer (Goldiamond, 1962; Hull, 1939; Keller & Schoenfeld, 1950; Schoenfeld & Cumming, 1963; Sidman et al., 1974) and may be considered instances of "concept learning" (Dixon & Spradlin, 1976; Keller & Schoenfeld, 1950; Spradlin & Dixon, 1976).

If mediated transfer is eminent, the questions of control by S+ and/or S- rules are also relevant. That humans evince stimulus equivalences under nonidentity matching conditions has been amply demonstrated (Dixon, 1978; Dixon & Spradlin, 1976; Lazar, 1977; Sidman, 1971; Sidman & Cresson, 1973; Sidman et al., 1974; Spradlin & Dixon, 1976; Wetherby et al., Note 2), however, a qualitative analysis of the mediated associations in terms of S+ and S- rules has yet to be performed. Moreover, the basic paradigms used to establish mediated associations (Jenkins & Palermo, 1964) have not been compared within a matching context. As in the previous example, the third stimulus term C might be used as a sample for the comparison responses (stimulus equivalence paradigm). Or instead, C might serve as another comparison for the A sample (response equivalence paradigm). Finally, C might function as a comparison, but with B used as the sample (chaining paradigm). Will comparable mediated associations evolve from these training sequences? Additionally, are the prevailing sample-comparison rules congruent with those that may exist in the trained A-B and the equivalent B-A relations?

The questions posed above have not been previously addressed. An analysis of them would contribute considerably to our knowledge of the stimulus equivalence phenomenon demonstrated by humans performing nonidentity matching-to-sample. Consequently, the overall objective of this research is to delineate the types of rules or response strategies that characterize human discriminative behavior evidenced by nonidentity matching. Arbitrary relations explicitly trained and those that emerge via indirect association are subjected to analysis.

Retarded humans have been the most frequent participants in research on mediated transfer of matching-to-sample (Dixon, 1978; Dixon & Spradlin, 1976; Sidman, 1971; Sidman & Cresson, 1973; Sidman et al., 1974; Spradlin et al., 1973; Spradlin & Dixon, 1976). The use of intellectually delayed humans in the present study represents an attempt to further our understanding of the complex discriminative behavior exemplary of this population.

CHAPTER II

REVIEW OF THE LITERATURE

This review commences with an overview of current conceptualizations of conditional discrimination learning. These theoretical postulates are an outgrowth of research with nonhuman laboratory animals, namely, pigeons. This framework will provide an appropriate referent for subsequent discussions of related research conducted with humans. The research relevant to this investigation is classified in two major categories: that pertaining to the development of stimulus equivalences, and that concerned with the degree of stimulus control exerted by matching and nonmatching samples and comparisons (i.e., S+ and S- rules).

An Overview of the Learning Models

Inspired by Lashley's (1938) early research with rats, Carter and Werner (1978) recently outlined three models that pertain to the issue of what an organism learns as a result of conditional discrimination training. Farthing and Opuda (1974) and Zentall and Hogan (1974) have advanced similar propositions. As stated, the three models appear well suited to account for identity matching and oddity behavior. Nonidentity matching may be discussed with respect to the first two considerations, and, with some additional elaboration, the third model seems appropriate as well. Each model lends itself to empirical verification.

The configuration model considers the possibility that an organism simply acquires a set of discriminations based on all possible stimulus arrangements which constitute the matching task. For example, in a two-choice nonidentity problem there are four possible trial configurations: B1 (left key) - A1 (center key) - B2 (right key), B2-A1-B1, B2-A2-B1, and B1-A2-B2. Thus, a subject might learn to respond to the left key when faced with B1-A1-B2 and B2-A2-B1; whereas, given B2-A1-B1 and B1-A2-B2, will learn to select the right key.

The multiple-rule model suggests that each sample functions as an "instructional" stimulus (Goldiamond & Dyrud, 1968) that designates which discrimination between comparisons is in effect on a given trial. Stated differently, the subject behaves according to "if..., then..." rules (Carter, 1971; Carter & Eckerman, 1975). Such "rules" may be conceptualized as S+ rules or S- rules (Berryman et al., 1965; Cumming & Berryman, 1961). Under the S+ rule, for example, a subject might learn that if A1 is the sample, then respond to B1; but if A2, then select B2. Responding according to the S- rule, a subject might learn that if A1, do not choose B2; and given A2, do not select B1.

As an adjunct to the multiple-rule model, the coding hypothesis (Lawrence, 1963; Schoenfeld & Cumming, 1963) has also appeared in discussions of pigeon's matching and oddity behavior under transfer conditions (Berryman et al., 1965; Carter & Werner, 1978; Cumming & Berryman, 1961; Cumming et al., 1965). The basic tenet underlying the coding hypothesis is that the acquisition of a particular sample-comparison relation depends upon the establishment of an intervening <u>coding response</u> (Lawrence, 1963; Schoenfeld & Cumming, 1963). To illustrate, reconsider the A-B matching procedure with accompanying coding responses (CRs): In the presence of sample A1, CR1 occurs, which in turn regulates the selection of B1; sample A2, however, is followed by CR2, which governs selection of B2. Consequently, the presentation of each sample activates a specific coding response, which ultimately manifests itself in the emission of an appropriate comparison response. The mediational function of coding responses is considered unique to the explicitly trained sample-comparison relations. Transfer to novel matching or oddity problems would not be expected since coding responses have not been acquired for these stimulus arrangements.

The <u>single-rule model</u>, or what might be considered "concept" learning (Carter & Werner, 1978), holds that a subject responds according to the overall relational property that distinguishes a given conditional discrimination problem. Lashley's version of the single-rule model might be stated as follows: Any stimulus designated correct in context A is incorrect in the presence of context B. Empirical evidence is derived from the subject's successful transfer to novel stimulus configurations that adhere to the singular rule. For example, in identity matching, the subject learns to respond to the comparisons that are the "same as" the samples; while during oddity, responses are guided by the "different from" principle. Thus, the reinforced stimulus classes are dictated by the similarities or differences between samples and comparisons. In the case of nonidentity matching, however, where there are no physical similarities between stimuli, the single-rule model is evidenced by the demonstrated functional equivalence among stimuli (Dixon, 1978; Dixon & Spradlin, 1976; Spradlin et al., 1973; Spradlin & Dixon, 1976). The notion of stimulus equivalences has long been recognized as a useful explanatory device for the fact that physically disparate stimuli can come to control the same response through indirect association (Goldiamond, 1962; Hull, 1939; Keller & Schoenfeld, 1950). Extended to nonidentity matching, the stimulus equivalence or single-rule model might be stated as follows: Any instance of a given stimulus class used as a sample will control responses to any other instance of that class used as a comparison. This interpretation appears consistent with the idea that evidence for conceptual behavior exists when transfer of responding occurs within and between discriminated classes of stimuli (Keller & Schoenfeld, 1950).

The succeeding section provides a thorough examination of the research conducted with humans under nonidentity matching. Critical exemplars from pigeon research are also included. As alluded to earlier, pigeons and people differ markedly in their transfer performance under such conditions; on the surface, this appears to be a minimally significant observation. The observation becomes important, however, when one considers how present and future research with humans might be encompassed within the preceding theoretical framework or contribute to a recasting of it.

Stimulus Equivalences

The reversibility test of stimulus equivalences. Statements about the formation of stimulus equivalences must be based on patterns of comparison responding observed in the presence of novel arrays of a particular stimulus class (Farthing & Opuda, 1974). A rudimentary manipulation that meets this requirement is the test of stimulus equivalence within the context of reversibility or interchangeability of the trained samples and comparisons. To exemplify, reconsider the baseline nonidentity matching task: Given sample A1, responses to comparison B1 are reinforced; and in the presence of A2, B2 is the reinforced comparison. In shorthand notation (Berryman et al., 1965; Cumming & Berryman, 1961; Cumming, Berryman, & Cohen, 1965), the A-B task is depicted as: A1 (B2, B1*) A2(B1, B2*), where the samples are denoted outside the parentheses and the comparisons within. The asterisk identifies the reinforced comparison, and the left-right positioning of comparisons is disregarded. While such reinforcement contingencies operationally define the boundaries of the two stimulus classes, independent tests for functional class membership or stimulus equivalence must be conducted. Therefore, following a high level of correct matching on this problem, a transfer test is administered in which the B stimuli become samples for the first time, and the A stimuli are presented as comparisons. The B-A matching test may be denoted as follows: B1(A2, A1) B2(A1, A2). If the respective A and B stimuli are indeed equivalent, then the B-A trials should be matched as accurately as the ongoing A-B trials.

Pigeons respond near chance level when confronted with reversibility tests, demonstrating the nonequivalence of samples and comparisons (Gray, 1966; Hogan & Zentall, 1977; Rodewald, 1974). For instance Rodewald (1974) first taught pigeons a nonidentity matching task involving hues as samples and lines as comparisons. Specifically, when the sample was illuminated with red, responses to the comparison key displaying three vertical lines were reinforced; but when the sample was green, responses to the three horizontal lines were reinforced. Following a high level of correct matching on this problem, the birds were given a transfer test in which the lines became samples and the hues became comparisons. This test resulted in a deterioration of matching accuracy to preacquisition levels. Although sufficient test evidence is presently lacking, it might be concluded that the pigeons acquired sets of S+ rules such that their performance was under the control of specific stimulus-response chains: e.g., if red, choose vertical; if green, select horizontal. Such a conclusion is consistent with the majority of the simultaneous identity matching and oddity literature using the present procedures (Berryman et al., 1965; Cumming & Berryman, 1961, 1965; Farthing & Opuda, 1974; Holmes, 1979). Yet, a direct test of this supposition is needed to rule out the alternative configuration model.

To date, an analysis of sample-comparison reversibility has not been performed with retarded subjects. However, the unpublished findings of Wetherby et al. (Note 2) suggest that young normal children exhibit this kind of equivalence. Reversibility probes were conducted as part of a more comprehensive assessment of stimulus equivalences following multi-stage nonidentity matching training. For example, children were trained on A-B, C-B, and A-D tasks; all associations involved arbitrary geometric forms. The matching accuracy of the children was unaltered during a subsequent test for reversibility which consisted of B-A, B-C, and D-A trials. As one might surmise from this example, additional tests for equivalence could be conducted. Indeed, the authors found evidence for the following equivalences: A-C, B-D, and C-D. These latter demonstrations of transfer are considered mediated equivalences, that is, those that arise via indirect association with members of a given stimulus class.

Mediation tests of stimulus equivalences. Additional, perhaps more conclusive evidence for stimulus equivalences can be derived through the use of mediated transfer paradigms. Jenkins and Palermo (1964) outlined three basic paradigms of this sort: stimulus equivalence, response equivalence, and chaining procedures. The nomenclature connotes the inferred associative process involved in each. The logic of the stimulus equivalence paradigm specifies that: If sample A controls comparison B, and sample C also controls B; then with A as the sample, C should be selected. It might also be expected that sample C will control appropriate A responding. Thus, samples A and C become equivalent via their association with a common comparison, B. A three-member stimulus class is the result. Under the response equivalence paradigm, however, the associative element is at the sample level: If sample A controls B, and A also controls C; then B will control C, and C will control B. The chaining paradigm also involves three stimuli, but the associative term is used first as a comparison, then as a sample: If sample A controls B, and B controls C; then A will control C, and vice versa.

A logical analysis suggests that transfer in each mediation paradigm might depend upon the fundamental process of sample-comparison reversibility (Jenkins, 1963). That is, before the third term C can become an equivalent member of the class, the A and B stimuli must be equivalent: If A controls B; then B must control A. Only then might one expect the indirect equivalence of C as a result of direct training with either A or B (e.g., train A-B and C-B; then test for A-C and C-A). As previously mentioned, Wetherby et al. (Note 2) found that young children readily exhibit both kinds of equivalence -- an outcome consistent with this analysis. The tactic of including tests for both reversibility and mediation might disclose data relevant to this issue.

The three mediated transfer paradigms may be summarized as follows: 1) stimulus equivalence: Train A-B and C-B, then test for A-C and C-A; 2) response equivalence: Train A-B and A-C, then test for B-C and C-B; and 3) chaining: Train A-B and B-C, then test for A-C and C-A. In addition, tests for reversibility might be administered. For example, following training under the stimulus equivalence paradigm, a probe for sample-comparison reversibility would consist of B-A and B-C trials. In each instance, stimulus equivalence would be evidenced by demonstrated matching accuracy comparable to that exhibited during the trained sample-comparison relations. Research conducted with humans has concentrated on the establishment of mediated equivalences using the previously outlined paradigms and permutations thereof. Similar research involving nonhuman species is nonexistent.

Sidman (1971) investigated the formation of stimulus equivalences within the context of the response equivalence paradigm. The subject was a severely retarded adolescent. The sample and comparison stimuli were comprised of pictures, printed words, or spoken words of 20 referents (e.g., axe, bed, bee, and box). The subject entered the experiment able to match spoken words and pictures (A-B) and could name the pictures (B-A); but was unable to match spoken words to printed words (A-C), pictures to printed words (B-C and C-B), or name the printed words (C-A). The critical manipulation involved teaching A-C matching: with spoken words as the samples, responses to their printed word comparisons were reinforced. Subsequent transfer tests revealed that the subject would match pictures and printed words (B-C and C-B), and could name the printed words as well (C-A). In essence, the pictures and printed words became equivalent, or members of the same stimulus class, thereby establishing a rudimentary form of reading comprehension. Sidman and Cresson (1973) replicated these results with two Down's syndrome adolescents who also required training on the A-B matching relation (spoken word-picture matching).

In a discussion of these findings, Sidman acknowledged that further research would be necessary to evaluate the nature of the transfer. One question concerns the generality of the transfer phenomenon. Are such equivalences restricted to cross-modal tasks (e.g., auditory-visual tasks)? Would B-C and C-B matching emerge after a history of association with another visual symbol during the A-B, A-C training? Another question has to do with a determination of the "mediator" in these experiments. The emergent picture-word and word-picture matching could have been mediated by their common stimulus associate (dictated words), or their common response (words spoken by the subject). A subsequent study addressed this latter issue.

Sidman et al. (1974) re-examined the mediated transfer of matching with a chaining paradigm. Two Down's syndrome males served as subjects. The stimuli for one subject were the same as those used in earlier studies (Sidman, 1971; Sidman & Cresson, 1973). For the other subject the stimuli were upper- and lower-case letters and their dictated names. Subjects were first taught the A-B (auditory-visual) and the B-C (visual-visual) matching tasks. They were then tested for the emergence of A-C and the two naming tasks: B-A and C-A. Sidman et al. reasoned that if A-C emerged, but the subjects were relatively inaccurate in naming the visual stimuli, mediation would have occurred via stimulus associations. The results of this study generally concurred with this logic: A-C transfer did occur without a concomitant increase in naming performance. These results may appear at odds with Jenkin's (1963) suggestion that reversibility and mediated transfer necessarily coexist. It should be noted, however, that Sidman's subjects did achieve considerable skill in naming when compared to their entry performance. They were also proficient in C-B matching, the reversible counterpart to the second stage of training (B-C). C-B matching occurred spontaneously with one subject and was trained with the other. Considering the relative lack of B-A responding, it may be that certain task variables hindered transfer across receptive and expressive modalities. Other research has demonstrated that behaviors trained at either the receptive or expressive level do not automatically emerge in the other (e.g., Guess & Baer, 1973; Speidel, 1978). The mediated transfer evidenced in Sidman's study can be attributed to the functional equivalence between B and C.

Spradlin and his associates (Dixon, 1978; Dixon & Spradlin, 1976; Spradlin et al., 1973; Spradlin & Dixon, 1976; Wetherby, Note 2) have conducted several analyses of mediated transfer using nonidentity matching procedures. In Experiment 2 of Spradlin et al. (1973), three moderately retarded adolescents were exposed to a multi-stage paradigm that resembled the stimulus equivalence procedure. Geometric forms were used as sample and comparison stimuli. There were three training phases: A-B, C-B, and A-D. The critical data were gathered from a test session in which C-D trials were presented. If samples A and C functioned as equivalent stimuli, then sample C should also control appropriate D responding without direct training. In fact, this is exactly what was revealed during the transfer session. On the first exposure to the C-D trials, all subjects appropriately matched with greater than 90% accuracy. Wetherby et al.

(Note 2) replicated these results.

In Experiment 3 of Spradlin et al. (1973), three new moderately retarded subjects were exposed to the basic response equivalence paradigm. Accordingly, they were trained on A-B and A-C matching problems, then tested for the emergence of B-C. The results were equivocal: Only one subject appeared to show transfer during the first test session. Another subject evidenced transfer during the fifth transfer session, while the third subject responded at or near chance level throughout the study. Furthermore, a reversal control manipulation for the two subjects that showed transfer failed to alter their probe performance. As the authors pointed out, the inconclusive transfer results may have been attributable to a procedural variable. In contrast to Experiment 2, there was no attempt to maintain the high level of A-B responding evidenced during baseline while the subjects were tested on B-C. Only A-C trials were intermixed with the B-C trials. It remains to be determined if the response equivalence paradigm is sufficient for the production of mediated transfer within the visual modality. Likewise, an analysis of the complementary stimulus equivalence and chaining paradigms has yet to be performed.

Spradlin and Dixon (1976) extended the foregoing study. Two moderately retarded adolescents served. Training first established two stimulus classes, each comprised of four visual stimuli. The classes were formed by having each member serve as both a sample and a comparison for every other member of the class: e.g., A-B, B-A, A-C, C-A, A-D, D-A, B-C, C-B, B-D, D-B, C-D, and D-C. This multi-stage procedure combines the three primary transfer processes overviewed previously (stimulus and response equivalence, and chaining) and reversed relations are explicitly taught. Next, the subjects were taught to select one visual class member in response to an auditory sample (e.g., "Find voo" versus "Find zi"). Subsequent test sessions were conducted to determine if the auditory samples would control comparison responses to the remaining class members. If auditory-visual stimulus equivalences had in fact been established, then transfer should be observed during the first session. The results showed that training one auditory-visual association was insufficient to produce transfer, even after several test sessions. However, after training the subjects to select a second class member in response to the auditory sample, transfer to the remaining two class members gradually occurred by the ninth test session.

These results suggest that there may be some circumstances where the emergence of mediated transfer is not instantaneous. Research may determine that the inclusion of cross-modal matching and/or the size of the initially trained stimulus classes may be influential variables. Thus, it may be necessary to train more than one stimulus class exemplar to achieve transfer, or in some cases, mediated equivalences may be observed simply after repeated probing (e.g., Spradlin et al., 1973; Dixon & Spradlin, 1976).

The Spradlin and Dixon (1976) results were replicated by Dixon and Spradlin (1976) in a series of experiments. The results of Experiment 1 showed that three of six moderately retarded subjects exhibited transfer after being taught one exemplar auditory-visual association. In Experiment 2, the authors determined that if subjects were taught to select one visual comparison from the class in the presence of a new visual sample, transfer occurred to the remaining members of the class. Two of the Experiment 1 subjects who did not show transfer participated in Experiment 3. It was found that when additional auditory-visual exemplars were trained, transfer to the other class members was achieved. One of the Experiment 1 subjects who evidenced transfer was used in Experiment 4. This experiment demonstrated that the auditory-visual control would transfer to a new visual stimulus added to the class as a comparison stimulus. In addition, if a new comparison was conditioned to the auditory sample, that visual stimulus would control appropriate comparison selections to the remainder of the stimulus class.

Dixon (1978) explored another variation of the response equivalence paradigm. Moderately and severely retarded subjects were trained to perform a series of auditory-visual matching tasks. Two stimulus classes were established such that each of two labels was paired with four visual referents: e.g., A ("La" versus "Dee") -B, A-C, A-D, and A-E. Once criterion was reached, subjects were tested for visual stimulus equivalences (B-C, C-B, etc.). The combined results from two experiments showed that the transfer data for 10 of 12 subjects were congruent with the predicted stimulus classes.

Taken together, several summary statements can be made regarding Spradlin's work in mediated transfer: First, mediated transfer need not be cross-modal. Spradlin et al. (1973) and Wetherby et al. (Note 2) demonstrated that mediated stimulus equivalences could be established entirely within the visual modality. Second, the Spradlin et al. (1973) findings suggest that the stimulus equivalence transfer paradigm may be sufficient for the generation of mediated transfer, while the efficacy of the response equivalence procedure remains to be explored. Finally, the Dixon (1978), Dixon and Spradlin (1976), and Spradlin and Dixon (1976) studies suggest that mediated transfer may occur within multi-element stimulus classes.

A study by Lazar (1977) examined the possibility that matching-to-sample might be used to generate mediated stimulus equivalences to classes of stimuli established outside the matching paradigm. Three normal adults participated. Subjects were initially trained to perform four sequence tasks involving pairs of visual stimuli. They were required to point to A1 then A2, B1 then B2, C1 then C2, and D1 then D2. The establishment of sequence classes was then confirmed during a test in which all combinations of the "first" and "second" stimuli were presented (e.g., A1 then B2, B1 then A2, etc.). Next, a pretest was conducted to establish a baseline of sequence performance with new stimuli: E1 then E2, and F1 then F2. The subjects failed to consistently sequence these stimuli in accordance with the experimental designations. A series of matching-to-sample training and testing sessions then ensued. This manipulation involved presenting members of the sequence classes as samples and the new stimuli as comparisons. For example, with A1 as the sample, responses to E1 were reinforced; and when A2 was the sample, E2 was the reinforced comparison. All stimuli were divided into three sets. After Set 1 was trained, transfer to Set 2 was evaluated. If transfer was not observed, Set 2 was trained with subsequent transfer testing with Set 3. If necessary Set 3 was also trained. The logic was that during matching training, the samples and comparisons should become equivalent. Such equivalence might be observed when the second or third set of stimuli were used as probes. For example, after matching training on A1 then E2, and A2 then E2, would subjects appropriately match B1 and E1, and B2 and E2? If A1 and B1 were equivalent "first" members of the sequence class, and A1 and E1 were equivalent; then E1 should be selected when B1 was the sample. Likewise, B2-E2 matching should emerge if A2 and E2 were equivalent. The results showed that none of the subjects transferred within the sets of matching problems after training on the first set. After training on the second set, however, one subject showed transfer to the third. The other two subjects were then trained on Set 3. A final test was administered to determine if the E and F stimuli would now control sequencing as predicted by the matching training. During this test, two of the three subjects showed near perfect sequencing: They pointed to E1 then E2, and F1 then F2. The third subject failed to show transfer even after repeated testing. Apparently, the matching experience for this subject failed to establish the predicted stimulus equivalences. To test this assumption further, the third subject was probed for the reversibility of the trained matching associations. For example, the subject was originally trained with A1 and A2 as samples, and E1 and E2 as comparisons. If samples and comparisons were equivalent, it should be possible to substitute one for the other without a deleterious effect on matching performance. Therefore, the subject was given E1 and E2 as samples, and A1 and A2 as comparisons. The subject failed to match appropriately during a series of such reversal tests. Even when explicitly taught to perform several reversal problems, this subject's performance to new probe stimuli remained at chance level. These results confirmed that stimulus equivalences had not been established for this subject.

Lazar's findings clearly suggest that matching-to-sample may be used to enlarge stimulus classes formulated outside the matching context, and again, that mediated transfer is not unique to cross-modal tasks. Yet, new questions arise when the results of the matching phase of this study are scrutinized. It remains to be ascertained why transfer failed to occur within the matching context for one subject and why matching training did not produce stimulus equivalences for the other participant. The relation between sample-comparison reversibility and mediated transfer also remains undetermined.

Summary. The preceding review suggests that the phenomenon of stimulus equivalence is reliable across a variety of human subjects and stimulus dimensions. The configurational and multiple-rule models are contraindicated because of the generative nature of human transfer in nonidentity matching. Both models predict a deterioration of matching accuracy to chance levels under either the reversibility or mediated transfer tests. Therefore, demonstrated stimulus equivalences conform to the single-rule or concept learning interpretation outlined by Carter and Werner (1978). Yet, if the three models are considered hierarchically arranged, the single-rule explanation may contain elements of the multiple-rule model. Indeed, Cumming and Berryman (1961) suggest that "generalized" matching or single-rule responding may be attributed to subjects learning both the S+ and S- rules delineated in the multiple-rule model. An analysis from this standpoint would contribute to a more precise elucidation of the processes involved in nonidentity matching. The feasibility of such an analysis is addressed in the following section.

Sample-Comparison "Rules"

The distinction between S+ and S- rules suggests two testable hypotheses: A subject behaving in concordance with the S+ rule would continue to match accurately given novel comparisons (N1 and N2) and the trained A-B "matching" stimuli. This test might consist of the following trials: A1(N1, B1) A2(N2, B2). The S- rule assumption could also be tested using novel comparisons, but in conjunction with "nonmatching" samples and comparisons: e.g., A1(B2, N1) A2(B1, N2). Given trials of this sort, the S- rule predicts that the novel stimuli (N1 and N2) would be selected. This prediction is based on the assumption that subjects learn that the A1-B2 and A2-B1 configurations are incorrect; they will therefore respond away from these combinations.

To exemplify, consider the analysis of Berryman et al. (1965) who trained pigeons on an oddity task with red, green, and blue stimuli. Trials involved one of the hues as the sample with the identical hue as one comparison and one of the remaining hues as the other comparison. The birds were reinforced for selecting the comparison that "mismatched" the sample. For example, with red as the sample, and red and green as comparisons, responses to green were reinforced. Following acquisition, oddity transfer was evaluated. A yellow hue was programmed to illuminate where blue had originally occurred. Berryman et al. suggested that the pigeons could have acquired the oddity task by learning to approach the correct comparisons, or avoid the incorrect comparisons. In other words, the samples may signify which of the comparisons is the S+, or the correct stimulus; or the sample may function to designate the incorrect comparison, or the S-. An estimation of the rule in operation was ascertained by assessing performance during two types of trials with the yellow hue: G(G, Y*) and R(R, Y*). If the S+ rule was operating, the subjects would perform at the same level as they initially performed with blue: i.e., on G(G, B*) and R(R, B*) trials. This analysis follows since the green and red samples functioned as selectors of S+s, and the reinforced comparisons were not available during the test. The S- rule, on the other hand, predicts that there would be no disruption in performance and matching accuracy would essentially parallel that evidenced during the final day of training with blue. The S- rule follows since the subject has learned that the samples designate the comparisons that are incorrect: With red as the sample, avoid the red comparison; and with green as the sample, avoid the green comparison. The results of this study suggested that the pigeon's performance could best be accounted for in terms of the S+ rule.

Human subjects, however, appear capable of learning about nonreinforced stimulus combinations and show consistent response patterns as a result of such learning. Dixon and Dixon (1978) recently demonstrated that after identity matching training, children reliably avoided responding to nonmatching samples and comparisons; instead, they selected an alternate comparison not related to the ongoing training. During the first experiment, preschoolers were exposed to a two-choice identity matching problem involving form stimuli. After reaching criterion performance, nonreinforced test trials were interspersed among the matching trials. The test trials consisted of the trained sample stimuli and incorrect comparisons, and novel comparison stimuli. The results from the test trials evinced that five of six children repeatedly selected the novel comparisons, an outcome predicted by the S- rule. In a second experiment, measures were taken to rule out the likelihood that the subject's selections were based on the "novelty" of the unfamiliar comparisons. This was done by briefly training the subjects with the stimuli that would eventually comprise the novel comparisons during the probes for S- responding. Stimulus control consistent with the S+ rule was inferred from the observation that the subject's matching performance was not disrupted by these new stimulus configurations. The original matching problem was then retrained and the probes for S- control readministered. Once again, the children responded away from the nonmatching stimuli and selected the alternate comparisons. In a replication, Dixon and Dixon (Note 1) demonstrated that retarded subjects also evince S- responding following a history of identity matching training. Unassessed in either study was whether the S- rule would occur in the presence of novel identity matching problems. To evaluate this possibility, one could first demonstrate transfer of the identity relation to new matching problems inserted as nonreinforced probes. Subsequently, tests for S- control could be conducted using the nonmatching stimuli comprising the identity transfer test, plus novel incorrect comparisons. It may be possible that S- responding would generalize beyond the originally trained problem to the "concept" of identity matching.

The S- responding evidenced in the aforementioned studies might be representative of a more general tendency of humans to avoid responding to choice stimuli that have a history of association with specific instructional stimuli. Dixon (1977) reported a similar phenomenon in a study of stimulus control by spoken words over the selection of visual stimuli. Dixon first trained retarded subjects to select one of three visual stimuli in the presence of one spoken word. Only two choices were available from trial-to-trial. Under test conditions, two untrained words were randomly introduced as verbal stimuli and the subjects consistently responded away from the trained visual choice. While training was not conducted within a a matching-to-sample framework, the subjects apparently learned a conditional discrimination: When the trained word is presented, the trained choice is correct; but in the presence of untrained words, the alternate choices are correct. Dixon went on to show that no association existed between the untrained words and the unfamiliar choices. That is, on certain test trials the untrained words were presented with the two familiar visual choices. Since stimulus control broke down during this condition, the author concluded that the consistent pairing of novel stimuli originally displayed depended on the presence of the reinforced visual choice. These results are consistent with the observation that preschool children acquire new word-object associations more rapidly when the alternate choice objects are "known" as opposed to "unknown" (Vincent-Smith, Bricker, & Bricker, 1974). While the generality of control by trained comparisons over novel samples and comparisons remains unassessed, the foregoing highlights an interesting direction for future research.

Summary. Research with pigeons suggests that identity matching and oddity are dictated by S+ rule learning. Apparently nothing is learned about the nonreinforced sample and comparison stimuli (Berryman et al., 1965; Cumming & Berryman, 1961, 1965; Farthing & Opuda, 1974). Even when pigeons are explicitly trained to withhold responses in the presence of nonreinforced configurations, complete transfer to unfamiliar incorrect samples and comparisons is not observed (Urcuioli & Nevin, 1975; Urcuioli, 1977). The pigeon's apparent failure to acquire the S- rules that define the boundaries of a given conditional discrimination may be responsible for its observed failure to demonstrate conceptual transfer (Cumming & Berryman, 1961). Empirical evidence notwithstanding, Carter and Werner (1978) suggested that a similar account appropriately describes the pigeon's nonidentity matching performance.

Thus far, the S- rule interpretation appears applicable to human identity matching behavior (Dixon & Dixon, 1978, Note 1). As suggested by Cumming and Berryman (1961), it may be the case that one of the factors responsible for the generalized identity matching of humans (Levin & Maurer, 1969; Saunders, 1973; Scott, 1964; Sherman et al., 1970) is their ability to learn both S+ and S- rules. Are similar processes involved in human nonidentity matching? The aforementioned research strongly favors the stimulus equivalence conceptualization of human nonidentity matching. While the generality of this supposition remains to be tested, it appears that the stimuli comprising a given class will govern appropriate matching behavior regardless of their prior histories as samples or comparisons. Once a stimulus has been associated with a single member of an established class, it functions as an equivalent class counterpart. Whether or not nonidentity matching and resultant stimulus equivalences are characterized by S+ and/or S- rules are open questions.

CHAPTER III

STATEMENT OF THE PROBLEM

A determination of the rules that appear descriptive of human matching-to-sample performance has important implications for a theoretical discussion of conditional discrimination learning. Existing pigeon data fit well into the framework of the multiple-rule model and coding hypothesis (Carter & Werner, 1978). The discriminative behavior of pigeons is radically disrupted when novel stimuli are presented according to ongoing identity matching and oddity contingencies (Berryman et al., 1965; Cumming & Berryman, 1961, 1965; Farthing & Opuda, 1974; Holmes, 1979). In contrast, the extant research suggests that a single-rule model, or concept learning (Carter & Werner, 1978) interpretation is a more accurate explanation of human conditional discrimination performance. Humans appear to abstract rules of "sameness" and "different from" and readily transfer to new stimulus dimensions (Levin & Maurer, 1969; Saunders, 1973; Scott, 1964; Sherman et al., 1970). The nonidentity matching literature also suggests that in contrast to pigeons (Gray, 1966; Hogan & Zentall, 1977; Rodewald, 1974), humans tend to learn an equivalency among physically dissimilar classes of stimuli (Dixon, 1978; Dixon & Spradlin, 1976; Lazar, 1977; Sidman, 1971; Sidman & Cresson, 1973; Sidman et al., 1974; Spradlin et al., 1973; Spradlin & Dixon, 1976; Wetherby et al., Note 2).

It has been posited that the apparent species difference may be attributed to the pigeon's failure to learn about "incorrect" sample-comparison associations (Cumming & Berryman, 1961). Whether the pigeon's performance can be attributed to a fundamental lack of associative learning capacity or as yet undetermined procedural variables remain unresolved questions (Premack, 1976, 1978). We now have evidence that humans, however, do acquire S- rules when exposed to identity matching problems (Dixon & Dixon, 1978, Note 1). This might be the underlying process responsible for their ability to perform generalized identity matching and oddity. The extent to which humans learn both S+ and S- rules in other matching contexts remains to be ascertained and is a general objective of the present study. The present research attempted to determine if S+ and S- rules characterize trained A-B and equivalent B-A matching relations (Experiment 1), and equivalences derived from mediated transfer procedures (Experiment 2).

CHAPTER IV

EXPERIMENT 1: CONTROL BY MATCHING AND NONMATCHING STIMULI IN TRAINED A-B AND EQUIVALENT B-A ASSOCIATIONS

Introduction

The purpose of this experiment was to assess the extent to which matching and nonmatching stimuli controlled conditional responding in nonidentity matching-to-sample. The analysis encompassed both the trained A-B samples and comparisons, and the equivalent B-A stimuli. If the differential stimulus control reported in identity matching (Dixon & Dixon, 1978, Note 1) is a more general characteristic of human matching performance, then clear differentiation of control by matching and nonmatching configurations would be expected. Thus, consistent with the S+ rule, subjects confronted with novel comparisons and the matching samples and comparisons should avoid the novel stimuli and continue to match appropriately. However, given the novel comparisons and the nonmatching stimuli, subjects should respond exclusively to the novel stimuli, an outcome predicted by the S- rule.

Method

Subjects

The subjects were four male residents (ED, DW, JT, and JL) of Parsons State Hospital and Training Center. According to available records, all subjects were experimentally naive. They were chosen on the basis of their availability, willingness to participate, and ability to acquire a preliminary A-B matching problem. The apparatus and training procedures described later were utilized during this screening session; the stimuli (Dixon & Dixon, 1978), however, were not used in subsequent experimentation. To be included in this investigation, candidates were required to respond with 90-100% accuracy during the third block of 50 nonidentity trials. A total of 22 male residents were screened to find the 13 used in the two experiments. Table 1 describes the pertinent characteristics of all participants.

Ethical considerations. Throughout the conduct of this research, all necessary precautions were taken to safeguard the rights and welfare of the persons involved. Participants were not subjected to any physical or psychological risks or discomforts. This study was conducted at the Parsons Research Center on the grounds of Parsons State Hospital and Training Center. The Research Center is a branch of the Bureau of Child Research, an affiliate of the University of Kansas. Immediate supervision of this project was the responsibility of Dr. Joseph Spradlin, Professor of Human Development, University of Kansas. This line of investigation was approved by the University of Kansas ethics committee governing research with humans. Consent agreements were obtained from parents or guardians of all subjects. (See Appendix A.)

Apparatus

One wall of the experimental space contained the following: a

Table 1

Subject characteristics: Chronological ages and durations of residency are expressed in years-months. Intelligence quotients were determined by either the Wechsler Intelligence Scale for Children (WISC) or the Wechsler Adult Intelligence Scale (WAIS).

Subject	CA	IQ	Length of Residency	Etiology
ED	13-0	67 WISC	1-4	Postnatal Injury
DW	16-5	78 WAIS	0-10	Unknown
JT	15-5	58 WISC	7-4	Psycho-Social Disadvantage
JL	15-6	65 WISC	6-0	Psycho-Social Disadvantage
MP	18-0	52 WAIS[a]	9-1	Unknown
JK	15-3	85 WISC	1-0	Unknown
LE	18-11	80 WAIS	2-0	Unknown
JC	15-5	70 WISC	0-11	Psycho-Social Disadvantage
LM	15-3	50 WISC	1-7	Unknown
NO	15-7	71 WISC	0-9	Unknown
LH	15-7	64 WISC	6-5	Unknown
AP	16-5	72 WAIS	7-5	Unknown
GC	15-9	61 WAIS	1-9	Unknown

[a] IQ determination based on Nonverbal Scale only.

stimulus display/response panel, a token receptacle, door chimes, and a buzzer. The display panel was mounted 1 m from the floor and contained three circular keys (32 mm dia) that formed a triangle with a base of 50 mm and sides of 83mm each. The token tray was mounted 12 cm directly above the panel. The door chimes and buzzer were attached near the ceiling. Each of the three keys was equipped with a 12-stimulus rear projector (Industrial Electronics Engineers, Inc., one-plane readouts, Model 2000). White figures (approximately 16 mm character size) on dark backgrounds served as stimuli. Figures 1-4 illustrate the stimuli which were reproductions of select Greek letters, astrological symbols, and forms adapted from previous research (Caron, 1968; Gibson, Gibson, Pick, & Osser, 1962; Vellutino, Harding, Phillips, & Steger, 1975). The utilization of the various stimuli was accomplished by interchanging the stimulus negatives housed within four panels of projectors. Capacitance sensing switches detected touch responses to the display windows. Tokens (metal washers) were dispensed via a Davis Universal feeder (Model 310). BRS solid state circuitry and a Narcor tape reader (Model 1280B) programmed stimulus events from an adjacent room. Responses were recorded on digital counters and a Practical Automation, Inc., printout counter (Model MMP-6 Moduprint).

Design

Within- and between-subject analyses were used to evaluate the various test conditions against a baseline of criterion level matching performance. Figures 1 and 2 depict exemplar training and test-

Figure 1. Representative sample (top-center figure of each triad) and comparison (side figures) stimuli used during Experiment 1. Stimulus Sets Ia and Ib were used during the initial sequence of training and testing conditions. The "+" denotes the reinforced comparison during training, the "-" identifies the nonreinforced comparison. All test trials were presented as nonreinforced probes. The letter/number designations (A1, B2, etc.) correspond to the trial notation used in Tables 3 and 4.

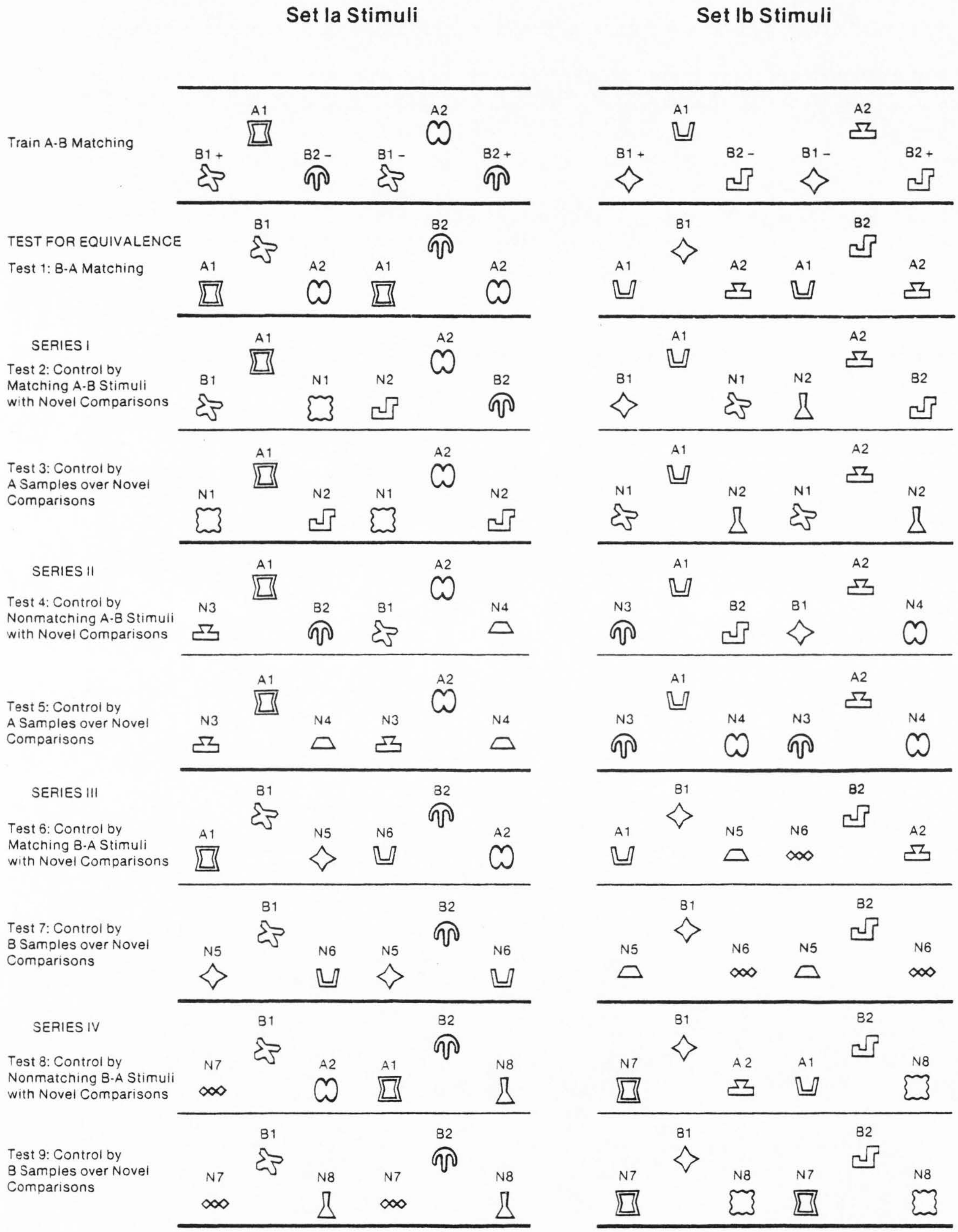
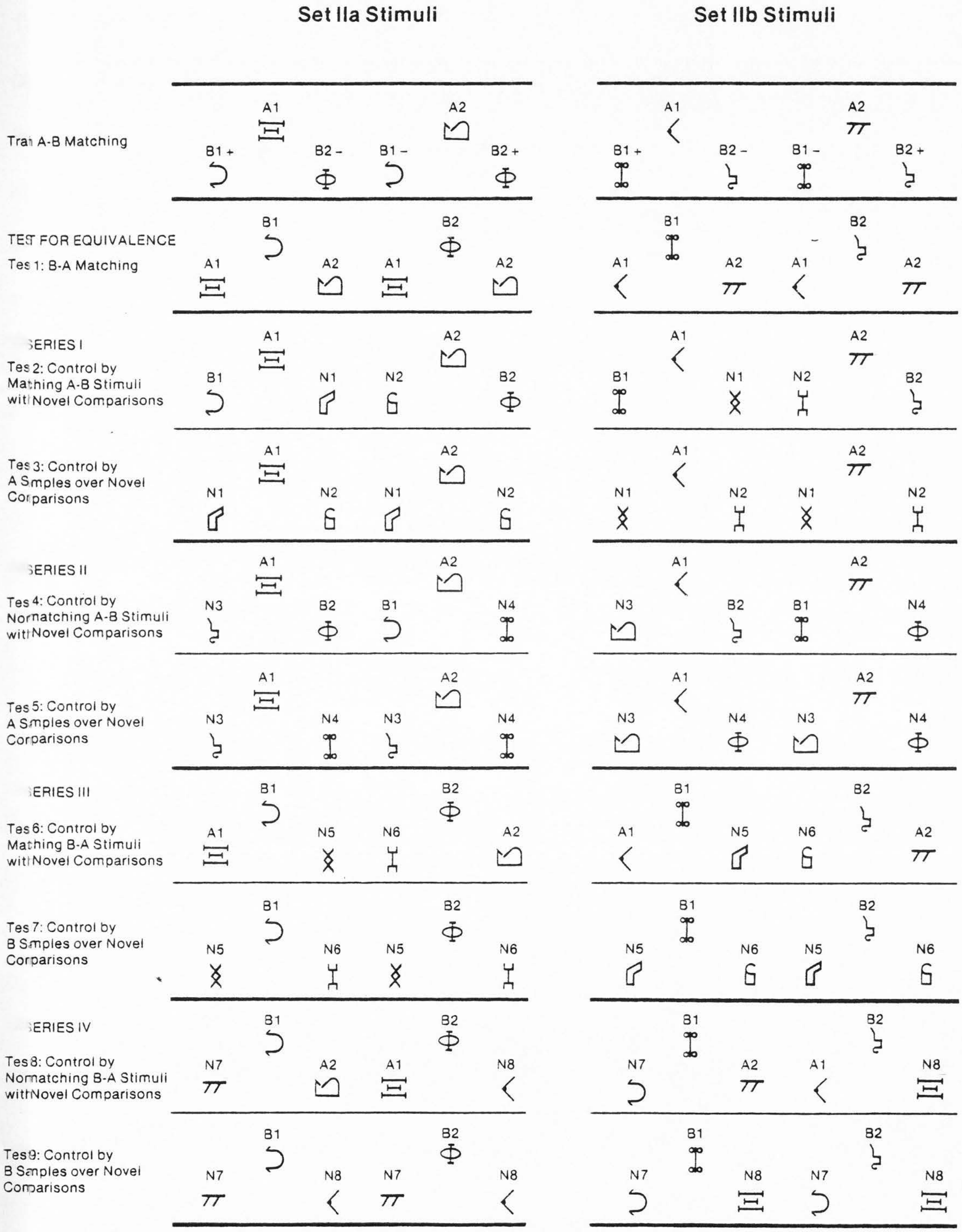

Set Ia Stimuli
Set Ib Stimuli
Train A-B Matching
A1 A2
B1 + B2 - B1 - B2 +
TEST FOR EQUIVALENCE
Test 1: B-A Matching
B1 B2
A1 A2 A1 A2
SERIES I
Test 2: Control by Matching A-B Stimuli with Novel Comparisons
A1 A2
B1 N1 N2 B2
Test 3: Control by A Samples over Novel Comparisons
A1 A2
N1 N2 N1 N2
SERIES II
Test 4: Control by Nonmatching A-B Stimuli with Novel Comparisons
A1 A2
N3 B2 B1 N4
Test 5: Control by A Samples over Novel Comparisons
A1 A2
N3 N4 N3 N4
SERIES III
Test 6: Control by Matching B-A Stimuli with Novel Comparisons
B1 B2
A1 N5 N6 A2
Test 7: Control by B Samples over Novel Comparisons
B1 B2
N5 N6 N5 N6
SERIES IV
Test 8: Control by Nonmatching B-A Stimuli with Novel Comparisons
B1 B2
N7 A2 A1 N8
Test 9: Control by B Samples over Novel Comparisons
B1 B2
N7 N8 N7 N8

Figure 2. Representative stimuli (Sets IIa and IIb) used during the replication sequence of training and testing conditions in Experiment 1. See Figure 1 for details.


Set IIa Stimuli
Set IIb Stimuli
A-B Matching
EQUIVALENCE
1: B-A Matching
ERIES I
2: Control by
hing A-B Stimuli
Novel Comparisons
3: Control by
mples over Novel
parisons
ERIES II
4: Control by
matching A-B Stimuli
Novel Comparisons
5: Control by
mples over Novel
parisons
ERIES III
6: Control by
hing B-A Stimuli
Novel Comparisons
7: Control by
mples over Novel
parisons
ERIES IV
8: Control by
matching B-A Stimuli
Novel Comparisons
9: Control by
mples over Novel
parisons
A1
A2
B1 +
B2 -
B1 -
B2 +
B1
B2
N1
N2
N3
N4
N5
N6
N7
N8

ing stimulus configurations. After acquiring the initial A-B matching problem with Set I stimuli, subjects proceeded through 18 test conditions. In a subsequent replication, another A-B task was trained with Set II stimuli and the tests were readministered. ED and JT were assigned to Sets Ia and IIa as illustrated in the figures; DW and JL were exposed to Sets Ib and IIb. As an additional control, JT and JL were assigned to reversed sample-comparison arrangements during training and testing: e.g., the illustrated B2 was used as the B1 stimulus, B1 was used as B2, N2 as N1, etc. Table 2 describes the sequence of events experienced by each subject. Additional design considerations are discussed later with respect to the repeated testing strategy.

Training Procedures

Sessions were conducted at the same time each day, Sunday through Friday. Sessions terminated after the completion of 84 trials. At the end of each session, tokens were exchanged for currency at the rate of three tokens to one cent under the 100% feedback contingencies. The token-currency exchange ratio was shifted to 1:1 when the intermittent schedule of feedback was in effect.

Trials and consequences. Trials commenced with a sample displayed on the center key. The specific sample varied across trials and the same sample occurred no more than two consecutive times. A single sample response illuminated the comparison keys with the matching and nonmatching stimuli. The sample remained illuminated until a

Table 2

Sequence of conditions for subjects of Experiment 1. Tests 1-9 are listed in their order of occurrence for each subject. Figures 1 and 2 illustrate stimulus configurations corresponding to the training and testing conditions for each subject.

ED	DW	JT	JL	ED	DW	JT	JL
1. Train A-B Matching[a]				3. Train A-B Matching[b]			
2. Administer Tests[a]				4. Administer Tests[b]			
1	1	1	1	1	1	1	1
2	5	7	8	8	7	5	2
3	4	6	9	9	6	4	3
2	5	7	8	8	7	5	2
3	4	6	9	9	6	4	3
4	6	9	3	3	9	6	4
5	7	8	2	2	8	7	5
4	6	9	3	3	9	6	4
5	7	8	2	2	8	7	5
1	1	1	1	1	1	1	1
7	8	2	5	5	2	8	7
6	9	3	4	4	3	9	6
7	8	2	5	5	2	8	7
6	9	3	4	4	3	9	6
9	3	4	6	6	4	3	9
8	2	5	7	7	5	2	8
9	3	4	6	6	4	3	9
8	2	5	7	7	5	2	8

[a]Stimulus Sets Ia and Ib were used for the initial conditions.

[b]Stimulus Sets IIa and IIb were used for the replication conditions.

comparison response was emitted. The left-right position of the comparisons alternated systematically with a maximum of three successive trials programmed on the same side. Each comparison appeared equally often in the left and right positions, and each sample occurred an equal number of times. When the feedback contingencies were in effect, responding to the matching comparison resulted in the sound of chimes, delivery of a token, a 3-sec intertrial interval with all keys dark, and the next trial. Nonmatching selections produced a 0.5 sec buzzer, the intertrial interval, and the next trial.

Instructions. During the initial session, subjects were seated before the display panel with all keys dark. The experimenter then advanced the programming tape to the first trial and provided the following instructions while physically guiding the subject's sample and comparison responses: "When you see this thing come on (the sample key), touch it with your finger, then touch this thing (the correct comparison key). Good, you made the bell go on and you got a token. You can trade the tokens for money when we're done. To help you earn tokens, a buzzer will go on when you choose the wrong thing. Let me show you. When this thing comes on (the sample), don't touch this thing (the incorrect comparison). See, you made the buzzer go on. You don't get a token when the buzzer goes on." After eight additional demonstrations of correct trial sequences, the experimenter said, "OK, see how many you can get right on your own. I'll wait outside for you. Work until I tell you to stop." The experimenter then began the programming tape again and the recorded session commenced.

Train A-B matching. The procedures described here were used to train both the initial A-B matching task with Set I stimuli, and the replication problem with Set II. Training consisted of 84 trials: In the presence of sample A1, a response to comparison B1 produced a token; and when sample A2 was displayed, B2 was the comparison that produced a token. Using the previously described notation system, the A-B training may be denoted: A1(B2, B1*) A2(B1, B2*). Training continued until a subject met a criterion of one session of 95-100% correct responding. At this point, the above mentioned contingencies for correct and incorrect responses were in effect for all trials. Next, intermittent consequences were programmed, such that 33% of the trials resulted in either the chimes and token, or buzzer (i.e., 28 feedback trials). Feedback occurred on a maximum of two consecutive trials, while no more than six successive no-feedback trials occurred. An equal number of feedback trials were programmed on the left and right keys. These contingencies were instated in order to accommodate the eventual nonreinforced probe trials during the test sessions. To facilitate the transition from continuous to intermittent feedback, the experimenter informed the subject: "For the next few days you won't get tokens every time you choose the right thing, only some of the time. The bell and buzzer won't come on every time either. But now, the tokens you get will be worth one penny each, so you can still earn the same amount of money. Work hard and see if you can get all the tokens." Training under the intermittent schedule of consequences continued until a subject responded correctly on 95-100% of the 84 trials for three consecutive sessions.

Testing Procedures

The intermittent schedule remained in effect throughout subsequent test sessions. Each of the test sessions involved 72 A-B matching trials plus 12 randomly interspersed no-feedback probe trials. Test sessions were introduced without explanation. Inquiries regarding the new stimulus configurations resulted in the experimenter saying, "I'm sorry, we can't talk about it now." A single test session was conducted each day. Although unnecessary in this study, provisions were made for additional training had A-B matching accuracy fallen below 95% correctness during test sessions.

Rationale. The overall objective of the test sessions was to evaluate the possible emergence of stimulus equivalence and to assess the nature of the "rules" governing the trained and equivalent matching behavior. Conceptually, the assessment of stimulus equivalence is relatively straightforward and will be considered later (Test 1). However, before detailing Tests 2-9, an overview of the repeated testing strategy is warranted.

The tests organized under Series I and II evaluated the notion that nonidentity matching may be characterized by sets of S+ and S- rules, respectively. Series III and IV asked whether similar rules were evidenced in the equivalent B-A relations. As shown in Figures

1 and 2, each series was comprised of a test for control by matching or nonmatching stimuli over novel comparisons (Tests 2, 4, 6, and 8), and a test designed to evaluate any preferential responding when the novel comparisons were pitted against each other in the presence of familiar samples (Tests 3, 5, 7, and 9). Table 2 shows that these preference tests were administered before and after the tests for stimulus control. This design feature was incorporated in light of some preliminary findings which suggested that subjects may demonstrate conditional discriminative responding during nonreinforced preference tests. For example, a subject might consistently select N1 when exposed to the novel comparisons N1 and N2 in the presence of A1; while in the presence of A2, always choose N2 (Test 3). The emergence of nonreinforced categorization was used to further demonstrate stimulus control. For instance, if the above preferences were evident, the subsequent test for control by matching stimuli (Test 2) attempted to shift control <u>away from</u> the preferred novel comparisons. Thus, in the presence of A1 and the preferred N1, would responses occur to the matching comparison B1? Similarly, would B2 be consistently selected given A2 and N2? Such an outcome was expected if a subject had indeed acquired a set of S+ rules during the A-B training.

To carry the example further, suppose a test for control by nonmatching stimuli (Test 4) was conducted following conditional responding during a preference test (Test 5). That is, the subject always responded to N3 given sample A1, and selected N4 with sample A2. The test for control by nonmatching stimuli would present trials involving

A1 as the sample and B2 and N4 as comparisons, and A2 along with B1 and N3. Responding according to S- rules would predict that the novel comparisons would be selected during this test, even though the sample-novel comparison arrangements were previously found to be least preferred. The logic developed here will receive further elaboration.

During all tests, transfer was considered evident if performance on the test trials was comparable to accuracy levels achieved during the criterion A-B matching training. Specifically, the criterion for transfer required that at least 10 of 12 comparison responses (83-100%) were in the predicted direction. The probability of two or fewer incorrect selections on a 12-trial test is equal to or less than .016 (binomial test).

Test 1: B-A matching (test for equivalence). Test 1 was used to evaluate the possibility that A-B training produced an equivalence between samples and comparisons. As shown in Figures 1 and 2, this condition constituted a test for the reversibility of the A-B association: B1 and B2 were presented as samples and A1 and A2 as comparisons. Will subjects select A1 given B1, and choose A1 in the presence of B2? Test 1 trials may be denoted as: B1(A2, A1) B2(A1,A2).

Tests 2 and 6: Control by matching stimuli with novel comparisons. The purpose of Test 2 was to assess the extent to which the original A-B training established sets of S+ rules. Test 2 trials took the basic form of: A1(N1, B1) A2(N2, B2). Test 6 provided a similar analysis under the equivalent B-A condition: B1(N5, A1)

B2(N6, A2). During either test, subjects were expected to continue to match appropriate B or A comparisons.

Tests 4 and 8: Control by nonmatching stimuli with novel comparisons. Test 4 evaluated the degree of S- control exerted by the nonmatching stimuli encountered during A-B training. Thus, when presented with trials A1(B2, N3) A2(B1, N4), subjects should consistently select the novel comparisons if operating under an S- rule. Test 8 asked the same question concerning the B-A relation. Test 8 configurations were B1(A2, N7) B2(A1, N8).

Tests 3, 5, 7, and 9: Control by A and B samples over novel comparisons. As discussed earlier, these tests served as control measures for any untrained preferences shown over the novel comparisons in the presence of A or B samples. In each test, subjects were given a trained sample and the two novel comparisons used for that particular test, e.g., A1(N1, N2) A2(N1, N2) were the trial configurations for Test 3. Figures 1 and 2 illustrate some of the stimuli comprising these tests.

Besides the trial configurations mentioned previously, alternative arrangements of comparison stimuli were used. For example, Test 2 was presented in one of two ways during the repeated testing: 1) A1(N1, B1) A2(N2, B2), or 2) A1(N2, B1) A2(N1, B2). Subjects were confronted with one or both alternatives, depending on their performance during the prior preference testing. The reason for this was alluded to earlier. During the preference tests, subjects could show conditional responding to the novel comparisons. Thus, when a test for sample-comparison control was administered, the novel comparisons were arranged in an attempt to shift these preferences. To restate the strategy, in the case of the S+ rule analysis, preferred novel stimuli were combined with matching (trained or equivalent) samples and comparisons. However, a test for the S- rule involved the nonpreferred novel comparisons in conjunction with the nonmatching stimuli.

Results

Acquisition of A-B Matching

All subjects evidenced rapid acquisition of A-B matching. DW and JT met criterion on the first A-B task (Set I stimuli) within the minimum four sessions, ED and JL took five sessions each to reach criterion. All subjects met criterion on the second A-B problem (Set II stimuli) within four sessions. Throughout all test sessions, trained A-B matching performance was unimpaired, never diminishing below 96% accuracy. The percentages denoted within parentheses in Table 3 depict representative A-B accuracy levels achieved during test sessions.

Test Sessions

Table 3 illustrates the critical test data obtained from the experiment. Recall that each test session involved 72 trained A-B trials and 12 nonreinforced test trials.

Test 1. This test examined the extent to which the trained A-B relations were equivalent within the framework of sample-comparison

Table 3

Experiment 1 results: Tests for equivalence (Test 1), and control by matching (Tests 2 and 6) and nonmatching (Tests 4 and 8) stimuli are summarized. Tests listed in third and fourth positions were administered after training the second matching problem. Percentages in parentheses depict performance during the trained A-B trials.

Subjects/ Test Order		Test 1: % B-A Matching	Test 2: % A-B Matching with Novel Incorrect Comparisons	Test 4: % Selection of Novel Comparisons with Nonmatching A-B Stimuli	Test 6: % B-A Matching with Novel Incorrect Comparisons	Test 8: % Selection of Novel Comparisons with Nonmatching B-A Stimuli
ED	1.	(100) 100	(99) 100	(100) 83	(99) 100	(99) 92
	2.	(100) 100	(100) 100	(99) 100	(99) 100	(100) 75
	3.	(97) 100	(97) 100	(99) 100	(100) 100	(100) 100
	4.	(100) 100	(99) 100	(99) 100	(100) 92	(100) 100
DW	1.	(99) 100	(99) 100	(99) 100	(97) 100	(99) 100
	2.	(97) 92	(100) 100	(99) 100	(99) 100	(99) 100
	3.	(100) 100	(100) 92	(99) 100	(100) 100	(99) 100
	4.	(98) 100	(100) 100	(97) 100	(96) 100	(99) 100
JT	1.	(100) 100	(100) 100	(99) 100	(100) 100	(100) 100
	2.	(100) 100	(100) 100	(96) 100	(99) 100	(100) 100
	3.	(100) 100	(99) 100	(99) 100	(100) 100	(100) 100
	4.	(100) 100	(100) 100	(99) 100	(97) 100	(100) 100
JL	1.	(100) 100	(99) 100	(99) 83	(100) 100	(100) 100
	2.	(100) 100	(97) 100	(100) 100	(99) 100	(100) 100
	3.	(100) 100	(100) 100	(100) 100	(100) 100	(100) 100
	4.	(100) 92	(97) 100	(100) 100	(99) 100	(100) 100

reversibility: i.e., B-A matching. Table 3 discloses that such reversibility uniformly occurred across all subjects; B-A matching was perfect during 14 of 16 administrations of the test. In the remaining two sessions, DW and JL matched 92% of the B-A configurations (11/12 trials).

Tests 2 and 4. During Test 2, subjects were given the trained A-B samples and comparisons in conjunction with novel stimuli as alternate comparisons. Table 3 reveals that the insertion of these novel comparisons had virtually no effect on appropriate matching. Test 4 involved the A samples and nonmatching B comparisons, along with novel comparisons. Under this test, the subjects reliably selected the novel comparisons.

Tests 6 and 8. Tests 6 and 8 were analogous to the foregoing test conditions but examined the degree of control exerted by the equivalent B-A matching and nonmatching configurations. The results of Test 6 demonstrated that the subjects appropriately matched B-A stimuli given novel incorrect comparisons. Test 8 showed that except for ED's second exposure to the test, there was a marked tendency to select the novel comparisons instead of the nonmatching B stimuli.

Representative test series. Table 4 depicts exemplar sequences of preference tests and tests for control by matching and nonmatching stimuli. As earlier described, and as shown in this table, a given test series either began with a preference test or a test for stimulus control. Also illustrated in this table is the strategy of arranging the specific configurations of Tests 2, 4, 6, or 8 depend-

Table 4

Experiment 1 results: Percentages of comparison selection during representative tests for control by matching or nonmatching stimuli, and their respective preference tests (Tests 3, 5, 7, and 9). Percentages in parentheses depict performance during the trained A-B trials.

Subjects/ Session #		Test Configurations and % Comparison Selection					Subjects/ Session #		Test Configurations and % Comparison Selection				
		Series I							Series III				
ED	7	Test 2:	A1(N1, B1)		A2(N2, B2)		JT	32	Test 6:	B1(N5, A1)		B2(N6, A2)	
		(99)	0	100	0	100			(100)	0	100	0	100
	8	Test 3:	A1(N1, N2)		A2(N1, N2)			33	Test 7:	B1(N5, N6)		B2(N5, N6)	
		(99)	100	0	0	100			(99)	0	100	83	17
	9	Test 2:	A1(N1, B1)		A2(N2, B2)			34	Test 6:	B1(N6, A1)		B2(N5, A2)	
		(100)	0	100	0	100			(97)	0	100	0	100
	10	Test 3:	A1(N1, N2)		A2(N1, N2)			35	Test 7:	B1(N5, N6)		B2(N5, N6)	
		(100)	100	0	0	100			(100)	0	100	100	0

Table 4 (Continued)

Subjects/ Session #		Test Configurations and % Comparison Selection		
		Series II		
DW	5	Test 5: (100)	A1(N3, N4) 17 83	A2(N3, N4) 67 33
	6	Test 4: (99)	A1(B2, N3) 0 100	A2(B1, N4) 0 100
	7	Test 5: (100)	A1(N3, N4) 100 0	A2(N3, N4) 0 100
	8	Test 4: (99)	A1(B2, N4) 0 100	A2(B1, N3) 0 100

Subjects/ Session #		Test Configurations and % Comparison Selection		
		Series IV		
JL	42	Test 9: (100)	B1(N7, N8) 50 50	B2(N7, N8) 33 67
	43	Test 8: (100)	B1(A2, N8) 0 100	B2(A1, N7) 0 100
	44	Test 9: (99)	B1(N7, N8) 33 67	B2(N7, N8) 50 50
	45	Test 8: (100)	B1(A2, N7) 0 100	B2(A1, N8) 0 100

ing on an individual subject's preference performance. For example, consider Series III by JT. The series commenced with Test 6 and JT appropriately selected the matching A comparisons 100% of the time. In the subsequent Test 7, JT showed a consistent "conditional" preference: N6 was always chosen when B1 was the sample, and N5 was selected five out of six times (83%) when B2 was the sample. The next administration of Test 6, then, pitted the preferred novel comparisons against the equivalent A comparisons; JT again selected the A comparisons over the novel stimuli. Finally, another Test 7 session confirmed the subject's conditional preference performance when novel comparisons alone were presented.

The Series II results by DW further exemplify the strategy of sequencing test conditions. DW began the series with a preference test, Test 5. Moderate conditional preferences were shown: N4 was selected 83% of the time (5/6 trials) in the presence of A1, and N3 67% of the time (4/6 trials) given sample A2. Since Test 4 (or Test 8) was concerned with the degree of responding to novel stimuli, the less preferred novel stimuli were combined with the nonmatching A-B stimuli. As shown, DW chose the novel comparisons 100% of the time. During the subsequent Test 5, DW evidenced a shift in preferences, consequently, the final Test 4 involved the most recently nonpreferred novel comparisons. Again, however, when the nonmatching A-B samples and comparisons were presented, DW responded away from the B comparisons and selected the novel stimuli.

The conditional preferences illustrated in Table 4, and particularly the shift in preferences shown by DW, were not uniformly reliable phenomena. Subjects often showed a stimulus preference or resorted to some undetectable alternation strategy. (Session-by-session test results may be found in Appendix B.)

Discussion

The present test data substantiate the conclusion that the subjects learned complementary sets of S+ and S- rules as a result of the A-B matching training, a finding congruent with analyses of identity matching behavior (Dixon & Dixon, 1978, Note 1). These rules were evident given either the trained A-B configurations, or the equivalent B-A stimuli. In both cases, novel comparisons were rejected when the matching samples and comparisons were available, but the novel comparisons were consistently selected when the non-matching stimuli were presented.

An order effect may be implicated with respect to the rule governed behavior demonstrated in B-A matching: Tests for S+ and S- responding always followed equivalence tests. Though B-A matching went unreinforced, it may be argued that this test experience somehow fostered the observed control in the presence of novel comparisons. Consequently, Experiment 2 controlled for this possibility.

CHAPTER V

EXPERIMENT 2: CONTROL BY MATCHING AND NONMATCHING STIMULI IN MEDIATED STIMULUS EQUIVALENCES

Introduction

The results of Experiment 1 suggested that the process of acquiring the A-B matching task involved learning complementary sets of S+ and S- rules. That is, on a given trial, the sample stimulus presumably served a twofold function: It instructed the subject as to which comparison was the S+, and the comparison that functioned as the S-. Moreover, this dual sample control was found to exist in the equivalent B-A relation. The present experiment analyzed the possibility that such differential control by matching and nonmatching stimuli also characterizes stimulus equivalences established via mediated transfer. Equivalent associations demonstrated under the stimulus equivalence, response equivalence, and chaining transfer paradigms were subjected to analysis. Secondarily, stimulus equivalences as determined by sample-comparison reversibility were also evaluated in this experiment. This was done simply to determine if reversibility and mediated transfer necessarily occur together.

Method

Subjects and Apparatus

The 12 male participants in this experiment were divided into three groups. Each group was composed of three naive members and one from Experiment 1. The apparatus remained the same.

Design

Figures 3 and 4 illustrate representative training and testing conditions for Experiment 2. The three groups differed with respect to the type of training and transfer paradigm used: Group 1, stimulus equivalence; Group 2, response equivalence; and Group 3, chaining. Use of the three paradigms controlled for potential biases when samples <u>or</u> comparisons were used as the associative stimuli. Within each group, the experimental strategy was similar to Experiment 1: Two matching tasks were trained, each followed by series of test sessions. Two members of each group; MP and JL, JC and LM, and LH and GC were first trained and tested with Set IIIa stimuli; then Set IVa. The remaining subjects; JK and LE, DW and NO, and AP and ED were first assigned to Set IIIb; then Set IVb. As in Experiment 1, half the subjects (JL, LE, LM, NO, GC, and ED) were exposed to sample-comparison configurations that were the reverse of those illustrated in the figures. Table 5 overviews the sequence of conditions that occurred for each subject.

Group 1 Procedures: Stimulus Equivalence Paradigm

Sessions were again conducted six days per week, but terminated after 168 trials. The previously described token exchange ratios, trial procedures, and consequences were used.

<u>Train A-B, C-B matching</u>. Figure 3 depicts the four types of

Figure 3. Representative stimuli (Sets IIIa and IIIb) used during the initial training and testing conditions in Experiment 2 for Group 1 subjects (Stimulus Equivalence). The letter/number designations correspond to the trial notation used in Tables 6 and 7. Group 2 (Response Equivalence) and Group 3 (Chaining) were also initially exposed to these stimuli, but in combinations appropriate for their respective paradigms. See Figure 1 for details.

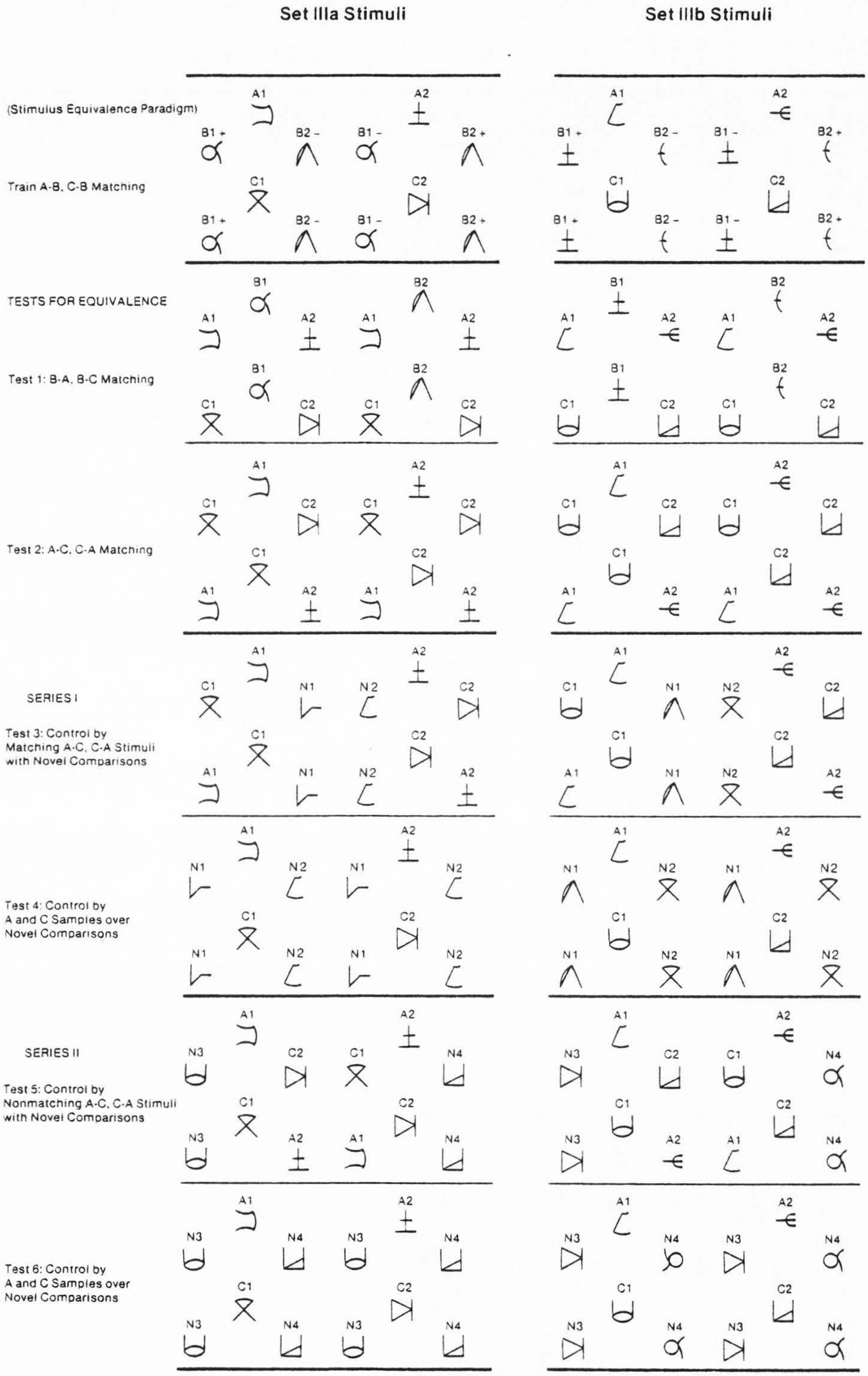

Set IIIa Stimuli
Set IIIb Stimuli
(Stimulus Equivalence Paradigm)
Train A-B, C-B Matching
TESTS FOR EQUIVALENCE
Test 1: B-A, B-C Matching
Test 2: A-C, C-A Matching
SERIES I
Test 3: Control by Matching A-C, C-A Stimuli with Novel Comparisons
Test 4: Control by A and C Samples over Novel Comparisons
SERIES II
Test 5: Control by Nonmatching A-C, C-A Stimuli with Novel Comparisons
Test 6: Control by A and C Samples over Novel Comparisons
A1
A2
B1 +
B2 -
B1 -
B2 +
C1
C2
B1
B2
N1
N2
N3
N4

Figure 4. Representative stimuli (Sets IVa and IVb) used during the replication sequence of training and testing conditions in Experiment 2 for Group 2 (Response Equivalence) and Group 3 (Chaining). The replication conditions for Group 1 (Stimulus Equivalence) utilized different combination of these stimuli. The trial notation depicted in Tables 6 and 7 corresponds to the letter/number assignments illustrated. See Figure 1 for details.

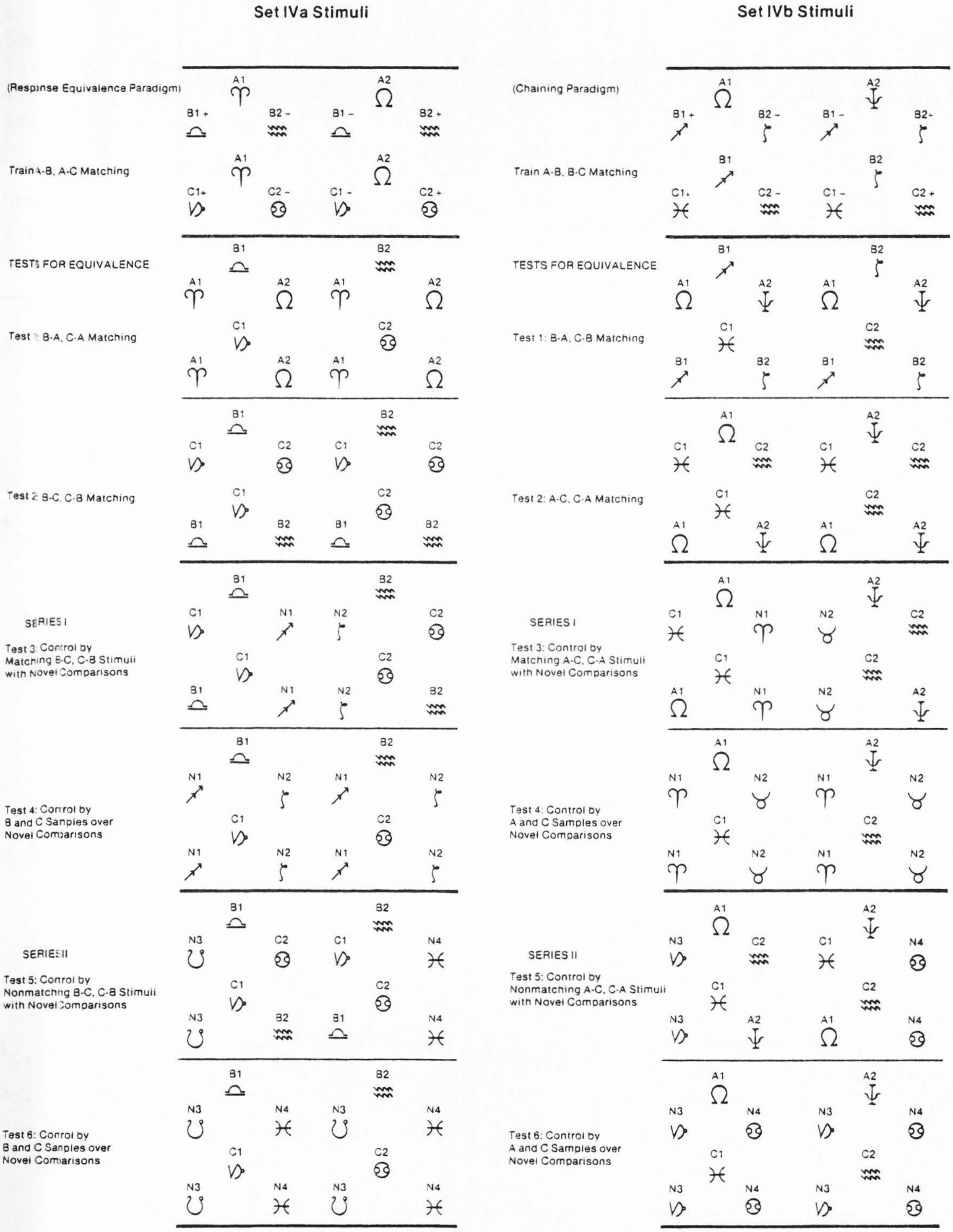

Set IVa Stimuli
Set IVb Stimuli
(Response Equivalence Paradigm)
(Chaining Paradigm)
Train A-B, A-C Matching
Train A-B, B-C Matching
TESTS FOR EQUIVALENCE
Test 1: B-A, C-A Matching
Test 1: B-A, C-B Matching
Test 2: B-C, C-B Matching
Test 2: A-C, C-A Matching
SERIES I
Test 3: Control by Matching B-C, C-B Stimuli with Novel Comparisons
Test 3: Control by Matching A-C, C-A Stimuli with Novel Comparisons
Test 4: Control by B and C Samples over Novel Comparisons
Test 4: Control by A and C Samples over Novel Comparisons
SERIES II
Test 5: Control by Nonmatching B-C, C-B Stimuli with Novel Comparisons
Test 5: Control by Nonmatching A-C, C-A Stimuli with Novel Comparisons
Test 6: Control by B and C Samples over Novel Comparisons
Test 6: Control by A and C Samples over Novel Comparisons

Table 5

Sequence of conditions for subjects of Experiment 2. Tests 1-6 are listed in their order of occurrence for each subject. Figures 3 and 4 illustrate stimulus configurations corresponding to the training and testing conditions for the subjects of each group.

Grp 1:	MP	JK	JL	LE
Grp 2:	JC	DW	LM	NO
Grp 3:	LH	AP	GC	ED
1. Train[a]:				
A-B, C-B Matching (Grp 1) A-B, A-C Matching (Grp 2) A-B, B-C Matching (Grp 3)				
2. Administer Tests[a]:				
	1	4	2	6
	2	3	1	5
		4		6
	3	3	5	5
	4		6	
	3	2	5	1
	4	1	6	2
	2	5	1	3
	1	6	2	4
		5		3
	6	6	4	4
	5		3	
	6	1	4	2
	5	2	3	1

Grp 1:	MP	JK	JL	LE
Grp 2:	JC	DW	LM	NO
Grp 3:	LH	AP	GC	ED
3. Train[b]:				
A-B, C-B Matching (Grp 1) A-B, A-C Matching (Grp 2) A-B, B-C Matching (Grp 3)				
4. Administer Tests[b]:				
	5	1	3	2
	6	2	4	1
	5		3	
	6	6	4	4
		5		3
	2	6	1	4
	1	5	2	3
	4	2	6	1
	3	1	5	2
	4		6	
	3	3	5	5
		4		6
	1	3	2	5
	2	4	1	6

[a]Stimulus Sets IIIa and IIIb were used for the initial conditions.

[b]Stimulus Sets IVa and IVb were used for the replication conditions.

training configurations that comprised the criterion A-B, C-B discrimination. Consistent with the previous notation system, the four trials were: A1(B2, B1*) A2(B1, B2*) C2(B1, B2*). In short, subjects were reinforced for selecting the comparison B1, when A1 and C1 were presented as samples, and for responding to B2, given the samples A2 and C2. Terminal performance was accomplished in three phases: First, subjects were trained on a 168-trial A-B matching problem to a criterion of 95-100% correct responding for one session under continuous feedback. Second, subjects were exposed to a 168-trial mixture of 84 A-B trials and 84 C-B trials. Instructions essentially identical to those in Experiment 1 were used to introduce each of the first two phases. The A-B, C-B training continued until one session of 95-100% correct matching occurred. Finally, the intermittent contingencies were instated and continued until three consecutive sessions occurred with 95-100% correct matching.

Test sessions. As before, the intermittent schedule of feedback remained in effect throughout testing. All test sessions described next consisted of 168 trials: 144 A-B, C-B trials, and 24 nonreinforced probes. Figure 3 outlines the sample and comparison stimuli that comprised the probe trials inserted during the various tests.

Tests 1 and 2: Tests for equivalences. Stimulus equivalence was evaluated in two ways for the three groups of this experiment. As in Experiment 1, Test 1 constituted a reversibility test of the trained samples and comparisons: For Group 1, this involved the trials

B1(A2, A1) B2(A1, A2) B1(C2, C1) B2(C1, C2). Interspersed among the 144 trained A-B, C-B trials were 12 B-A trials and 12 B-C trials. Test 2 assessed the formation of stimulus equivalences in terms of mediated transfer. Accordingly, Group 1 received the following 12 A-C and 12 C-A trials intermixed with the trained trials: A1(C2, C1) A2(C1, C2) C1(A2, A1) C2(A1, A2).

Tests 3 and 5: Control by matching and nonmatching stimuli with novel comparisons. Once again, there were two versions of both Test 3 and Test 5 so that any conditional preferences shown during Tests 4 and 6 could be explicitly arranged for the purpose of testing stimulus control. Test 3 probed for the existence of S+ control in the indirect associations A-C and C-A: e.g., A1(N1, C1) A2(N2, C2) C1 (N1, A1) C2(N2, A2). Thus, when given the sample A1 and the comparisons C1 and N1, will subjects select C1? Alternately, given C2 as the sample plus comparisons A2 and N2, will A2 be chosen? These questions are analogous to those asked in Tests 2 and 6 of Experiment 1. In a similar vein, Test 5 for Group 1 probed for control by nonmatching A-C, C-A stimuli: e.g., A1(C2, N3) A2(C1, N4) C1(A2, N3) C2(A1,N4). Consistent with the logic of Tests 4 and 8 of Experiment 1, subjects were expected to select the novel comparisons consistently.

Tests 4 and 6: Control by A and C samples over novel comparisons. The stimulus arrangements for Tests 4 and 6, and their order of occurrence across subjects are summarized in Figure 3 and Table 5, respectively. The rationale and procedures for administration were identical to those used in Experiment 1 for Tests 3, 5, 6, and 9. Each test involved 12 trials with A as the sample, and 12 trials with C as the sample: e.g., for Test 4 the trials A1(N1, N2) A2(N1, N2) C1(N1, N2) C2(N1, N2) were used.

Group 2 Procedures: Response Equivalence Paradigm

Train A-B, A-C matching. Figure 4 shows the types of stimuli that were used with Group 2. Criterion A-B, A-C matching was trained in the manner described for Group 1. Considering the paradigm differences, however, subjects here were taught to select B1 and C1 when given sample A1, and to choose B2 and C2 when sample A2 was displayed: A1(B2, B1*) A2(B1, B2*) A1(C2,C1*) A2(C1, C2*).

Test sessions. Figure 4 and Table 5 summarize the test procedures. Each test corresponded exactly to its numerical counterpart for Group 1 in terms of conceptualization and administration, but, of course, the specific stimuli differed. The test for reversibility (Test 1) involved B-A and C-A trials; and the test for mediated transfer (Test 2) probed with B-C and C-B trials. Subsequently, Tests 3 and 5 were used to ascertain whether or not S+ and S- rules existed in the B-C and C-B associations. Appropriate preference tests (Tests 4 and 6) intervened.

Group 3 Procedures: Chaining Paradigm

Figure 4 and Table 5 provide the essential information regarding the manipulations conducted with Group 3. All training and testing procedures were identical to those described for Groups 1 and 2. The factor that differentiated this group from the others was the nature of the matching training prior to testing. Under the chaining paradigm, subjects were trained to select B1 in the presence of A1, and B2 when A2 was displayed. Concurrently, with B1 as the sample, subjects were reinforced for selecting C1, and C2 was the correct selection given sample B2. The chaining procedure may be denoted: A1(B2, B1*) A2(B1, B2*) B1(C2, C1*) B2(C1, C2*).

Results

Group 1: Acquisition of Matching

According to the stimulus equivalence paradigm, Group 1 subjects were required to learn A-B, C-B matching tasks prior to the various test sessions. Each subject learned two matching problems. In order to meet criterion level matching, a minimum of five sessions was required. The subjects took the following number of sessions to acquire the first and second matching tasks, respectively: MP, 9-7; JK, 6-8; JL, 8-6; and LE, 14-9. As indicated in Table 6 (percentages in parentheses), performance during the trained A-B, C-B trials remained high (97-100%) throughout all test sessions, including the intervening preference tests.

Group 1: Test Sessions

Table 6 summarizes the essential findings from the test sessions conducted with Group 1. The 24 test trials within each test were equally divided between the two types of configurations relevant to

Table 6

Experiment 2 results: Tests for equivalence (Tests 1 and 2), and control by matching (Test 3) and nonmatching (Test 5) stimuli are summarized. See Table 3 for details.

Subjects/ Test Order		Test 1: % Sample-Comparison Reversibility			Test 2: % Mediated Matching			Test 3: % Mediated Matching with Novel Incorrect Comparisons			Test 5: % Selection of Novel Comparisons with Nonmatching Mediated Stimuli		
Grp 1: (A-B, C-B Trn'd)			B-A	B-C		A-C	C-A		A-C	C-A		A-C	C-A
MP	1.	(100)	92	92	(99)	58	33	(100)	50	42	(99)	67	58
	2.	(99)	50	50	(99)	50	50	(99)	58	50	(97)	67	67
	3.	(100)	50	50	(100)	67	33	(99)	50	50	(99)	67	75
	4.	(99)	50	50	(100)	50	50	(100)	50	50	(100)	50	50
JK	1.	(99)	100	92	(99)	100	100	(99)	100	100	(98)	100	100
	2.	(97)	100	100	(99)	92	100	(100)	100	100	(97)	100	100
	3.	(97)	100	92	(97)	100	92	(99)	100	100	(99)	100	100
	4.	(100)	100	100	(99)	100	100	(99)	100	100	(99)	100	100
JL	1.	(100)	100	100	(100)	100	100	(100)	100	100	(100)	100	100
	2.	(99)	100	100	(99)	100	100	(99)	100	100	(100)	100	100
	3.	(98)	92	100	(99)	83	100	(99)	100	100	(99)	100	92
	4.	(99)	100	100	(100)	100	100	(99)	100	100	(99)	100	100
LE	1.	(99)	100	100	(99)	83	83	(97)	83	92	(100)	100	92
	2.	(99)	100	100	(99)	100	92	(100)	100	100	(100)	100	92
	3.	(100)	92	100	(99)	92	100	(99)	100	100	(98)	100	100
	4.	(99)	100	100	(99)	92	100	(97)	100	100	(99)	92	100

Table 6 (Continued)

Subjects/ Test Order		Test 1: % Sample-Comparison Reversibility			Test 2: % Mediated Matching			Test 3: % Mediated Matching with Novel Incorrect Comparisons			Test 5: % Selection of Novel Comparisons with Nonmatching Mediated Stimuli		
Grp 2: (A-B, A-C Trn'd)			B-A	C-A		B-C	C-B		B-C	C-B		B-C	C-B
JC	1.	(100)	100	100	(100)	100	100	(100)	100	100	(99)	100	100
	2.	(99)	100	100	(98)	100	100	(99)	100	100	(98)	100	100
	3.	(100)	100	100	(99)	100	100	(99)	100	100	(99)	100	100
	4.	(100)	100	100	(99)	100	100	(99)	100	100	(99)	100	100
DW	1.	(99)	100	100	(100)	100	100	(99)	100	100	(100)	100	100
	2.	(99)	100	100	(99)	100	100	(99)	100	100	(100)	100	100
	3.	(99)	100	100	(100)	100	100	(99)	100	100	(100)	100	100
	4.	(100)	100	100	(100)	100	100	(100)	100	100	(99)	100	100
LM	1.	(99)	100	100	(99)	33	50	(99)	100	100	(98)	0	0
	2.	(98)	100	100	(96)	83	100	(99)	100	100	(99)	50	42
	3.	(99)	100	100	(100)	92	100	(98)	100	100	(99)	92	92
	4.	(99)	100	100	(98)	100	92	(98)	100	100	(98)	100	92
NO	1.	(99)	100	100	(100)	100	100	(99)	100	100	(100)	100	100
	2.	(99)	100	100	(99)	100	100	(99)	100	100	(100)	100	100
	3.	(99)	100	100	(100)	100	100	(100)	100	100	(99)	92	100
	4.	(100)	100	100	(100)	100	100	(99)	100	100	(99)	100	100

Table 6 (Continued)

Subjects/ Test Order		Test 1: % Sample-Comparison Reversibility			Test 2: % Mediated Matching			Test 3: % Mediated Matching with Novel Incorrect Comparisons			Test 5: % Selection of Novel Comparisons with Nonmatching Mediated Stimuli		
Grp 3: (A-B, B-C Trn'd)			B-A	C-B		A-C	C-A		A-C	C-A		A-C	C-A
LH	1.	(100)	100	100	(99)	100	100	(99)	100	100	(100)	100	100
	2.	(99)	100	100	(100)	100	100	(99)	100	100	(99)	100	100
	3.	(99)	100	100	(100)	100	100	(99)	92	100	(100)	100	92
	4.	(100)	100	100	(100)	100	100	(100)	100	92	(100)	100	100
AP	1.	(100)	92	92	(99)	83	83	(99)	100	83	(98)	58	58
	2.	(96)	92	100	(98)	83	92	(99)	92	92	(99)	67	75
	3.	(100)	100	100	(99)	92	100	(99)	100	100	(99)	100	100
	4.	(100)	100	100	(97)	92	100	(100)	92	100	(99)	92	100
GC	1.	(99)	100	83	(97)	100	83	(99)	92	92	(98)	100	100
	2.	(98)	100	100	(98)	100	100	(99)	92	92	(100)	100	100
	3.	(99)	100	100	(99)	100	100	(100)	100	100	(99)	100	100
	4.	(97)	92	100	(98)	100	100	(99)	100	92	(98)	100	100
ED	1.	(100)	100	92	(100)	92	92	(100)	100	100	(98)	100	92
	2.	(99)	100	100	(99)	100	92	(99)	100	100	(97)	92	92
	3.	(100)	75	92	(99)	92	83	(99)	100	100	(99)	100	100
	4.	(97)	83	92	(98)	100	92	(99)	100	92	(99)	100	92

each test. Each percentage is based on the 12 trials pertaining to that type of test. Note that each test was administered four times. The first and second administrations followed the initial matching training; the third and fourth after learning the second matching task.

Tests 1 and 2. As in Experiment 1, Test 1 probed for the existence of sample-comparison reversibility, but here B-A and B-C trials were involved. As shown in Table 6, three of four subjects showed consistent B-A and B-C matching under this test. The fourth subject, MP, evidenced appropriate reversibility on 92% of the probe trials during the first Test 1, then declined to chance level during the remaining tests. Test 2 constituted the assessment for mediated transfer of matching and the results of three subjects showed clear evidence for such transfer. MP, however, responded at or near chance level during all mediated transfer tests.

Tests 3 and 5. Test 3 was similar to Experiment 1 probes for control by matching stimuli. Here, however, the analysis was performed with the samples and comparisons involved in the mediated transfer test. Thus, the subjects were given the matching A-C and C-A stimuli along with novel comparisons. The three subjects that showed mediated transfer also matched appropriately under this test. The performance of MP was again at chance level. Test 5 attempted to determine if the nonmatching A-C and C-A stimuli would control responses to novel comparisons. The three subjects who showed appropriate control in Tests 2 and 3 consistently responded as predicted. With one exception, MP's selection accuracy was at chance level throughout the Test 5 sessions.

Group 2: Acquisition of Matching

Group 2 subjects were exposed to the response equivalence paradigm. The criterion level task involved A-B, A-C matching. The first matching problem was acquired in 7, 6, 8, and 5 sessions by JC, DW, LM, and NO, respectively. All subjects achieved the second matching task within the minimum five sessions. As shown in Table 6 (percentages in parentheses), matching accuracy on the trained A-B, A-C trials never fell below criterion during subsequent test sessions.

Group 2: Test Sessions

Table 6 depicts the test results for Group 2. All tests were conceptually similar to those used with Group 1. All subjects showed perfect reversibility under Test 1. Additionally, the results of three subjects (JC, DW, and NO) are consistent with the majority of Group 1 subjects. These subjects all evinced uniform mediated transfer (Test 2); and evidenced mediated matching given novel comparisons (Test 3). These subjects also reliably selected the novel comparisons when combined with the nonmatching B-C and C-B stimuli (Test 5). LM's performance under Test 2 and 5 deviated from that of the other subjects. Evidence for mediated transfer occurred only during the second and subsequent administrations of Test 2. Under Test 5, LM began by always rejecting the novel stimuli, then performed at chance level. During the last two administrations of Test 5, LM responded reliably to the novel comparisons.

Group 3: Acquisition of Matching

Group 3 also learned two matching problems, but under the chaining paradigm: A-B, B-C matching. Overall, acquisition for this group compared favorably to Groups 1 and 2. LH required 6 sessions to learn the first matching task and 5 for the second; AP, 10 and 6; GC, 11 and 9; and ED, 5 and 9 sessions. Throughout all subsequent test sessions performance during the trained matching problems remained uniformly high (96-100%), as shown in Table 6 for Group 3.

Group 3: Test Sessions

The bulk of the test data shown in Table 6 for Group 3 is consistent with that produced by Groups 1 and 2. Except for ED's third exposure to Test 1, sample-comparison reversibility was amply demonstrated by all subjects, as well as mediated transfer (Test 2). During Tests 3 and 5, these subjects also replicated previous findings: Mediated transfer occurred with novel incorrect comparisons available, and novel comparisons were consistently chosen when non-matching stimuli were presented. AP responded reliably to the novel stimuli during Test 5 after training on the second matching task.

Representative Test Series

Table 7 depicts select sequences of Series I and II tests for the three groups. Besides providing a more detailed account of Tests 3 and 5, Tests 4 and 6 are displayed. These test series again illus-

Table 7

Experiment 2 results: Percentages of comparison selection during representative tests for control by matching or nonmatching stimuli, and their respective preference tests (Tests 4 and 6). Percentages in parentheses depict performance during trained matching trials.

Subjects/ Session #		Test Configurations and % Comparison Selection				
		<u>Series I</u>: Grp 1 (A-B, C-B Trn'd)				
MP	12	Test 3:	A1(N1, C1)	A2(N2, C2)	C1(N1, A1)	C2(N2, A2)
		(100)	50 50	50 50	67 33	50 50
	13	Test 4:	A1(N1, N2)	A2(N1, N2)	C1(N1, N2)	C2(N1, N2)
		(100)	50 50	50 50	50 50	50 50
	14	Test 3:	A1(N2, C1)	A2(N1, C2)	C1(N2, A1)	C2(N1, A2)
		(99)	50 50	50 50	33 67	50 50
	15	Test 4:	A1(N1, N2)	A2(N1, N2)	C1(N1, N2)	C2(N1, N2)
		(98)	67 33	50 50	50 50	50 50
JK	7	Test 4:	A1(N1, N2)	A2(N1, N2)	C1(N1, N2)	C2(N1, N2)
		(99)	0 100	100 0	0 100	83 17
	8	Test 3:	A1(N2, C1)	A2(N1, C2)	C1(N2, A1)	C2(N1, A2)
		(99)	0 100	0 100	0 100	0 100
	9	Test 4:	A1(N1, N2)	A2(N1, N2)	C1(N1, N2)	C2(N1, N2)
		(98)	17 83	100 0	17 83	100 0
	10	Test 3:	A1(N2, C1)	A2(N1, C2)	C1(N2, A1)	C2(N1, A2)
		(100)	0 100	0 100	0 100	0 100
		<u>Series II</u>: Grp 2 (A-B, A-C Trn'd)				
LM	11	Test 5:	B1(C2, N3)	B2(C1, N4)	C1(B2, N3)	C2(B1, N4)
		(98)	100 0	100 0	100 0	100 0
	12	Test 6:	B1(N3, N4)	B2(N3, N4)	C1(N3, N4)	C2(N3, N4)
		(100)	100 0	33 67	83 17	67 33
	13	Test 5:	B1(C2, N4)	B2(C1, N3)	C1(B2, N4)	C2(B1, N3)
		(99)	0 100	100 0	17 83	100 0
	14	Test 6:	B1(N3, N4)	B2(N3, N4)	C1(N3, N4)	C2(N3, N4)
		(99)	0 100	0 100	0 100	0 100

Table 7 (Continued)

Subjects/ Session #		Test Configurations and % Comparison Selection			
NO	6	Test 6: (99)	B1(N3, N4) 100 0	B2(N3, N4) 0 100	C1(N3, N4) 100 0	C2(N3, N4) 0 100
	7	Test 5: (100)	B1(C2, N4) 0 100	B2(C1, N3) 0 100	C1(B2, N4) 0 100	C2(B1, N3) 0 100
	8	Test 6: (99)	B1(N3, N4) 0 100	B2(N3, N4) 100 0	C1(N3, N4) 0 100	C2(N3, N4) 100 0
	9	Test 5: (100)	B1(C2, N3) 0 100	B2(C1, N4) 0 100	C1(B2, N3) 0 100	C2(B1, N4) 0 100
		<u>Series I</u>: Grp 3 (A-B, B-C Trn'd)				
AP	11	Test 4: (96)	A1(N1, N2) 33 67	A2(N1, N2) 67 33	C1(N1, N2) 50 50	C2(N1, N2) 33 67
	12	Test 3: (99)	A1(N2, C1) 0 100	A2(N2, C2) 0 100	C1(N2, A1) 33 67	C2(N1, A2) 0 100
	13	Test 4: (100)	A1(N1, N2) 17 83	A2(N1, N2) 33 67	C1(N1, N2) 33 67	C2(N1, N2) 50 50
	14	Test 3: (99)	A1(N2, C1) 0 100	A2(N1, C2) 17 83	C1(N2, A1) 0 100	C2(N1, A2) 17 83
		<u>Series II</u>: Grp 3 (A-B, B-C Trn'd)				
ED	35	Test 5: (99)	A1(C2, N3) 0 100	A2(C1, N4) 0 100	C1(A2, N3) 0 100	C2(A1, N4) 0 100
	36	Test 6: (97)	A1(N3, N4) 83 17	A2(N3, N4) 17 83	C1(N3, N4) 50 50	C2(N3, N4) 17 83
	37	Test 5: (99)	A1(C2, N4) 0 100	A2(C1, N3) 0 100	C1(A2, N4) 0 100	C2(A1, N3) 17 83
	38	Test 6: (96)	A1(N3, N4) 83 17	A2(N3, N4) 67 33	C1(N3, N4) 83 17	C2(N3, N4) 50 50

trate the strategy of using preferential responding during Tests 4 and 6 to experimental advantage. For example, on Session 7, JK began the Series I sequence with a preference test, Test 4. JK showed novel comparison selection that was clearly under the control of the sample stimuli. That is, given samples A1 and C1, N2 was chosen; whereas, given A2 and C2, N1 was selected all but once. The subsequent Test 3 demonstrated that the presence of the matching stimuli resulted in a dramatic shift in comparison selection. These effects were replicated during a readministration of the two tests. As illustrated by ED, the tactic for evaluating control by nonmatching stimulus equivalents (Series II tests) differed. On Session 35, ED was given Test 5 and consistently selected the novel comparisons in configurations which also involved the matching A-C and C-A stimuli. Some degree of preferential responding was then found under Test 6. The next administration of Test 5, then, evaluated if the nonmatching equivalents could effect a shift in responding to the novel stimuli, an outcome verified during Session 37. (Appendices C, D, and E contain complete descriptions and results for all test sessions for each subject.)

Discussion

Mediated associations were found to embody sample-comparison stimulus control consistent with the S+ and S- rule distinction. The 11 of 12 subjects who showed consistent mediated transfer also evinced that: a) The equivalent stimuli were matched when novel comparisons were available (Test 3); and b) the presence of nonequivalent samples and comparisons controlled responding to novel comparisons (Test 5). Thus, such dual control is not restricted to associations directly trained or their reversible counterparts, as determined in Experiment 1. Apparently, these indirect equivalents and their twofold function can be brought about under at least three fundamental associative learning paradigms: stimulus equivalence, response equivalence, or chaining. All training procedures appeared equally efficient in this regard.

The emergence of mediated transfer and differential stimulus control were not universal phenomena in this experiment. The Test 1 and 2 results of MP and LM suggest that there are some circumstances where sample-comparison reversibility will occur without necessarily leading to mediated transfer. The relationship between S+ and S- rule learning and mediated transfer is also unclear. MP, who showed no mediated transfer, also demonstrated little or no control by S+ and S- configurations. LM, on the other hand, showed mediated matching with novel comparisons present (Test 3), however, only after repeated training and testing, evidenced mediated transfer during Test 2 and control by nonmatching stimuli under Test 5.

CHAPTER VI

GENERAL DISCUSSION

The Formation of Stimulus Equivalences

Intellectually delayed humans were taught nonidentity matching-to-sample with visual stimuli. Contrary to the extant research with pigeons (Gray, 1966; Hogan & Zentall, 1977; Rodewald, 1974), test sessions confirmed the stimulus equivalence or single-rule (Carter & Werner, 1978) interpretation of the trained associations. At one level of analysis, the reversibility tests of Experiment 1 demonstrated that the two explicitly trained members of the stimulus classes were interchangeable: Following training on A-B configurations, the subjects correctly matched the B-A samples and comparisons. Thus, the stimuli originally used as comparisons effectively controlled matching to their respective class members when presented as samples for the first time. Experiment 2 evinced that three-member stimulus classes were established without direct training under three associative learning paradigms. Consequently, given a trained relationship between sample A and comparison B, a third stimulus, C, became an equivalent class member by direct training as a sample for B (stimulus equivalence); as a comparison for A (response equivalence); or as a comparison with B used as the sample (chaining). Stimulus equivalences were verified by appropriate sample-comparison matching between C and the third class member not directly encountered with C;

that is, A-C and C-A, B-C and C-B, and A-C and C-A matching, respectively. The comparable efficacy with which the three procedures generated mediated transfer extends previous analyses of response equivalence and chaining paradigms (Lazar, 1977; Sidman, 1971; Sidman & Cresson, 1973; Sidman et al., 1974).

In contrast to the findings of Spradlin et al. (1973), the present results demonstrated that mediated transfer was reliably achieved via minimal two-stage training. Spradlin et al. reported that two of three moderately retarded subjects trained under a response equivalence paradigm failed to evidence mediated transfer. Unlike the Spradlin et al. study, however, the present investigation maintained criterion level A-B performance while A-C matching was trained and the subsequent B-C and C-B test trials were administered. Thus, mediated transfer was not dependent upon long-term memory for earlier acquired matching associations. The intermixing of the various training and testing phases may have been an important factor in the initial establishment of mediated associations.

Sample-comparison reversibility might be considered a necessary prerequisite for the emergence of mediated transfer (Jenkins, 1963). The results of Experiment 2 lend some credence to this argument. All subjects who showed mediated transfer also evinced reversibility. However, the results of MP and LM illustrated cases where the reversibility of samples and comparisons, and mediated transfer were not perfectly correlated. From the present results it may be deduced that reversibility may be necessary but not sufficient for the emergence of mediation. Whether this finding reflects some basic difference between the two transfer tasks or methodological factors is an open question. Previous studies (Dixon & Spradlin, 1976; Lazar, 1977; Spradlin & Dixon, 1976) demonstrated that mediated transfer was not an immediate occurrence for all subjects. Extended testing or explicit training on reversed associations and several respresentative matching problems may be necessary to produce indirect stimulus equivalences with some subjects. For instance, had an attempt been made to maintain reversed matching during the mediation tests, MP might have also shown transfer. Likewise, continued training and exposure to the mediation test may have been responsible for LM's criterion level transfer. As Lazar (1977) surmised, acquisition of the different stages of matching might be relegated to simple rote learning without the employment of any logical problem solving strategy. This might be another way of saying that simple stimulus-response chains were learned or discriminations based on trial configurations. Unfortunately, evaluations of these alternatives were precluded in the present study and the results of previous research fail to shed any light on these questions. Parametric analyses of the stimulus and procedural variables that may contribute to the production of mediated transfer would have theoretical and pragmatic import. Since extra-experimental learning histories are obvious variables with older, more competent subjects, future research might profitably focus on persons who evidence severe linguistic deficits. Except for MP, all of the present subjects were relatively proficient in expressive language. They frequently engaged in spontaneous conversation with the experimenter and related detailed accounts of past and future activities. MP, however, displayed neither spontaneous expression, nor vocal imitation.

Stimulus Control by Samples and Comparisons

The evaluations for sample-comparison reversibility and mediated stimulus equivalences suggest a rather complex form of relational stimulus control was established with the present subjects. Further testing successfully elucidated some of the factors that may have contributed to such relational control. Apparently, as in trained identity matching (Dixon & Dixon, 1978, Note 1), arbitrary matching acquisition typically involves the formation of control by matching and nonmatching configurations. Applying the rule analysis of Cumming and Berryman (Berryman et al., 1965; Cumming & Berryman, 1961) to the current data, the sample stimulus served a bipartite function. The S+ rule was evidenced by appropriate matching when novel incorrect comparisons were available. The S- rule interpretation was supported by the consistent selection of the novel comparisons when nonmatching samples and comparisons were also presented. Both S+ and S- rule performances were also observed during nonreinforced tests which involved reversed equivalents (Experiment 1) and mediated equivalents (Experiment 2). Preference tests determined that the rule governed behaviors were a product of the combined presence of the sample and comparison stimuli. Again, these findings are in contrast to the available pigeon data (Carter & Werner, 1978).

There are several factors related to the present procedures that may have fostered the observed control by matching and nonmatching stimulus configurations. Most notable are the possible influences of the explicit verbal instructions and the differential feedback provided during training. Would contingency-shaped matching performance yield control during tests for S+ and S- responding comparable to that prefaced with verbal instructions? Likewise, did the contingent buzzer somehow inhibit responding to nonmatching comparisons and thereby promote selection of the novel stimuli? These factors, as well as those previously mentioned regarding the formation of stimulus equivalences should be considered in future investigations.

As discussed earlier, the relationship between demonstrated S+ and S- rule behavior and mediated transfer is unclear from the present results. For the 9 of 12 subjects of Experiment 2 who demonstrated immediate and consistent mediated transfer, S+ and S- stimulus control were also observed. As shown by LM and AP, however, evidence for mediated transfer occurred without the combined S+ and S- functions of the sample stimuli. This suggests that while humans tend to learn complementary sets of sample-comparison rules, stimulus equivalences may be a product of S+ rules, S- rules, or both. An experimental test of this notion would attempt to generate stimulus equivalences entirely on the basis of exposure to positive or negative instances of a given stimulus class. For example, C1 might be categorized as an instance of class A1-B1 because subjects were taught that C1 was also an S+ in the presence of A1. Conversely, other subjects might be taught that C1 was not an instance of A2-B2, i.e., an S- in the presence of A2; therefore C1 might be assumed to be member of the A1-B1 stimulus class. Such an experiment would be related to the controversy over the relative importance of the S+ and S- in discrimination learning (Mackintosh, 1974). It may well be that humans are capable of complex categorization on the basis of either training history.

Another direction for future research might be to focus on the role of the comparison stimuli in control over novel comparisons. There are some data which suggest that the S- responding evidenced in this study might not be entirely attributable to the combined presence of nonmatching samples and comparisons. Subjects may avoid responding to any comparison that has an explicit history of association with an instructional stimulus. For example, Dixon (1977), after training spoken word-object relations, probed with trials that involved the trained choice, a novel spoken word, and an untrained choice object. These and other test conditions determined that subjects would consistently respond away from the trained object and select the untrained choice. Similarly, research in receptive language acquisition suggests that humans tend to respond away from "known" choices when new spoken words are encountered (Vincent-Smith et al., 1975). These results suggest an additional analysis of stimulus equivalences: Would any member of an established stimulus class exert similar control in the presence of novel samples and comparisons? To illustrate, assume that subjects were first taught a visual A-B matching problem: A1(B2, B1*) A2(B1, B2*). A subsequent test would involve the following kinds of trials: N1(B1, N3) N2(B2, N4). Dixon's findings predict that subjects would select the novel comparisons N3 and N4, instead of the trained comparisons. Furthermore, if the A-B relations are indeed equivalent; then one would expect the same degree of control over novel comparisons when the A stimuli were used as comparisons. Such trials would appear as N1(A1, N3) N2(A2, N4).

To summarize, the present findings, as well as those of other researchers (Dixon, 1978; Dixon & Spradlin, 1976; Lazar, 1977; Sidman, 1971; Sidman & Cresson, 1973; Sidman et al., 1974; Spradlin et al., 1973; Spradlin & Dixon, 1976; Wetherby et al., Note 2), are not consistent with a multiple-rule/coding response explanation of matching-to-sample (Carter & Werner, 1978). The nonidentity matching performance of humans is characterized by the formation of stimulus equivalences, performance congruent with a single-rule or concept learning model (Carter & Werner, 1978) of matching. Empirically, stimulus equivalences are demonstrated by the substitutability of samples and comparisons within a designated stimulus class. Equivalences may emerge via direct association with existing class members while serving in either one of the matching contexts, as samples or comparisons. Performance under the stimulus equivalence model may be generally described as follows: A stimulus used as either a sample or a comparison for a designated stimulus class will automatically function appropriately as a sample or comparison for other members of the class. When placed in the role of a sample, equivalent class members will exercise a twofold instructional function. The S+ rule function might be stated as: Given a sample and matching comparison from a trained stimulus class, and an unfamiliar comparison, select the trained comparison. The S- rule, however, might be stated: Given a sample and nonmatching comparison from a trained stimulus class, and an unfamiliar comparison, select the unfamiliar comparison. The present analysis of S+ and S- rules provides a beginning determination of the extent to which stimulus class members are in fact equivalent. Future research should ascertain the conditional discrimination histories responsible for stimulus equivalences and dual sample control. The contextual boundaries of demonstrated equivalences also need delineation; this should include an analysis of the relative contributions of the trained comparison stimuli in control over novel comparison selection.

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APPENDICIES

Appendix A

Request for Participation and Consent Agreement

Dear (Parent or Guardian):

This letter is to request permission for (Name of Resident) to participate in a study of matching skills. The matching problems used in our study are similar to those a student faces when learning language concepts. The student is shown a "sample" picture and asked to choose one of two "choice" pictures that goes with the sample. Once the student learns to reliably choose the correct picture, we present a series of related picture-matching problems. We are interested in determining if the student can learn that the two pictures go together in a variety of contexts. We would also like to determine the types of learning experiences required to teach these conceptual skills.

The matching problems are presented automatically by a programming machine. This machine is located in a separate room near the student's work area. The student sits in a chair and faces a Plexiglas panel where the pictures are displayed. When the student touches the correct choice picture, a chime sounds and a token is delivered. The tokens can be traded for pennies after the session. Incorrect choices are followed by a brief sound of a buzzer.

Students who participate in this study will not be subjected to any discomforts or physical or psychological risks. They may benefit by learning some new matching skills. (Name of Resident) is free to withdraw from the study at any time or you may withdraw your child at any time. We will also be happy to answer any inquiries concerning the project.

The principal investigator in this study is Dr. Joseph Spradlin, Professor of Human Development, University of Kansas. Participants are seen by Robert Stromer at the Research Center, Parsons State Hospital and Training Center.

The attached Consent Agreement is for your signature and may be returned in the enclosed self-addressed envelope. An extra copy of this letter is provided for your records. If (Name of Resident) does participate in this project, we hope we will have the opportunity to meet with you and discuss your child's performance.

Thank you for your cooperation and consideration.

Sincerely,

Robert Stromer, M.S.
Junior Scientist

- Consent Agreement -

I give my permission for (Name of Resident) to participate in the research project on matching-to-sample. I have been informed of the procedures involved and have been told that there are no anticipated risks or discomforts for my child.

Parent/Guardian Date

Appendix B

Table 1

Description of conditions and test results for subjects of Experiment 1. Samples are denoted outside the parentheses, the comparisons within. The asterisk signifies a reinforced comparison. Percentages in parentheses represent performance during trained trials, other percentages reflect comparison selection during test trials.

Session #	Subject ED		
1-5	Train A-B Matching (Set Ia Stimuli): A1(B2, B1*) A2(B1, B2*)		
	Test for Equivalence		
6	Test 1:	B1(A2, A1)	B2(A1, A2)
	(100)	0 100	0 100
	Series I		
7	Test 2:	A1(N1, B1)	A2(N2, B2)
	(99)	0 100	0 100
8	Test 3:	A1(N1, N2)	A2(N1, N2)
	(99)	100 0	0 100
9	Test 2:	A1(N1, B1)	A2(N2, B2)
	(100)	0 100	0 100
10	Test 3:	A1(N1, N2)	A2(N1, N2)
	(100)	100 0	0 100
	Series II		
11	Test 4:	A1(B2, N3)	A2(B1, N4)
	(100)	33 67	0 100
12	Test 5:	A1(N3, N4)	A2(N3, N4)
	(99)	100 0	17 83
13	Test 4:	A1(B2, N4)	A2(B1, N3)
	(99)	0 100	0 100

Table 1 (Continued)

14	Test 5: A1(N3, N4) A2(N3, N4) (100) 100 0 0 100
	<u>Test for Equivalence</u>
15	Test 1: B1(A2, A1) B2(A1, A2) (100) 0 100 0 100
	<u>Series III</u>
16	Test 7: B1(N5, N6) B2(N5, N6) (99) 0 100 83 17
17	Test 6: B1(N6, A1) B2(N5, A2) (99) 0 100 0 100
18	Test 7: B1(N5, N6) B2(N5, N6) (99) 67 33 100 0
19	Test 6: B1(N6, A1) B2(N5, A2) (99) 0 100 0 100
	<u>Series IV</u>
20	Test 9: B1(N7, N8) B2(N7, N8) (99) 50 50 67 33
21	Test 8: B1(A2, N7) B2(A1, N8) (100) 0 100 17 83
22	Test 9: B1(N7, N8) B2(N7, N8) (100) 50 50 50 50
23	Test 8: B1(A2, N8) B2(A1, N7) (100) 17 83 33 67
24-27	Train A-B Matching (Set IIa Stimuli): A1(B2, B1*) A2(B1, B2*)
	<u>Test for Equivalence</u>
28	Test 1: B1(A2, A1) B2(A1, A2) (97) 0 100 0 100

Table 1 (Continued)

	Series IV				
29	Test 8:	B1(A2,	N7)	B2(A1,	N8)
	(100)	0	100	0	100
30	Test 9:	B1(N7,	N8)	B2(N7,	N8)
	(100)	67	33	17	83
31	Test 8:	B1(A2,	N8)	B2(A1,	N7)
	(100)	0	100	0	100
32	Test 9:	B1(N7,	N8)	B2(N7,	N8)
	(99)	0	100	100	0
	Series I				
33	Test 3:	A1(N1,	N2)	A2(N1,	N2)
	(100)	67	33	50	50
34	Test 2:	A1(N1,	B1)	A2(N2,	B2)
	(97)	0	100	0	100
35	Test 3:	A1(N1,	N2)	A2(N1,	N2)
	(100)	0	100	50	50
36	Test 2:	A1(N2,	B1)	A2(N1,	B2)
	(99)	0	100	0	100
	Test for Equivalence				
37	Test 1:	B1(A2,	A1)	B2(A1,	A2)
	(100)	0	100	0	100
	Series II				
38	Test 5:	A1(N3,	N4)	A2(N3,	N4)
	(97)	17	83	0	100
39	Test 4:	A1(B2,	N3)	A2(B1,	N3)
	(99)	0	100	0	100
40	Test 5:	A1(N3,	N4)	A2(N3,	N4)
	(100)	50	50	100	0

Table 1 (Continued)

41	Test 4: A1(B2, N3) A2(B1, N4) (97) 0 100 0 100
	<u>Series III</u>
42	Test 6: B1(N5, A1) B2(N6, A2) (100) 0 100 0 100
43	Test 7: B1(N5, N6) B2(N5, N6) (99) 100 0 17 83
44	Test 6: B1(N5, A1) B2(N6, A2) (100) 17 83 0 100
45	Test 7: B1(N5, N6) B2(N5, N6) (97) 67 33 83 17
Session #	**Subject DW**
1-4	Train A-B Matching (Set Ib Stimuli): A1(B2, B1*) A2(B1, B2*)
	<u>Test for Equivalence</u>
5	Test 1: B1(A2, A1) B2(A1, A2) (99) 0 100 0 100
	<u>Series II</u>
6	Test 5: A1(N3, N4) A2(N3, N4) (100) 17 83 67 33
7	Test 4: A1(B2, N3) A2(B1, N4) (99) 0 100 0 100
8	Test 5: A1(N3, N4) A2(N3, N4) (100) 100 0 0 100
9	Test 4: A1(B2, N4) A2(B1, N3) (99) 0 100 0 100

Table 1 (Continued)

	Series III					
10	Test 6: (97)	B1(N5, A1)		B2(N6, A2)		
		0	100	0	100	
11	Test 7: (97)	B1(N5, N6)		B2(N5, N6)		
		50	50	83	17	
12	Test 6: (99)	B1(N6, A1)		B2(N5, A2)		
		0	100	0	100	
13	Test 7: (97)	B1(N5, N6)		B2(N5, N6)		
		67	33	67	33	
	Test for Equivalence					
14	Test 1: (97)	B1(A2, A1)		B2(A1, A2)		
		0	100	17	83	
	Series IV					
15	Test 8: (99)	B1(A2, N7)		B2(A1, N8)		
		0	100	0	100	
16	Test 9: (100)	B1(N7, N8)		B2(N7, N8)		
		67	33	67	33	
17	Test 8: (99)	B1(A2, N8)		B2(A1, N7)		
		0	100	0	100	
18	Test 9: (100)	B1(N7, N8)		B2(N7, N8)		
		33	67	33	67	
	Series I					
19	Test 3: (100)	A1(N1, N2)		A2(N1, N2)		
		83	17	0	100	
20	Test 2: (99)	A1(N1, B1)		A2(N2, B2)		
		0	100	0	100	
21	Test 3: (97)	A1(N1, N2)		A2(N1, N2)		
		0	100	83	17	
22	Test 2: (100)	A1(N2, B1)		A2(N1, B2)		
		0	100	0	100	

Table 1 (Continued)

23-26	Train A-B Matching (Set IIb Stimuli): A1(B2, A1*) A2(B1, B2*)
	<u>Test for Equivalence</u>
27	Test 1: B1(A2, A1) B2(A1, A2) (100) 0 100 0 100
	<u>Series III</u>
28	Test 7: B1(N5, N6) B2(N5, N6) (100) 100 0 0 100
29	Test 6: B1(N5, A1) B2(N6, A2) (100) 0 100 0 100
30	Test 7: B1(N5, N6) B2(N5, N6) (100) 50 50 67 33
31	Test 6: B1(N6, A1) B2(N5, A2) (96) 0 100 0 100
	<u>Series IV</u>
32	Test 9: B1(N7, N8) B2(N7, N8) (97) 100 0 0 100
33	Test 8: B1(A2, N8) B2(A1, N7) (99) 0 100 0 100
34	Test 9: B1(N7, N8) B2(N7, N8) (100) 0 100 100 0
35	Test 8: B1(A2, N7) B2(A1, N8) (100 0 100 0 100
	<u>Test for Equivalence</u>
36	Test 1: B1(A2, A1) B2(A1, A2) (98) 0 100 0 100
	<u>Series I</u>
37	Test 2: A1(N1, B1) A2(N2, B2) (100) 17 83 0 100

Table 1 (Continued)

38	Test 3:	A1(N1,	N2)	A2(N1,	N2)
	(100)	50	50	50	50
39	Test 2:	A1(N2,	B1)	A2(N1,	B2)
	(100)	0	100	0	100
40	Test 3:	A1(N1,	N2)	A2(N1,	N2)
	(99)	67	33	50	50
	Series III				
41	Test 4:	A1(B2,	N3)	A2(B1,	N4)
	(99)	0	100	0	100
42	Test 5:	A1(N3,	N4)	A2(N3,	N4)
	(99)	100	0	0	100
43	Test 4:	A1(B2,	N4)	A2(B1,	N3)
	(97)	0	100	0	100
44	Test 5:	A1(N3,	N4)	A2(N3,	N4)
	(99)	17	83	83	17

Session #	Subject JT				
1-4	Train A-B Matching (Set Ia Stimuli): A1(B2, B1*) A2(B1, B2*)				
	Test for Equivalence				
5	Test 1:	B1(A2,	A1)	B2(A1,	A2)
	(100)	0	100	0	100
	Series III				
6	Test 7:	B1(N5,	N6)	B2(N5,	N6)
	(100)	50	50	50	50
7	Test 6:	B1(N5,	A1)	B2(N6,	A2)
	(100)	0	100	0	100
8	Test 7:	B1(N5,	N6)	B2(N5,	N6)
	(100)	100	0	0	100

Table 1 (Continued)

9	Test 6:	B1(N5,	A1)	B2(N6,	A2)
	(99)	0	100	0	100
	Series IV				
10	Test 9:	B1(N7,	N8)	B2(N7,	N8)
	(100)	67	33	50	50
11	Test 8:	B1(A2,	N8)	B2(A1,	N7)
	(100)	0	100	0	100
12	Test 9:	B1(N7,	N8)	B2(N7,	N8)
	(100)	50	50	50	50
13	Test 8:	B1(A2,	N7)	B2(A1,	N8)
	(99)	0	100	0	100
	Test for Equivalence				
14	Test 1:	B1(A2,	A1)	B2(A1,	A2)
	(100)	0	100	0	100
	Series I				
15	Test 2:	A1(N1,	B1)	A2(N2,	B2)
	(100)	0	100	0	100
16	Test 3:	A1(N1,	N2)	A2(N1,	N2)
	(99)	67	33	33	67
17	Test 2:	A1(N1,	B1)	A2(N2,	B2)
	(100)	0	100	0	100
18	Test 3:	A1(N1,	N2)	A2(N1,	N2)
	(99)	100	0	50	50
	Series II				
19	Test 4:	A1(B2,	N3)	A2(B1,	N4)
	(99)	0	100	0	100
20	Test 5:	A1(N3,	N4)	A2(N3,	N4)
	(100)	17	83	17	83
21	Test 4:	A1(B2,	N4)	A2(B1,	N3)
	(96)	0	100	0	100

Table 1 (Continued)

22	Test 5:	A1(N3,	N4)	A2(N3,	N4)
	(100)	0	100	100	0
23-26	Train A-B Matching (Set IIa Stimuli): A1(B2, B1*) A2(B1, B2*)				
	<u>Test for Equivalence</u>				
27	Test 1:	B1(A2,	A1)	B2(A1,	A2)
	(100)	0	100	0	100
	<u>Series II</u>				
28	Test 5:	A1(N3,	N4)	A2(N3,	N4)
	(99)	100	0	33	67
29	Test 4:	A1(B2,	N4)	A2(B1,	N3)
	(99)	0	100	0	100
30	Test 5:	A1(N3,	N4)	A2(N3,	N4)
	(100)	83	17	50	50
31	Test 4:	A1(B2,	N4)	A2(B1,	N3)
	(99)	0	100	0	100
	<u>Series III</u>				
32	Test 6:	B1(N5,	A1)	B2(N6,	A2)
	(100)	0	100	0	100
33	Test 7:	B1(N5,	N6)	B2(N5,	N6)
	(99)	0	100	83	17
34	Test 6:	B1(N6,	A1)	B2(N5,	A2)
	(97)	0	100	0	100
35	Test 7:	B1(N5,	N6)	B2(N5,	N6)
	(100)	0	100	100	0
	<u>Test for Equivalence</u>				
36	Test 1:	B1(A2,	A1)	B2(A1,	A2)
	(100)	0	100	0	100

Table 1 (Continued)

	<u>Series IV</u>
37	Test 8: B1(A2, N7) B2(A1, N8) (100) 0 100 0 100
38	Test 9: B1(N7, N8) B2(N7, N8) (100) 83 17 33 67
39	Test 8: B1(A2, N8) B2(A1, N7) (100) 0 100 0 100
40	Test 9: B1(N7, N8) B2(N7, N8) (99) 100 0 33 67
	<u>Series I</u>
41	Test 3: A1(N1, N2) A2(N1, N2) (98) 17 83 67 33
42	Test 2: A1(N2, B1) A2(N1, B2) (99) 0 100 0 100
43	Test 3: A1(N1, N2) A2(N1, N2) (100) 0 100 83 17
44	Test 2: A1(N2, B1) A2(N1, B2) (100) 0 100 0 100

Session #	Subject JL
1-5	Train A-B Matching (Set Ib Stimuli): A1(B2, B1*) A2(B1, B2*)
	<u>Test for Equivalence</u>
6	Test 1: B1(A2, A1) B2(A1, A2) (100) 0 100 0 100
	<u>Series IV</u>
7	Test 8: B1(A2, N7) B2(A1, N8) (100) 0 100 0 100

Table 1 (Continued)

8	Test 9: (100)	B1(N7,	N8)	B2(N7,	N8)
		50	50	33	67
9	Test 8: (100)	B1(A2,	N8)	B2(A1,	N7)
		0	100	0	100
10	Test 9: (99)	B1(N7,	N8)	B2(N7,	N8)
		33	67	67	33
	Series I				
11	Test 3: (100)	A1(N1,	N2)	A2(N1,	N2)
		0	100	100	0
12	Test 2: (99)	A1(N2,	B1)	A2(N1,	B2)
		0	100	0	100
13	Test 3: (99)	A1(N1,	N2)	A2(N1,	N2)
		50	50	67	33
14	Test 2: (97)	A1(N2,	B1)	A2(N1,	B2)
		0	100	0	100
	Test for Equivalence				
15	Test 1: (100)	B1(A2,	A1)	B2(A1,	A2)
		0	100	0	100
	Series II				
16	Test 5: (100)	A1(N3,	N4)	A2(N3,	N4)
		100	0	0	100
17	Test 4: (99)	A1(B2,	N4)	A2(B1,	N3)
		17	83	17	83
18	Test 5: (100)	A1(N3,	N4)	A2(N3,	N4)
		33	67	50	50
19	Test 4: (100)	A1(B2,	N3)	A2(B1,	N4)
		0	100	0	100
	Series III				
20	Test 6: (100)	B1(N5,	A1)	B2(N6,	A2)
		0	100	0	100

Table 1 (Continued)

21	Test 7: B1(N5, N6) B2(N5, N6) (100) 50 50 100 0
22	Test 6: B1(N6, A1) B2(N5, A2) (99) 0 100 0 100
23	Test 7: B1(N5, N6) B2(N5, N6) (100) 33 67 50 50
24-27	Train A-B Matching (Set IIb Stimuli): A1(B2, B1*) A2(B1, B2*)
	Test for Equivalence
28	Test 1: B1(A2, A2) B2(A1, A2) (100) 0 100 0 100
	Series I
29	Test 2: A1(N1, B1) A2(N2, B2) (100) 0 100 0 100
30	Test 3: A1(N1, N2) A2(N1, N2) (100) 33 67 50 50
31	Test 2: A1(N2, B1) A2(N1, B2) (97) 0 100 0 100
32	Test 3: A1(N1, N2) A2(N1, N2) (99) 50 50 50 50
	Series II
33	Test 4: A1(B2, N3) A2(B1, N4) (100) 0 100 0 100
34	Test 5: A1(N3, N4) A2(N3, N4) (100) 50 50 17 83
35	Test 4: A1(B2, N4) A2(B1, N3) (100) 0 100 0 100
36	Test 5: A1(N3, N4) A2(N3, N4) (100) 50 50 50 50

Table 1 (Continued)

	<u>Test for Equivalence</u>				
37	Test 1:	B1(A2,	A1)	B2(A1,	A2)
	(100)	17	83	0	100
	<u>Series III</u>				
38	Test 7:	B1(N5,	N6)	B2(N5,	N6)
	(100)	50	50	100	0
39	Test 6:	B1(N6,	A1)	B2(N5,	A2)
	(100)	0	100	0	100
40	Test 7:	B1(N5,	N6)	B2(N5,	N6)
	(100)	83	17	17	83
41	Test 6:	B1(N5,	A1)	B2(N6,	A2)
	(99)	0	100	0	100
	<u>Series IV</u>				
42	Test 9:	B1(N7,	N8)	B2(N7,	N8)
	(100)	50	50	33	67
43	Test 8:	B1(A2,	N8)	B2(A1,	N7)
	(100)	0	100	0	100
44	Test 9:	B1(N7,	N8)	B2(N7,	N8)
	(99)	33	67	50	50
45	Test 8:	B1(A2,	N7)	B2(A1,	N8)
	(100)	0	100	0	100

Appendix C

Table 2

Description of conditions and test results for Group 1 subjects (Stimulus Equivalence) of Experiment 2. See Appendix B for details.

Session #	Subject MP				
1-9	Train A-B, C-B Matching (Set IIIa Stimuli): A1(B2, B1*) A2(B1, B2*) C1(B2, B1*) C2(B1, B2*)				
	Tests for Equivalence				
10	Test 1:	B1(A2, A1)	B2(A1, A2)	B1(C2, C1)	B2(C1, C2)
	(100)	0 100	17 83	17 83	0 100
11	Test 2:	A1(C2, C1)	A2(C1, C2)	C1(A2, A1)	C2(A1, A2)
	(99)	33 67	50 50	67 33	67 33
	Series I				
12	Test 3:	A1(N1, C1)	A2(N2, C2)	C1(N1, A1)	C2(N2, A2)
	(100)	50 50	50 50	67 33	50 50
13	Test 4:	A1(N1, N2)	A2(N1, N2)	C1(N1, N2)	C2(N1, N2)
	(100)	50 50	50 50	50 50	50 50
14	Test 3:	A1(N2, C1)	A2(N1, C2)	C1(N2, A1)	C2(N1, A2)
	(99)	50 50	50 50	33 67	50 50
15	Test 4:	A1(N1, N2)	A2(N1, N2)	C1(N1, N2)	C2(N1, N2)
	(98)	67 33	50 50	50 50	50 50
	Tests for Equivalence				
16	Test 2:	A1(C2, C1)	A2(C1, C2)	C1(A2, A1)	C2(A1, A2)
	(99)	50 50	50 50	50 50	50 50
17	Test 1:	B1(A2, A1)	B2(A1, A2)	B1(C2, C1)	B2(C1, C2)
	(99)	50 50	50 50	50 50	50 50
	Series II				
18	Test 6:	A1(N3, N4)	A2(N3, N4)	C1(N3, N4)	C2(N3, N4)
	(100)	83 17	83 17	83 17	50 50

Table 2 (Continued)

19	Test 5:	A1(C2, N4)		A2(C1, N3)		C1(A2, N4)		C2(A1, N3)	
	(99)	50	50	17	83	50	50	33	67
20	Test 6:	A1(N3, N4)		A2(N3, N4)		C1(N3, N4)		C2(N3, N4)	
	(99)	100	0	100	0	100	0	83	17
21	Test 5:	A1(C2, N4)		A2(C1, N3)		C1(A2, N4)		C2(A1, N3)	
	(97)	50	50	17	83	50	50	17	83
22-28	Train A-B, C-B Matching (Set IVa Stimuli): A1(B2, B1*) A2(C1, C2*) C1(A2, A1*) C2(A1, A2*)								
	Series II								
29	Test 5:	A1(C2, N3)		A2(C1, N4)		C1(A2, N3)		C2(A1, N4)	
	(99)	0	100	67	33	0	100	50	50
30	Test 6:	A1(N3, N4)		A2(N3, N4)		C1(N3, N4)		C2(N3, N4)	
	(100)	50	50	83	17	50	50	67	33
31	Test 5:	A1(C2, N3)		A2(C1, N4)		C1(A2, N3)		C2(A1, N4)	
	(100)	50	50	50	50	50	50	50	50
32	Test 6:	A1(N3, N4)		A2(N3, N4)		C1(N3, N4)		C2(N3, N4)	
	(100)	50	50	50	50	50	50	50	50
	Tests for Equivalence								
33	Test 2:	A1(C2, C1)		A2(C1, C2)		C1(A2, A1)		C2(A1, A2)	
	(100)	33	67	33	67	83	17	50	50
34	Test 1:	B1(A2, A1)		B2(A1, A2)		B1(C2, C1)		B2(C1, C2)	
	(100)	50	50	50	50	50	50	50	50
	Series I								
35	Test 4:	A1(N1, N2)		A2(N1, N2)		C1(N1, N2)		C2(N1, N2)	
	(100)	50	50	50	50	50	50	50	50
36	Test 3:	A1(N1, C1)		A2(N2, C2)		C1(N1, A1)		C2(N2, A2)	
	(99)	50	50	50	50	50	50	50	50
37	Test 4:	A1(N1, N2)		A2(N1, N2)		C1(N1, N2)		C2(N1, N2)	
	(100)	50	50	50	50	50	50	50	50

Table 2 (Continued)

38	Test 3:	A1(N2,	C1)	A2(N1,	C2)	C1(N2,	A1)	C2(N1,	A2)
	(100)	50	50	50	50	50	50	50	50
	Tests for Equivalence								
39	Test 1:	B1(A2,	A1)	B2(A1,	A2)	B1(C2,	C1)	B2(C1,	C2)
	(99)	50	50	50	50	50	50	50	50
40	Test 2:	A1(C2,	C1)	A2(C1,	C2)	C1(A2,	A1)	C2(A1,	A2)
	(100)	50	50	50	50	50	50	50	50
Session #	Subject JK								
1-6	Train A-B, C-B Matching (Set IIIb Stimuli): A1(B2, B1*) A2(B1, B2*) C1(B2, B1*) C2(B1, B2*)								
	Series I								
7	Test 4:	A1(N1,	N2)	A2(N1,	N2)	C1(N1,	N2)	C2(N1,	N2)
	(99)	0	100	100	0	0	100	83	17
8	Test 3:	A1(N2,	C1)	A2(N1,	C2)	C1(N2,	A1)	C2(N1,	A2)
	(99)	0	100	0	100	0	100	0	100
9	Test 4:	A1(N1,	N2)	A2(N1,	N2)	C1(N1,	N2)	C2(N1,	N2)
	(98)	17	83	100	0	17	83	100	0
10	Test 3:	A1(N2,	C1)	A2(N1,	C2)	C1(N2,	A1)	C2(N1,	A2)
	(100)	0	100	0	100	0	100	0	100
	Tests for Equivalence								
11	Test 2:	A1(C2,	C1)	A2(C1,	C2)	C1(A2,	A1)	C2(A1,	A2)
	(99)	0	100	0	100	0	100	0	100
12	Test 1:	B1(A2,	A1)	B2(A1,	A2)	B1(C2,	C1)	B2(C1,	C2)
	(99)	0	100	0	100	17	83	0	100
	Series II								
13	Test 5:	A1C2,	N3)	A2(C1,	N4)	C1(A2,	N3)	C2(A1,	N4)
	(98)	0	100	0	100	0	100	0	100

Table 2 (Continued)

14	Test 6: (99)	A1(N3, N4) 100 0	A2(N3, N4) 0 100	C1(N3, N4) 100 0	C2(N3, N4) 17 83
15	Test 5: (97)	A1(C2, N4) 0 100	A2(C1, N3) 0 100	C1(A2, N4) 0 100	C2(A1, N3) 0 100
16	Test 6: (97)	A1(N3, N4) 17 83	A2(N3, N4) 83 17	C1(N3, N4) 0 100	C2(N3, N4) 100 0
	<u>Tests for Equivalence</u>				
17	Test 1: (97)	B1(A2, A1) 0 100	B2(A1, A2) 0 100	B1(C2, C1) 0 100	B2(C1, C2) 0 100
18	Test 2: (99)	A1(C2, C1) 0 100	A2(C1, C2) 17 83	C1(A2, A1) 0 100	C2(A1, A2) 0 100
19-26	Train A-B, C-B Matching (Set IVb Stimuli):	A1(B2, B1*)	A2(B1, B2*)	C1(B2, B1*)	C2(B1, B2*)
	<u>Tests for Equivalence</u>				
27	Test 1: (97)	B1(A2, A1) 0 100	B2(A1, A2) 0 100	B1(C2, C1) 0 100	B2(C1, C2) 17 83
28	Test 2: (97)	A1(C2, C1) 0 100	A2(C1, C2) 0 100	C1(A2, A1) 17 83	C2(A1, A2) 0 100
	<u>Series II</u>				
29	Test 6: (99)	A1(N3, N4) 100 0	A2(N3, N4) 0 100	C1(N3, N4) 100 0	C2(N3, N4) 0 100
30	Test 5: (99)	A1(C2, N4) 0 100	A2(C1, N3) 0 100	C1(A2, N4) 0 100	C2(A1, N3) 0 100
31	Test 6: (99)	A1(N3, N4) 0 100	A2(N3, N4) 100 0	C1(N3, N4) 0 100	C2(N3, N4) 100 0
32	Test 5: (99)	A1(C2, N3) 0 100	A2(C1, N4) 0 100	C1(A2, N3) 0 100	C2(A1, N4) 0 100
	<u>Tests for Equivalence</u>				
33	Test 2: (99)	A1(C2, C1) 0 100	A2(C1, C2) 0 100	C1(A2, A1) 0 100	C2(A1, A2) 0 100

Table 2 (Continued)

34	Test 1:	B1(A2, A1)	B2(A1, A2)	B1(C2, C1)	B2(C1, C2)
	(100)	0 100	0 100	0 100	0 100
	<u>Series I</u>				
35	Test 3:	A1(N1, C1)	A2(N2, C2)	C1(N1, A1)	C2(N2, A2)
	(99)	0 100	0 100	0 100	0 100
36	Test 4:	A1(N1, N2)	A1(N1, N2)	C1(N1, N2)	C2(N1, N2)
	(99)	100 0	0 100	100 0	0 100
37	Test 3:	A1(N1, C1)	A2(N2, C2)	C1(N1, A1)	C2(N2, A2)
	(99)	0 100	0 100	0 100	0 100
38	Test 4:	A1(N1, N2)	A2(N1, N2)	C1(N1, N2)	C2(N1, N2)
	(99)	0 100	67 33	0 100	83 17
Session #	**Subject JL**				
1-8	Train A-B, C-B Matching (Set IIIa Stimuli):				
		A1(B2, B1*)	A2(B1, B2*)	C1(B2, B1*)	C1(B1, B2*)
	<u>Tests for Equivalence</u>				
9	Test 2:	A1(C2, C1)	A2(C1, C2)	C1(A2, A1)	C2(A1, A2)
	(100)	0 100	0 100	0 100	0 100
10	Test 1:	B1(A2, A1)	B2(A1, A2)	B1(C2, C1)	B2(C1, C2)
	(100)	0 100	0 100	0 100	0 100
	<u>Series II</u>				
11	Test 5:	A1(C2, N3)	A2(C1, N4)	C1(A2, N3)	C2(A1, N4)
	(100)	0 100	0 100	0 100	0 100
12	Test 6:	A1(N3, N4)	A2(N3, N4)	C1(N3, N4)	C2(N3, N4)
	(98)	83 17	17 83	67 33	83 17
13	Test 5:	A1(C2, N4)	A2(C1, N3)	C1(A2, N4)	C2(A1, N3)
	(100)	0 100	0 100	0 100	0 100
14	Test 6:	A1(N3, N4)	A2(N3, N4)	C1(N3, N4)	C2(N3, N4)
	(99)	67 33	50 50	83 17	33 67

Table 2 (Continued)

	<u>Tests for Equivalence</u>				
15	Test 1: (99)	B1(A2, A1) 0 100	B2(A1, A2) 0 100	B1(C2, C1) 0 100	B2(C1, C2) 0 100
16	Test 2: (99)	A1(C2, C1) 0 100	A2(C1, C2) 0 100	C1(A2, A1) 0 100	C2(A1, A2) 0 100
	<u>Series I</u>				
17	Test 4: (100)	A1(N1, N2) 17 83	A2(N1, N2) 67 33	C1(N1, N2) 50 50	C2(N1, N2) 67 33
18	Test 3: (100)	A1(N2, C1) 0 100	A2(N1, C2) 0 100	C1(N2, A1) 0 100	C2(N1, A2) 0 100
19	Test 4: (99)	A1(N1, N2) 83 17	A2(N1, N2) 50 50	C1(N1, N2) 17 83	C2(N1, N2) 50 50
20	Test 3: (99)	A1(N1, C1) 0 100	A2(N2, C2) 0 100	C1(N1, A1) 0 100	C2(N2, A2) 0 100
21-26	Train A-B, C-B Matching (Set IVa Stimuli): A1(B2, B1*) A2(B1, B2*) C1(B2, B1*) C2(B1, B2*)				
	<u>Series I</u>				
27	Test 3: (99)	A1(N1, C1) 0 100	A2(N2, C2) 0 100	C1(N1, A1) 0 100	C2(N2, A2) 0 100
28	Test 4: (99)	A1(N1, N2) 50 50	A2(N1, N2) 50 50	C1(N1, N2) 33 67	C2(N1, N2) 67 33
29	Test 3: (99)	A1(N2, C1) 0 100	A2(N1, C2) 0 100	C1(N2, A1) 0 100	C2(N1, A2) 0 100
30	Test 4: (100)	A1(N1, N2) 67 33	A2(N1, N2) 50 50	C1(N1, N2) 33 67	C2(N1, N2) 83 17
	<u>Tests for Equivalence</u>				
31	Test 1: (98)	B1(A2, A1) 0 100	B2(A1, A2) 17 83	B1(C2, C1) 0 100	B2(C1, C2) 0 100
32	Test 2: (99)	A1(C2, C1) 17 83	A2(C1, C2) 17 83	C1(A2, A1) 0 100	C2(A1, A2) 0 100

Table 2 (Continued)

Session #					
	Series II				
33	Test 6: (99)	A1(N3, N4) 67 33	A2(N3, N4) 17 83	C1(N3, N4) 67 33	C2(N3, N4) 33 67
34	Test 5: (99)	A1(C2, N4) 0 100	A2(C1, N3) 0 100	C1(A2, N4) 0 100	C2(A1, N3) 0 100
35	Test 6: (100)	A1(N3, N4) 50 50	A2(N3, N4) 33 67	C1(N3, N4) 50 50	C2(N3, N4) 33 67
36	Test 5: (99)	A1(C2, N4) 0 100	A2(C1, N3) 0 100	C1(A2, N4) 0 100	C2(A1, N3) 0 100
	Tests for Equivalence				
37	Test 2: (100)	A1(C2, C1) 0 100	A2(C1, C2) 0 100	C1(A2, A1) 0 100	C2(A1, A2) 0 100
38	Test 1: (99)	B1(A2, A1) 0 100	B2(A1, A2) 0 100	B1(C2, C1) 0 100	B2(C1, C2) 0 100

Session #	Subject LE				
1-14	Train A-B, C-B Matching (Set IIIb Stimuli): A1(B2, B1*) A2(B1, B2*) C1(B2, B1*) C2(B1, B2*)				
	Series II				
15	Test 6: (99)	A1(N3, N4) 33 67	A2(N3, N4) 33 67	C1(N3, N4) 100 0	C2(N3, N4) 33 67
16	Test 5: (100)	A1(C2, N4) 0 100	A2(C1, N3) 0 100	C1(A2, N4) 17 83	C2(A1, N3) 0 100
17	Test 6: (99)	A1(N3, N4) 33 67	A2(N3, N4) 0 100	C1(N3, N4) 83 17	C2(N3, N4) 67 33
18	Test 5: (100)	A1(C2, N4) 0 100	A2(C1, N3) 0 100	C1(A2, N4) 17 83	C2(A1, N3) 0 100

Table 2 (Continued)

	Tests for Equivalence				
19	Test 1:	B1(A2, A1)	B2(A1, A2)	B1(C2, C1)	B2(C1, C2)
	(99)	0 100	0 100	0 100	0 100
20	Test 2:	A1(C2, C1)	A2(C1, C2)	C1(A2, A1)	C2(A1, A2)
	(99)	17 83	17 83	0 100	33 67
	Series I				
21	Test 3:	A1(N1, C1)	A2(N2, C2)	C1(N1, A1)	C2(N2, A2)
	(97)	33 67	0 100	17 83	0 100
22	Test 4:	A1(N1, N2)	A2(N1, N2)	C1(N1, N2)	C2(N1, N2)
	(99)	17 83	50 50	67 33	50 50
23	Test 3:	A1(N2, C1)	A2(N1, C2)	C1(N2, A1)	C2(N1, A2)
	(100)	0 100	0 100	0 100	0 100
24	Test 4:	A1(N1, N2)	A2(N1, N2)	C1(N1, N2)	C2(N1, N2)
	(100)	50 50	17 83	33 67	33 67
	Tests for Equivalence				
25	Test 2:	A1(C2, C1)	A2(C1, C2)	C1(A2, A1)	C2(A1, A2)
	(99)	0 100	0 100	0 100	17 83
26	Test 1:	B1(A2, A1)	B2(A1, A2)	B1(C2, C1)	B2(C1, C2)
	(99)	0 100	0 100	0 100	0 100
27-35	Train A-B, C-B Matching (Set IVb Stimuli):				
	A1(B2, B1*)	A2(B1, B2*)	C1(B2, B1*)	C2(B1, B2*)	
	Tests for Equivalence				
36	Test 2:	A1(C2, C1)	A2(C1, C2)	C1(A2, A1)	C2(A1, A2)
	(99)	17 83	0 100	0 100	0 100
37	Test 1:	B1(A2, A1)	B2(A1, A2)	B1(C2, C1)	B2(C1, C2)
	(100)	0 100	17 83	0 100	0 100
	Series I				
38	Test 4:	A1(N1, N2)	A2(N1, N2)	C1(N1, N2)	C2(N1, N2)
	(98)	17 83	100 0	50 50	33 67
39	Test 3:	A1(N2, C1)	A2(N1, C2)	C1(N2, A1)	C2(N1, A2)
	(99)	0 100	0 100	0 100	0 100

Table 2 (Continued)

40	Test 4: (100)	A1(N1, N2) 67 33	A2(N1, N2) 67 33	C1(N1, N2) 50 50	C2(N1, N2) 33 67
41	Test 3: (97)	A1(N1, C1) 0 100	A2(N2, C2) 0 100	C1(N1, A1) 0 100	C2(N2, A2) 0 100
	Tests for Equivalence				
42	Test 1: (99)	B1(A2, A1) 0 100	B2(A1, A2) 0 100	B1(C2, C1) 0 100	B2(C1, C2) 0 100
43	Test 2: (99)	A1(C2, C1) 17 83	A2(C1, C2) 0 100	C1(A2, A1) 0 100	C2(A1, A2) 0 100
	Series II				
44	Test 5: (98)	A1(C2, N3) 0 100	A2(C1, N4) 0 100	C1(A2, N3) 0 100	C2(A1, N4) 0 100
45	Test 6: (100)	A1(N3, N4) 67 33	A2(N3, N4) 17 83	C1(N3, N4) 83 17	C2(N3, N4) 50 50
46	Test 5: (99)	A1(C2, N4) 17 83	A2(C1, N3) 0 100	C1(A2, N4) 0 100	C2(A1, N3) 0 100
47	Test 6: (97)	A1(N3, N4) 100 0	A2(N3, N4) 50 50	C1(N3, N4) 67 33	C2(N3, N4) 33 67

Appendix D

Table 3

Description of conditions and test results for Group 2 subjects (Response Equivalence) of Experiment 2. See Appendix B for details.

Session #	Subject JC								
1-7	Train A-B, A-C Matching (Set IIIa Stimuli): A1(B2, B1*) A2(B1, B2*) A1(C2, C1*) A2(C1, C2*)								
	Tests for Equivalence								
8	Test 1: (100)	B1(A2, A1)		B2(A1, A2)		C1(A2, A1)		C2(A1, A2)	
		0	100	0	100	0	100	0	100
9	Test 2: (100)	B1(C2, C1)		B2(C1, C2)		C1(B2, B1)		C2(B1, B2)	
		0	100	0	100	0	100	0	100
	Series I								
10	Test 3: (100)	B1(N1, C1)		B2(N2, C2)		C1(N1, B1)		C2(N2, B2)	
		0	100	0	100	0	100	0	100
11	Test 4: (99)	B1(N1, N2)		B2(N1, N2)		C1(N1, N2)		C2(N1, N2)	
		0	100	100	0	0	100	83	17
12	Test 3: (99)	B1(N2, C1)		B2(N1, C2)		C1(N2, B1)		C2(N1, B2)	
		0	100	0	100	0	100	0	100
13	Test 3: (100)	B1(N1, N2)		B2(N1, N2)		C1(N1, N2)		C2(N1, N2)	
		0	100	100	0	0	100	100	0
	Tests for Equivalence								
14	Test 2: (98)	B1(C2, C1)		B2(C1, C2)		C1(B2, B1)		C2(B1, B2)	
		0	100	0	100	0	100	0	100
15	Test 1: (99)	B1(A2, A1)		B2(A1, A2)		C1(A2, A1)		C2(A1, A2)	
		0	100	0	100	0	100	0	100
	Series II								
16	Test 6: (99)	B1(N3, N4)		B2(N3, N4)		C1(N3, N4)		C2(N3, N4)	
		100	0	0	100	83	17	0	100

Table 3 (Continued)

17	Test 5:	B1(C2, N4)	B2(C1, N3)	C1(B2, N4)	C2(B1, N3)
	(99)	0 100	0 100	0 100	0 100
18	Test 6:	B1(N3, N4)	B2(N3, N4)	C1(N3, N4)	C2(N3, N4)
	(99)	67 33	0 100	50 50	0 100
19	Test 5:	B1(C2, N4)	B2(C1, N3)	C1(B2, N4)	C2(B1, N3)
	(98)	0 100	0 100	0 100	0 100
20-24	Train A-B, A-C Matching (Set IVa Stimuli):				
	A1(B2, B1*)	A2(B1, B2*)	A1(C2, C1*)	A2(C1, C2*)	
	<u>Series II</u>				
25	Test 5:	B1(C2, N3)	B2(C1, N4)	C1(B2, N3)	C2(B1, N4)
	(99)	0 100	0 100	0 100	0 100
26	Test 6:	B1(N3, N4)	B2(N3, N4)	C1(N3, N4)	C2(N3, N4)
	(99)	100 0	0 100	100 0	0 100
27	Test 5:	B1(C2, N4)	B2(C1, N3)	C1(B2, N4)	C2(B1, N3)
	(99)	0 100	0 100	0 100	0 100
28	Test 6:	B1(N3, N4)	B2(N3, N4)	C1(N3, N4)	C2(N3, N4)
	(99)	83 17	0 100	100 0	0 100
	<u>Tests for Equivalence</u>				
29	Test 2:	B1(C2, C1)	B2(C1, C2)	C1(B2, B1)	C2(B1, B2)
	(99)	0 100	0 100	0 100	0 100
30	Test 1:	B1(A2, A1)	B2(A1, A2)	C1(A2, A1)	C2(A1, A2)
	(100)	0 100	0 100	0 100	0 100
	<u>Series I</u>				
31	Test 4:	B1(N1, N2)	B2(N1, N2)	C1(N1, N2)	C2(N1, N2)
	(98)	33 67	83 17	0 100	67 33
32	Test 3:	B1(N2, C1)	B2(N1, C2)	C1(N2, B1)	C2(N1, B2)
	(99)	0 100	0 100	0 100	0 100
33	Test 4:	B1(N1, N2)	B2(N1, N2)	C1(N1, N2)	C2(N1, N2)
	(99)	17 83	100 0	17 83	67 33

Table 3 (Continued)

34	Test 3: (99)	B1(N2, C1) 0 100	B2(N1, C2) 0 100	C1(N2, B1) 0 100	C2(N1, B2) 0 100
	Tests for Equivalence				
35	Test 1: (100)	B1(A2, A1) 0 100	B2(A1, A2) 0 100	C1(A2, A1) 0 100	C2(A1, A2) 0 100
36	Test 2: (99)	B1(C2, C1) 0 100	B2(C1, C2) 0 100	C1(B2, B1) 0 100	C2(B1, B2) 0 100

Session #	Subject DW				
1-6	Train A-B, A-C Matching (Set IIIb Stimuli): A1(B2, B1*) A2(B1, B2*) A1(C2, C1*) A2(C1, C2*)				
	Series I				
7	Test 4: (99)	B1(N1, N2) 100 0	B2(N1, N2) 100 0	C1(N1, N2) 100 0	C2(N1, N2) 83 17
8	Test 3: (99)	B1(N1, C1) 0 100	B2(N2, C2) 0 100	C1(N1, B1) 0 100	C2(N2, B2) 0 100
9	Test 4: (100)	B1(N1, N2) 100 0	B2(N1, N2) 67 33	C1(N1, N2) 100 0	C2(N1, N2) 100 0
10	Test 3: (99)	B1(N1, C1) 0 100	B2(N2, C2) 0 100	C1(N1, B1) 0 100	C2(N2, B2) 0 100
	Tests for Equivalence				
11	Test 2: (100)	B1(C2, C1) 0 100	B2(C1, C2) 0 100	C1(B2, B1) 0 100	C2(B1, B2) 0 100
12	Test 1: (99)	B1(A2, A1) 0 100	B2(A1, A2) 0 100	C1(A2, A1) 0 100	C2(A1, A2) 0 100
	Series II				
13	Test 5: (100)	B1(C2, N3) 0 100	B2(C1, N4) 0 100	C1(B2, N3) 0 100	C2(B1, N4) 0 100

Table 3 (Continued)

14	Test 6:	B1(N3, N4)	B2(N3, N4)	C1(N3, N4)	C2(N3, N4)
	(100)	100 0	33 67	100 0	33 67
15	Test 5:	B1(C2, N4)	B2(C1, N3)	C1(B2, N4)	C2(B1, N3)
	(100)	0 100	0 100	0 100	0 100
16	Test 6:	B1(N3, N4)	B2(N3, N4)	C1(N3, N4)	C2(N3, N4)
	(100)	0 100	100 0	0 100	100 0
	Tests for Equivalence				
17	Test 1:	B1(A2, A1)	B2(A1, A2)	C1(A2, A1)	C2(A1, A2)
	(99)	0 100	0 100	0 100	0 100
18	Test 2:	B1(C2, C1)	B2(C1, C2)	C1(B2, B1)	C2(B1, B2)
	(99)	0 100	0 100	0 100	0 100
19-23	Train A-B, A-C Matching (Set IVb Stimuli):				
	A1(B2, B1*)	A2(B1, B2*)	A1(C2, C1*)	A2(C1, C2*)	
	Tests for Equivalence				
24	Test 1:	B1(A2, A1)	B2(A1, A2)	C1(A2, A1)	C2(A1, A2)
	(99)	0 100	0 100	0 100	0 100
25	Test 2:	B1(C2, C1)	B2(C1, C2)	C1(B2, B1)	C2(B1, B2)
	(100)	0 100	0 100	0 100	0 100
	Series II				
26	Test 6:	B1(N3, N4)	B2(N3, N4)	C1(N3, N4)	C2(N3, N4)
	(100)	0 100	50 50	0 100	100 0
27	Test 5:	B1(C2, N3)	B2(C1, N4)	C1(B2, N3)	C2(B1, N4)
	(100)	0 100	0 100	0 100	0 100
28	Test 6:	B1(N3, N4)	B2(N3, N4)	C1(N3, N4)	C2(N3, N4)
	(99)	0 100	100 0	0 100	100 0
29	Test 5:	B1(C2, N3)	B2(C1, N4)	C1(B2, N3)	C2(B1, N4)
	(99)	0 100	0 100	0 100	0 100
	Tests for Equivalence				
30	Test 2:	B1(C2, C1)	B2(C1, C2)	C1(B2, B1)	C2(B1, B2)
	(100)	0 100	0 100	0 100	0 100

Table 3 (Continued)

31	Test 1:	B1(A2, A1)	B2(A1, A2)	C1(A2, A1)	C2(A1, A2)
	(100)	0 100	0 100	0 100	0 100
	Series I				
32	Test 3:	B1(N1, C1)	B2(N2, C2)	C1(N1, B1)	C2(N2, B2)
	(99)	0 100	0 100	0 100	0 100
33	Test 4:	B1(N1, N2)	B2(N1, N2)	C1(N1, N2)	C2(N1, N2)
	(100)	100 0	33 67	83 17	0 100
34	Test 3:	B1(N1, C1)	B2(N2, C2)	C1(N1, B1)	C2(N2, B2)
	(100)	0 100	0 100	0 100	0 100
35	Test 4:	B1(N1, N2)	B2(N1, N2)	C1(N1, N2)	C2(N1, N2)
	(99)	67 33	17 83	100 0	33 67
Session #	**Subject LM**				
1-8	Train A-B, A-C Matching (Set IIIa Stimuli):	A1(B2, B1*)	A2(B1, B2*)	A1(C2, C1*)	A2(C1, C2*)
	Tests for Equivalence				
9	Test 2:	B1(C2, C1)	B2(C1, C2)	C1(B2, B1)	C2(B1, B2)
	(99)	33 67	100 0	33 67	67 33
10	Test 1:	B1(A2, A1)	B2(A1, A2)	C1(A2, A1)	C2(A1, A2)
	(99)	0 100	0 100	0 100	0 100
	Series II				
11	Test 5:	B1(C2, N3)	B2(C1, N4)	C1(B2, N3)	C2(B1, N4)
	(98)	100 0	100 0	100 0	100 0
12	Test 6:	B1(N3, N4)	B2(N3, N4)	C1(N3, N4)	C2(N3, N4)
	(100)	100 0	33 67	83 17	67 33
13	Test 5:	B1(C2, N4)	B2(C1, N3)	C1(B2, N4)	C2(B1, N3)
	(99)	0 100	100 0	17 83	100 0
14	Test 6:	B1(N3, N4)	B2(N3, N4)	C1(N3, N4)	C2(N3, N4)
	(98)	0 100	0 100	0 100	0 100

Table 3 (Continued)

	Tests For Equivalence				
15	Test 1: (98)	B1(A2, A1) 0 100	B2(A1, A2) 0 100	C1(A2, A1) 0 100	C2(A1, A2) 0 100
16	Test 2: (96)	B1(C2, C1) 0 100	B2(C1, C2) 33 67	C1(B2, B1) 0 100	C2(B1, B2) 0 100
	Series I				
17	Test 4: (97)	B1(N1, N2) 67 33	B2(N1, N2) 33 67	C1(N1, N2) 33 67	C2(N1, N2) 33 67
18	Test 3: (99)	B1(N1, C1) 0 100	B2(N2, C2) 0 100	C1(N1, B1) 0 100	C2(N2, B2) 0 100
19	Test 4: (100)	B1(N1, N2) 17 83	B2(N1, N2) 33 67	C1(N1, N2) 33 67	C2(N1, N2) 17 83
20	Test 3: (99)	B1(N2, C1) 0 100	B2(N1, C2) 0 100	C1(N2, B1) 0 100	C2(N1, B2) 0 100
21-25	Train A-B, A-C Matching (Set IVa Stimuli):	A1(B2, B1*)	A2(B1, B2*)	A1(C2, C1*)	A2(C1, C2*)
	Series I				
26	Test 3: (98)	B1(N1, C1) 0 100	B2(N2, C2) 0 100	C1(N1, B1) 0 100	C2(N2, B2) 0 100
27	Test 4: (99)	B1(N1, N2) 0 100	B2(N1, N2) 0 100	C1(N1, N2) 0 100	C2(N1, N2) 0 100
28	Test 3: (98)	B1(N2, C1) 0 100	B2(N1, C2) 0 100	C1(N2, B1) 0 100	C2(N1, B2) 0 100
29	Test 4: (100)	B1(N1, N2) 50 50	B2(N1, N2) 67 33	C1(N1, N2) 67 33	C2(N1, N2) 83 17
	Tests for Equivalence				
30	Test 1: (99)	B1(A2, A1) 0 100	B2(A1, A2) 0 100	C1(A2, A1) 0 100	C2(A1, A2) 0 100
31	Test 2: (100)	B1(C2, C1) 17 83	B2(C1, C2) 0 100	C1(B2, B1) 0 100	C2(B1, B2) 0 100

Table 3 (Continued)

Session #					
	Series II				
32	Test 6:	B1(N3, N4)	B2(N3, N4)	C1(N3, N4)	C2(N3, N4)
	(100)	17 83	33 67	50 50	83 17
33	Test 5:	B1(C2, N3)	B2(C1, N4)	C1(B2, N3)	C2(B1, N4)
	(99)	17 83	0 100	17 83	0 100
34	Test 6:	B1(N3, N4)	B2(N3, N4)	C1(N3, N4)	C2(N3, N4)
	(98)	50 50	33 67	83 17	33 67
35	Test 5:	B1(C2, N4)	B2(C1, N3)	C1(B2, N4)	C2(B1, N3)
	(98)	0 100	0 100	17 83	0 100
	Tests for Equivalence				
36	Test 2:	B1(C2, C1)	B2(C1, C2)	C1(B2, B1)	C2(B1, B2)
	(98)	0 100	0 100	0 100	17 83
37	Test 1:	B1(A2, A1)	B2(A1, A2)	C1(A2, A1)	C2(A1, A2)
	(99)	0 100	0 100	0 100	0 100
Session #	**Subject NO**				
1-5	Train A-B, A-C Matching (Set IIIb Stimuli):				
	A1(B2, B1*)	A2(B1, B2*)	A1(C2, C1*)	A2(C1, C2*)	
	Series II				
6	Test 6:	B1(N3, N4)	B2(N3, N4)	C1(N3, N4)	C2(N3, N4)
	(99)	100 0	0 100	100 0	0 100
7	Test 5:	B1(C2, N4)	B2(C1, N3)	C1(B2, N4)	C2(B1, N3)
	(100)	0 100	0 100	0 100	0 100
8	Test 6:	B1(N3, N4)	B2(N3, N4)	C1(N3, N4)	C2(N3, N4)
	(99)	0 100	100 0	0 100	100 0
9	Test 5:	B1(C2, N3)	B2(C1, N4)	C1(B2, N3)	C2(B1, N4)
	(100)	0 100	0 100	0 100	0 100
	Tests for Equivalence				
10	Test 1:	B1(A2, A1)	B2(A1, A2)	C1(A2, A1)	C2(A1, A2)
	(99)	0 100	0 100	0 100	0 100

Table 3 (Continued)

11	Test 2:	B1(C2,	C1)	B2(C1,	C2)	C1(B2,	B1)	C2(B1,	B2)
	(100)	0	100	0	100	0	100	0	100
	Series I								
12	Test 3:	B1(N1,	C1)	B2(N2,	C2)	C1(N1,	B1)	C2(N2,	B2)
	(99)	0	100	0	100	0	100	0	100
13	Test 4:	B1(N1,	N2)	B2(N1,	N2)	C1(N1,	N2)	C2(N1,	N2)
	(99)	33	67	100	0	17	83	100	0
14	Test 3:	B1(N2,	C1)	B2(N1,	C2)	C1(N2,	B1)	C2(N1,	B2)
	(99)	0	100	0	100	0	100	0	100
15	Test 4:	B1(N1,	N2)	B2(N1,	N2)	C1(N1,	N2)	C2(N1,	N2)
	(100)	0	100	100	0	0	100	100	0
	Tests for Equivalence								
16	Test 2:	B1(C2,	C1)	B2(C1,	C2)	C1(B2,	B1)	C2(B1,	B2)
	(99)	0	100	0	100	0	100	0	100
17	Test 1:	B1(A2,	A1)	B2(A1,	A2)	C1(A2,	A1)	C2(A1,	A2)
	(99)	0	100	0	100	0	100	0	100
18-22	Train A-B, A-C Matching (Set IVb Stimuli): A1(B2, B1*) A2(B1, B2*) A1(C2, C1*) A2(C1, C2*)								
	Tests for Equivalence								
23	Test 2:	B1(C2,	C1)	B2(C1,	C2)	C1(B1,	B2)	C2(B1,	B2)
	(100)	0	100	0	100	0	100	0	100
24	Test 1:	B1(A2,	A1)	B2(A1,	A2)	C1(A2,	A1)	C2(A1,	A2)
	(99)	0	100	0	100	0	100	0	100
	Series I								
25	Test 4:	B1(N1,	N2)	B2(N1,	N2)	C1(N1,	N2)	C2(N1,	N2)
	(99)	83	17	0	100	100	0	0	100
26	Test 3:	B1(N1,	C1)	B2(N2,	C2)	C1(N1,	B1)	C2(N2,	B2)
	(100)	0	100	0	100	0	100	0	100
27	Test 4:	B1(N1,	N2)	B2(N1,	N2)	C1(N1,	N2)	C2(N1,	N2)
	(100)	100	0	0	100	100	0	17	83

Table 3 (Continued)

28	Test 3: (99)	B1(N1, C1) 0 100	B2(N2, C2) 0 100	C1(N1, B1) 0 100	C2(N2, B2) 0 100
	Tests for Equivalence				
29	Test 1: (100)	B1(A2, A1) 0 100	B2(A1, A2) 0 100	C1(A2, A1) 0 100	C2(A1, A2) 0 100
30	Test 2: (100)	B1(C2, C1) 0 100	B2(C1, C2) 0 100	C1(B2, B1) 0 100	C2(B1, B2) 0 100
	Series II				
31	Test 5: (99)	B1(C2, N3) 0 100	B2(C1, N4) 17 83	C1(B2, N3) 0 100	C2(B1, N4) 0 100
32	Test 6: (99)	B1(N3, N4) 17 83	B2(N3, N4) 83 17	C1(N3, N4) 0 100	C2(N3, N4) 100 0
33	Test 5: (99)	B1(C2, N3) 0 100	B2(C1, N4) 0 100	C1(B2, N3) 0 100	C2(B1, N4) 0 100
34	Test 6: (99)	B1(N3, N4) 83 17	B2(N3, N4) 0 100	C1(N3, N4) 100 0	C2(N3, N4) 0 100

Appendix E

Table 4

Description of conditions and test results for Group 3 subjects (Chaining) of Experiment 2. See Appendix B for details.

Session #	Subject LH			
1-6	Train A-B, B-C Matching (Set IIIa Stimuli): A1(B2, B1*) A2(B1, B2*) B1(C2, C1*) B2(C1, C2*)			
	Tests for Equivalence			
7	Test 1: B1(A2, A1)	B2(A1, A2)	C1(B2, B1)	C2(B1, B2)
	(100) 0 100	0 100	0 100	0 100
8	Test 2: A1(C2, C1)	A2(C1, C2)	C1(A2, A1)	C2(A1, A2)
	(99) 0 100	0 100	0 100	0 100
	Series I			
9	Test 3: A1(N1, C1)	A2(N2, C2)	C1(N1, A1)	C2(N2, A2)
	(99) 0 100	0 100	0 100	0 100
10	Test 4: A1(N1, N2)	A2(N1, N2)	C1(N1, N2)	C2(N1, N2)
	(99) 50 50	83 17	50 50	67 33
11	Test 3: A1(N2, C1)	A2(N1, C2)	C1(N2, A1)	C2(N1, A2)
	(99) 0 100	0 100	0 100	0 100
12	Test 4: A1(N1, N2)	A2(N1, N2)	C1(N1, N2)	C2(N1, N2)
	(97) 50 50	17 83	67 33	50 50
	Tests for Equivalence			
13	Test 2: A1(C2, C1)	A2(C1, C2)	C1(A2, A1)	C2(A1, A2)
	(100) 0 100	0 100	0 100	0 100
14	Test 1: B1(A2, A1)	B2(A1, A2)	C1(B2, B1)	C2(B1, B2)
	(99) 0 100	0 100	0 100	0 100
	Series II			
15	Test 6: A1(N3, N4)	A2(N3, N4)	C1(N3, N4)	C2(N3, N4)
	(99) 83 17	0 100	100 0	0 100

Table 4 (Continued)

16	Test 5: (100)	A1(C2, N4) 0 100	A2(C1, N3) 0 100	C1(A2, N4) 0 100	C2(A1, N3) 0 100
17	Test 6: (99)	A1(N3, N4) 100 0	A2(N3, N4) 0 100	C1(N3, N4) 100 0	C2(N3, N4) 0 100
18	Test 5: (99)	A1(C2, N4) 0 100	A2(C1, N3) 0 100	C1(A2, N4) 0 100	C2(A1, N3) 0 100
19-23	Train A-B, B-C Matching (Set IVa Stimuli): A1(B2, B1*) A2(B1, B2*) B1(C2, C1*) B2(C1, C2*)				
	Series II				
24	Test 5: (100)	A1(C2, N3) 0 100	A2(C1, N4) 0 100	C1(A2, N3) 17 83	C1(A2, N4) 0 100
25	Test 6: (99)	A1(N3, N4) 100 0	A2(N3, N4) 0 100	C1(N3, N4) 100 0	C2(N3, N4) 0 100
26	Test 5: (100)	A1(C2, N4) 0 100	A2(C1, N3) 0 100	C1(A2, N4) 0 100	C2(A1, N3) 0 100
27	Test 6: (99)	A1(N3, N4) 0 100	A2(N3, N4) 67 33	C1(N3, N4) 17 83	C2(N3, N4) 83 17
	Tests for Equivalence				
28	Test 2: (100)	A1(C2, C1) 0 100	A2(C1, C2) 0 100	C1(A2, A1) 0 100	C2(A1, A2) 0 100
29	Test 1: (99)	B1(A2, A1) 0 100	B2(A1, A2) 0 100	C1(B2, B1) 0 100	C2(B1, B2) 0 100
	Series I				
30	Test 4: (99)	A1(N1, N2) 100 0	A2(N1, N2) 0 100	C1(N1, N2) 100 0	C2(N1, N2) 0 100
31	Test 3: (99)	A1(N1, C1) 17 83	A2(N2, C2) 0 100	C1(N1, A1) 0 100	C2(N2, A2) 0 100
32	Test 4: (100)	A1(N1, N2) 100 0	A2(N1, N2) 0 100	C1(N1, N2) 100 0	C2(N1, N2) 0 100

Table 4 (Continued)

33	Test 3:	A1(N1, C1)	A2(N2, C2)	C1(N1, A1)	C2(N2, A2)
	(100)	0 100	0 100	0 100	0 100
	Tests for Equivalence				
34	Test 1:	B1(A2, A1)	B2(A1, A2)	C1(B2, B1)	C2(B1, B2)
	(100)	0 100	0 100	0 100	0 100
35	Test 2:	A1(C2, C1)	A2(C1, C2)	C1(A2, A1)	C2(A1, A2)
	(100)	0 100	0 100	0 100	0 100
Session #	Subject AP				
1-10	Train A-B, B-C Matching (Set IIIb Stimuli):				
	A1(B2, B1*) A2(B1, B2*) B1(C2, C1*) B2(C1, C2*)				
	Series I				
11	Test 4:	A1(N1, N2)	A2(N1, N2)	C1(N1, N2)	C2(N1, N2)
	(96)	33 67	67 33	50 50	33 67
12	Test 3:	A1(N2, C1)	A2(N1, C2)	C1(N2, A1)	C2(N1, A2)
	(99)	0 100	0 100	33 67	0 100
13	Test 4:	A1(N1, N2)	A2(N1, N2)	C1(N1, N2)	C2(N1, N2)
	(100)	17 83	33 67	33 67	50 50
14	Test 3:	A1(N2, C1)	A2(N1, C2)	C1(N2, A1)	C2(N1, A2)
	(99)	0 100	17 83	0 100	17 83
	Tests for Equivalence				
15	Test 2:	A1(C2, C1)	A2(C1, C2)	C1(A2, A1)	C2(A1, A2)
	(99)	0 100	33 67	17 83	17 83
16	Test 1:	B1(A2, A1)	B2(A1, A2)	C1(B2, B1)	C2(B1, B2)
	(100)	0 100	17 83	17 83	17 83
	Series II				
17	Test 5:	A1(C2, N3)	A2(C1, N4)	C1(A2, N3)	C2(A1, N4)
	(98)	17 83	67 33	50 50	33 67

Table 4 (Continued)

18	Test 6:	A1(N3, N4)	A2(N3, N4)	C1(N3, N4)	C2(N3, N4)
	(99)	50 50	17 83	83 17	0 100
19	Test 5:	A1(C2, N4)	A2(C1, N3)	C1(A2, N4)	C2(A1, N3)
	(99)	50 50	17 83	0 100	50 50
20	Test 6:	A1(N3, N4)	A2(N3, N4)	C1(N3, N4)	C2(N3, N4)
	(99)	83 17	33 67	50 50	33 67
	<u>Tests for Equivalence</u>				
21	Test 1:	B1(A2, A1)	B2(A1, A2)	C1(B2, B1)	C2(B1, B2)
	(96)	0 100	17 83	0 100	0 100
22	Test 2:	A1(C2, C1)	A2(C1, C2)	C1(A2, A1)	C2(A1, A2)
	(98)	17 83	17 83	0 100	17 83
23-28	Train A-B, B-C Matching (Set IVb Stimuli): A1(B2, B1*) A2(B1, B2*) B1(C2, C1*) B2(C1, C2*)				
	<u>Tests for Equivalence</u>				
29	Test 1:	B1(A2, A1)	B2(A1, A2)	C1(B2, B1)	C2(B1, B2)
	(100)	0 100	0 100	0 100	0 100
30	Test 2:	A1(C2, C1)	A2(C1, C2)	C1(A2, A1)	C2(A1, A2)
	(99)	17 83	0 100	0 100	0 100
	<u>Series II</u>				
31	Test 6:	A1(N3, N4)	A2(N3, N4)	C1(N3, N4)	C2(N3, N4)
	(100)	83 17	33 67	67 33	33 67
32	Test 5:	A1(C2, N4)	A2(C1, N3)	C1(A2, N4)	C2(A1, N3)
	(99)	0 100	0 100	0 100	0 100
33	Test 6:	A1(N3, N4)	A2(N3, N4)	C1(N3, N4)	C2(N3, N4)
	(99)	50 50	33 67	67 33	33 67
34	Test 5:	A1(C2, N4)	A2(C1, N3)	C1(A2, N4)	C2(A1, N3)
	(99)	0 100	17 83	0 100	0 100
	<u>Tests for Equivalence</u>				
35	Test 2:	A1(C2, C1)	A2(C1, C2)	C1(A2, A1)	C2(A1, A2)
	(97)	17 83	0 100	0 100	0 100

Table 4 (Continued)

36	Test 1: (100)	B1(A2, A1) 0	100	B2(A1, A2) 0	100	C1(B2, B1) 0	100	C2(B1, B2) 0	100
	Series I								
37	Test 3: (99)	A1(N1, C1) 0	100	A2(N2, C2) 0	100	C1(N1, A1) 0	100	C2(N2, A2) 0	100
38	Test 4: (100)	A1(N1, N2) 17	83	A2(N1, N2) 67	33	C1(N1, N2) 50	50	C2(N1, N2) 50	50
39	Test 3: (100)	A1(N2, C1) 17	83	A2(N1, C2) 0	100	C1(N2, A1) 0	100	C2(N1, A2) 0	100
40	Test 4: (99)	A1(N1, N2) 67	33	A2(N1, N2) 30	67	C1(N1, N2) 50	50	C2(N1, N2) 50	50

Session #	Subject GC								
1-11	Train A-B, B-C Matching (Set IIIa Stimuli): A1(B2, B1*) A2(B1, B2*) B1(C2, C1*) B2(C1, C2*)								
	Tests for Equivalence								
12	Test 2: (97)	A1(C2, C1) 0	100	A2(C1, C2) 0	100	C1(A2, A1) 17	83	C2(A1, A2) 17	83
13	Test 1: (99)	B1(A2, A1) 0	100	B2(A1, A2) 0	100	C1(B2, B1) 33	67	C2(B1, B2) 0	100
	Series II								
14	Test 5: (98)	A1(C2, N3) 0	100	A2(C1, N4) 0	100	C1(A2, N3) 0	100	C2(A1, N4) 0	100
15	Test 6: (96)	A1(N3, N4) 50	50	A2(N3, N4) 33	67	C1(N3, N4) 67	33	C2(N3, N4) 33	67
16	Test 5: (100)	A1(C2, N4) 0	100	A2(C1, N3) 0	100	C1(A2, N4) 0	100	C2(A1, N3) 0	100
17	Test 6: (98)	A1(N3, N4) 33	67	A2(N3, N4) 50	50	C1(N3, N4) 50	50	C2(N3, N4) 50	50

Table 4 (Continued)

	Tests for Equivalence								
18	Test 1: (98)	B1(A2, A1)		B2(A1, A2)		C1(B2, B1)		C2(B1, B2)	
		0	100	0	100	0	100	0	100
19	Test 2: (98)	A1(C2, C1)		A2(C1, C2)		C1(A2, A1)		C2(A1, A2)	
		0	100	0	100	0	100	0	100
	Series I								
20	Test 4: (97)	A1(N1, N2)		A2(N1, N2)		C1(N1, N2)		C2(N1, N2)	
		33	67	67	33	33	67	33	67
21	Test 3: (99)	A1(N2, C1)		A2(N1, C2)		C1(N2, A1)		C2(N1, A2)	
		17	83	0	100	17	83	0	100
22	Test 4: (97)	A1(N1, N2)		A2(N1, N2)		C1(N1, N2)		C2(N1, N2)	
		33	67	67	33	33	67	50	50
23	Test 3: (99)	A1(N2, C1)		A2(N1, C2)		C1(N2, A1)		C2(N1, A2)	
		0	100	17	83	17	83	0	100
24-32	Train A-B, B-C Matching (Set IVa Stimuli): A1(B2, B1*) A2(B1, B2*) B1(C2, C1*) B2(C1, C2*)								
	Series I								
33	Test 3: (100)	A1(N1, C1)		A2(N2, C2)		C1(N1, A1)		C2(N2, A2)	
		0	100	0	100	0	100	0	100
34	Test 4: (98)	A1(N1, N2)		A2(N1, N2)		C1(N1, N2)		C2(N1, N2)	
		50	50	50	50	83	17	33	67
35	Test 3: (99)	A1(N1, C1)		A2(N2, C2)		C1(N1, A1)		C2(N2, A2)	
		0	100	0	100	17	83	0	100
36	Test 4: (99)	A1(N1, N2)		A2(N1, N2)		C1(N1, N2)		C2(N1, N2)	
		50	50	83	17	50	50	33	67
	Tests for Equivalence								
37	Test 1: (99)	B1(A2, A1)		B2(A1, A2)		C1(B2, B1)		C2(B1, B2)	
		0	100	0	100	0	100	0	100
38	Test 2: (99)	A1(C2, C1)		A2(C1, C2)		C1(A2, A1)		C2(A1, A2)	
		0	100	0	100	0	100	0	100

Table 4 (Continued)

	Series II				
39	Test 6: (99)	A1(N3, N4) 67 33	A2(N3, N4) 50 50	C1(N3, N4) 67 33	C2(N3, N4) 33 67
40	Test 5: (99)	A1(C2, N4) 0 100	A2(C1, N3) 0 100	C1(A2, N4) 0 100	C2(A1, N3) 0 100
41	Test 6: (97)	A1(N3, N4) 50 50	A2(N3, N4) 17 83	C1(N3, N4) 50 50	C2(N3, N4) 50 50
42	Test 5: (98)	A1(C2, N4) 0 100	A2(C1, N3) 0 100	C1(A2, N4) 0 100	C2(A1, N3) 0 100
	Tests for Equivalence				
43	Test 2: (98)	A1(C2, C1) 0 100	A2(C1, C2) 0 100	C1(A2, A1) 0 100	C2(A1, A2) 0 100
44	Test 1: (97)	B1(A2, A1) 17 83	B2(A1, A2) 0 100	C1(B2, B1) 0 100	C2(B1, B2) 0 100

Session #	Subject ED				
1-5	Train A-B, B-C Matching (Set IIIb Stimuli): A1(B2, B1*) A2(B1, B2*) B1(C2, C1*) B2(C1, C2*)				
	Series II				
6	Test 6: (99)	A1(N3, N4) 17 83	A2(N3, N4) 100 0	C1(N3, N4) 0 100	C2(N3, N4) 50 50
7	Test 5: (98)	A1(C2, N3) 0 100	A2(C1, N4) 0 100	C1(A2, N3) 0 100	C2(A1, N4) 17 83
8	Test 6: (96)	A1(N3, N4) 17 83	A2(N3, N4) 100 0	C1(N3, N4) 17 83	C2(N3, N4) 100 0
9	Test 5: (97)	A1(C2, N3) 0 100	A2(C1, N4) 17 83	C1(A2, N3) 0 100	C2(A1, N4) 17 83

Table 4 (Continued)

	<u>Tests for Equivalence</u>				
10	Test 1: (100)	B1(A2, A1) 0 100	B2(A1, A2) 0 100	C1(B2, B1) 0 100	C2(B1, B2) 0 100
11	Test 2: (97)	A1(C2, C1) 0 100	A2(C1, C2) 17 83	C1(A2, A1) 0 100	C2(A1, A2) 17 83
	<u>Series I</u>				
12	Test 3: (100)	A1(N1, C1) 0 100	A2(N2, C2) 0 100	C1(N1, A1) 0 100	C2(N2, A2) 0 100
13	Test 4: (99)	A1(N1, N2) 33 67	A2(N1, N2) 67 33	C1(N1, N2) 50 50	C2(N1, N2) 67 33
14	Test 3: (99)	A1(N2, C1) 0 100	A2(N1, C2) 0 100	C1(N2, A1) 0 100	C2(N1, A2) 0 100
15	Test 4: (99)	A1(N1, N2) 50 50	A2(N1, N2) 83 17	C1(N1, N2) 33 67	C2(N1, N2) 67 33
	<u>Tests for Equivalence</u>				
16	Test 2: (99)	A1(C2, C1) 0 100	A2(C1, C2) 0 100	C1(A2, A1) 17 83	C2(A1, A2) 0 100
17	Test 1: (99)	B1(A2, A1) 0 100	B2(A1, A2) 0 100	C1(B2, B1) 0 100	C2(B1, B2) 0 100
18-26	Train A-B, B-C Matching (Set IVb Stimuli): A1(B2, B1*) A2(B1, B2*) B1(C2, C1*) B2(C1, C2*)				
	<u>Tests for Equivalence</u>				
27	Test 2: (99)	A1(C2, C1) 0 100	A2(C1, C2) 17 83	C1(A2, A1) 17 83	C2(A1, A2) 17 83
28	Test 1: (100)	B1(A2, A1) 33 67	B2(A1, A2) 17 83	C1(B2, B1) 17 83	C2(B1, B2) 0 100
	<u>Series I</u>				
29	Test 4: (98)	A1(N1, N2) 33 67	A2(N1, N2) 0 100	C1(N1, N2) 83 17	C2(N1, N2) 67 33
30	Test 3: (99)	A1(N1, C1) 0 100	A2(N2, C2) 0 100	C1(N1, A1) 0 100	C2(N2, A2) 0 100

Table 4 (Continued)

31	Test 4: (96)	A1(N1, N2) 67 33	A2(N1, N2) 33 67	C1(N1, N2) 67 33	C2(N1, N2) 50 50
32	Test 3: (99)	A1(N1, C1) 0 100	A2(N2, C2) 0 100	C1(N1, A1) 0 100	C2(N2, A2) 17 83
	Tests for Equivalence				
33	Test 1: (97)	B1(A2, A1) 33 67	B2(A1, A2) 0 100	C1(B2, B1) 17 83	C2(B1, B2) 0 100
34	Test 2: (98)	A1(C2, C1) 0 100	A2(C1, C2) 0 100	C1(A2, A1) 17 83	C2(A1, A2) 0 100
	Series II				
35	Test 5: (99)	A1(C2, N3) 0 100	A2(C1, N4) 0 100	C1(A2, N3) 0 100	C2(A1, N4) 0 100
36	Test 6: (97)	A1(N3, N4) 83 17	A2(N3, N4) 17 83	C1(N3, N4) 50 50	C2(N3, N4) 17 83
37	Test 5: (99)	A1(C2, N4) 0 100	A2(C1, N3) 0 100	C1(A2, N4) 0 100	C2(A1, N3) 17 83
38	Test 6: (96)	A1(N3, N4) 83 17	A2(N3, N4) 67 33	C1(N3, N4) 83 17	C2(N3, N4) 50 50

VITA

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Ph.D., Utah State University, Psychology, 1980

Honors, Memberships, and Affiliations

Member, American Psychological Association, "Student in Psychology," Division 25
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Fields of Present Major Scientific Interest

Experimental Analysis of Behavior, Applied Behavior Analysis, Experimental Child Psychology and Child Development, Language and Communicative Behavior, Stimulus Control, Parent and Teacher Training

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Teaching Assistant, Eastern Washington State College, Summer 1969, Fall 1970
Teaching Intern, Yakima Valley College, Winter 1971
Parent Trainer, Clark County School District, Las Vegas, NV, Fall 1971
School Psychologist, Clark County School District, Las Vegas, 1971-74
Behavioral Consultant, Behavior Management Co., Utah State University, 1975-76
Teaching Assistant, Utah State University, Winter 1976
Behavior Specialist, University Affiliated Exceptional Child Center, Utah State University, 1975-76
Parent Trainer, ECC, Utah State University, Winter 1976
Research Assistant & Junior Scientist, Bureau of Child Research, University of Kansas, 1977-78

Research Associate & Program Director, Personnel Preparation Project for the Severely Handicapped/Hearing Impaired, Dept. of Hearing and Speech, University of Kansas Medical Center, 1978-present

Supplemental Information

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School Psychologist, Nevada 1971-74

Consultantships

Guest Reviewer, Journal of Applied Behavior Analysis, 1975-76
Member, Kansas State Deaf-Blind Advisory Council

Publications

Articles

Stromer, R. The use of contingent reinforcement to increase the verbal behavior of a seven-year-old child. School Applications of Learning Theory, 1972, 5, 4-9.

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Association on Mental Deficiency, New Orleans, June 1977.

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Unpublished Papers

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