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Retention of information by object discrimination learning set experienced northern bluejays (Cyanocitta Cristata).

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RETENTION OF INFORMATION BY OBJECT DISCRIMINATION LEARNING SET EXPERIENCED NORTHERN BLUEJAYS (CYANOCITTA CRISTATA)

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RETENTION OF INFORMATION BY OBJECT DISCRIMINATION LEARNING SET EXPERIENCED NORTHERN BLUEJAYS (<u>CYNAOCITTA CRISTATA</u>)

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A series of experiments were conducted to examine the ability of object discrimination learning set (ODLS)-experienced bluejays (*Cyanocitta Cristata*) to retain the information necessary to solve ODLS problems. Experiment I. found that subjects retained the general rule or hypothesis information for solving ODLS problems over a retention interval (RI) of 5 months. Experiment I. also found that information concerning specific stimulus objects within each problem was not retained for more than several minutes. Experiment II. showed that no additional loss of information about stimulus objects occured over a 24 hour RI. The results of Experiments I. and II. indicate two distinct factors necessary for successful ODLS performance: knowledge about the correct hypothesis and knowledge about the specific stimulus objects. Experiments I. and II. also found better performance on problems which were reinforced on Trial 1 than on those which were nonreinforced on Trial 1. This result was discussed in terms of Bessemer's (1966) preference hypothesis. Experiments III. and IV. were designed to examine this difference between problems reinforced on Trial 1 and nonreinforced on Trial 1 by presenting a single stimulus object on Trial 1. The results of Experiments III. and IV. showed higher performance on problems nonreinforced on Trial 1. This result was probably due to an increased response shift tendency which accompanied the single-object procedure. These results with bluejays are in good agreement with the results of similar studies using rhesus monkeys.

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The purpose of the present series of experiments was to examine in some detail the characteristics of short-term memory in object discrimination learning set (ODLS)-experienced bluejays (Cyanocitta Cristata). ODLS consists of the presentation of a series of two-choice simultaneous discrimination problems. Typically, non-correction procedures are used with position irrelevant throughout. Each new problem is defined by the introduction of a new pair of discriminative stimuli. ODLS acquisition is defined as an increase in the speed of solving new problems accompanying experience with problem solving. Most comparative research performed with ODLS as the basic paradigm has concentrated on demonstration of ODLS acquisition. The only exceptions to this have been a large number of experiments with primates as subjects, particularly rhesus and other macaque species. The present experiment was designed to provide more analytic information about ODLS behavior in a species vastly different from the rhesus monkey.

One logical analysis of the ODLS situation suggests that there are basically two factors which the ODLS-experienced subject must be able to apply in order to solve new problems rapidly. First, the subject must have developed some pattern of responding which is applicable to all or most new problems, for example Restle's (1958) "type a, b, and c cues" or Levine's (1959) "hypotheses". For the ODLS procedure, the optimal response pattern would be to persist responding to previously reinforced stimuli and avoid respond-

ing to previously nonreinforced stimuli. Levine called this response pattern the "win-stay, lose-shift, object" hypothesis. In this discussion the term hypothesis will be used as a consistent pattern or rule for responding.

The second factor an ODLS subject must be able to apply is some source of information about the events of the previous trial, specifically which object was chosen and whether or not it was reinforced. This information is necessary if the hypothesis is to be used efficiently. Thus there are two distinct factors potentially involved in the ODLS performance of an experienced subject: a hypothesis and the outcome of the previous trial. These can be conceptualized as some type of general solution strategy which is used on all problems and the specific information necessary to apply that strategy on individual problems. For this discussion, these factors may be called hypothesis information and stimulus information, respectively. Although both thses types of information must be available to the subject to permit efficient ODLS performance, the two types may be acquired in similar or different ways, may rest on similar or different basic processes, and may or may not be retained equally well. The question concerning retention of these two types of information seems particularly amenable to experimental analysis.

The placement of a retention interval (RI) between problems or between trials within a problem may be used to examine the retention of both types of information. Hypothesis information can be studied by testing ODLS-experienced Ss

after a relatively long RI during which no problems are presented. Since these Ss had shown high levels of ODLS performance prior to the RI, it is assumed they had learned the correct hypothesis information. If an S shows only a performance decrement (as measured by the number of problems the S must receive before regaining the level of performance prior to the RI) following an RI, it can be assumed that the S did not forget the hypothesis information over the RI. If, on the other hand, the S's performance drops significantly and reacquisition resembles the learning of a naive S, it can be concluded that the S did lose the hypothesis information. Since new problems are used after the RI, a drop in performance cannot be due to loss of stimulus information.

The second factor, knowledge of stimulus information, may be examined similarly. Retention of this information may be analyzed by placing an RI between two trials of a problem and comparing performance of the trials preceeding and immediately following the RI. If the S's responding following an intraproblem RI resembles a naive S, it would be unclear whether hypothesis information or both hypothesis information and stimulus information were not retained. If performance only on the trial immediately following the RI is lower than is found without an RI, it can be said that only stimulus information was lost over the RI. Bessemer (1966) suggests that if an S loses the stimulus information during an RI, the situation on the trial immediately following the RI is similar to a Trial 1 situation.

It is now appropriate to look at the studies relevant to

hypothesis and stimulus information. Data from the literature on monkeys will be discussed first, followed by data from a study using birds. The initial theoretical aspect considered was retention of ODLS hypothesis information. Braun, Patton, and Barnes (1952) have shown that ODLS-experienced rhesus monkeys do not show a decrement in ODLS performance following an RI of eight weeks. Braun, *et al.*, trained rhesus monkeys on 515 ODLS problems, then introduced an eight week RI, then tested the *S*s on 96 new ODLS problems. Performance before the RI was approximately 90% correct, based on Trial 2 and 3 responses. After the RI, performance was about 83% correct on problems 1-16, then 97% correct for problems 17-32, again based on Trials 2 and 3. This performance following the RI is clearly unlike a naive *S* and would indicate good retention of hypothesis information. Chow (1952 and 1954) found similar results over a nine week RI, again with rhesus monkeys. These studies seem to show that hypothesis information in rhesus monkeys is unaffected by long RIs.

The second aspect, retention of stimulus information, has also been studied in monkeys. Zimmerman (1965) tested ODLS-experienced rhesus monkeys, but did not use the within-problem RI procedure. He gave six repeated relearning cycles of the same 100 six trial problems at 5 problems/day, thus making six cycles of 20 days each. Average Trial 1 performance increased from cycle to cycle, showing some retention of stimulus information over the 20 day cycle, even with 99 interpolated problems. There was, however, loss of stimulus

information as evidenced by a 15-20% drop in performance from the Trial 6 performance of a given problem in a given cycle to the Trial 1 performance on the same problem in the following cycle. Because of the repeated presentation of each problem and the many interpolated problems, it is difficult to reach any unequivocal conclusions about the effect of an RI on stimulus information. Strong (1959) has reported that ODLS-experienced rhesus monkeys could be trained to show no loss of stimulus information for RIs up to seven months. Strong, however, also used a procedure very much unlike the within-problem RI procedure described earlier. Strong required that Ss reach a criterion of 32 out of 36 trials correct for six, 6-trial problems before they were given six new problems. Relearning trials on all previous problems were reintroduced following mastery of each successive problem block. This extremely stringent criterion for learning each problem would be expected to cause over-learning and thus improve retention of stimulus information. Two other studies have shown evidence that stimulus information is lost over an RI. Leary (1956) presented each object for 6 or 12 acquisition trials. The object was paired with a positive or negative object retained from the preceeding problem for the first 6 trials and a novel object for the last 6 trials, if that was necessary. After a 24 hour RI, performance dropped about 40% from a level of approximately 90% correct on the trial preceeding the RI to about 50% on the first trial following the RI. The non-standard acquisition training, however, makes this result difficult

to discuss in terms of stimulus information. Finally, Bessemer (1966) used a procedure which placed the RI between Trials 3 and 4 of a problem. Three trials of acquisition were given on 8 problems, then an RI of either 4 min., 1 hour, or 24 hours was introduced, and finally retention trials for each problem were given. With average performance on the last acquisition trial at 93% correct, performance on the retention trial was found to be 75%, 68%, and 65% correct for RIs of 4 min., 1 hour, and 24 hours, respectively. Bessemer's results clearly show a loss of stimulus information over the RI. Although these studies are not conclusive in showing the existence or extent of stimulus information loss over an RI, Bessemer's experiment which used the most standard acquisition procedure did find a sizeable loss. In addition to this overall loss of stimulus information, Bessemer also found differential decrements in performance after the RI on problems which were reinforced on the first trial as opposed to problems which were not reinforced on the first trial. He found that retention performance on an R-T1 problem was approximately 85%, 80%, and 78% correct following intervals of 4 min., 1 hour, and 24 hours, respectively. Performance on NR-T1 problems for the same intervals was approximately 65%, 58%, and 53% correct.

One of the results described for primates has also been found to exist in ODLS-experienced birds. In regards to retention of hypothesis information, Kamil and Hunter (1970) have tested ODLS performance following a 21 week RI. The Ss had received 1000 ODLS problems, then were not run for the

21 week RI, then were given additional problems. Performance on Trial 2 of the problems following the RI was 70% correct in the first session of 5 problems, thus showing no loss of ODLS ability of hypothesis information during the RI.

The present study analyzed whether the phenomena described above, which have mainly been investigated in monkeys, are also present in the northern bluejay. Investigation of the bluejay's ability to retain hypothesis and stimulus information should provide evidence on how the ODLS-experienced bluejay solves a new problem. First, this study examined long-term retention of hypothesis information. Second, it investigated short-term retention of stimulus information. Finally, it examined whether bluejays exhibit differential retention performance following R-T1 and NR-T1 problems.

METHOD-General

Subjects: The Ss were five bluejays (*Cynaocitta Cristata*), 2 2½ years in age and 3 1½ years in age at the beginning of the study (one additional bird was dropped from the study following Experiment 1 because of erratic and poor performance in pretraining and his results are not included in the study). All Ss were captured locally when approximately 14 days old and were handraised in the laboratory. Birds S29 and S30 were taken from the same nest, but the nests of the other Ss are unknown. All Ss were ODLS -experienced, having already received 400-700 ODLS problems in previous experiments. The Ss had not, however, received any learning set problems in the 5 months prior to this study. All Ss were maintained at 85% *ad lib* feeding during the entire

study, in each experiment.

Apparatus: The apparatus was a modified version of the WGTA, similar to that used by Hunter and Kamil (1971). The bird chamber was made of Masonite, 26.7 x 33 x 33 cm high, with a wooden perch at one end. A smaller wooden enclosure was attached to the outside of the animal chamber on the end near the perch. The interior floor of this enclosure contained three shallow foodwells, one in the center and one on each side, 7.1 cm off the midline. The S's access was through small rectangular ports in front of the foodwells. A Masonite guillotine door separated the foodwell area from the animal chamber during intertrial intervals, and a hinged door constructed of perforated circuit board separated the E from the foodwell area during a trial. The interior of the foodwell area was lit by two 10-W bulbs. All interior portions of the apparatus were painted with nontoxic gray paint. During experimental sessions, the animal chamber was placed in an acoustically tiled cubicle, inside which masking white noise was present.

The stimulus objects were 3-dimensional "junk" objects taken from the laboratory collection. All objects had been used in previous studies with these Ss. Reinforcers were one half of a mealworm (tenebrio larvae).

Procedure: A problem in this study was how to re-pair stimulus objects into new pairs. Since the stimulus population in this study was limited to 180 objects, enough for 90 problems at one time, a re-pairing procedure was necessary after each cycle of 90 problems was exhausted. At the end of

each cycle a computer was used to randomly generate 90 new pairs from the numbers 1-180, which represented the stimulus objects. Care was taken by the E to see that as each cycle of new problems was introduced no object was repeated until at least 70 other objects had intervened. Also, any problem in which the stimulus objects were judged by the E to be too similar was not used.

Throughout the study a session consisted of 6, five-trial problems. For half of the problems in each session, both objects were baited on Trial 1 and for the remaining problems both objects were unbaited on Trial 1. When both objects were baited the object chosen on Trial 1 became the reinforced or positive object for the problem, while in the unbaited problems the object not chosen on Trial 1 became the positive object.

In order to control for the sequential position of the reinforced object during Trials 2-4, the 16 possible sequences (e.g. AAA-Positive Trial 1, BBA-Negative Trial 1, etc. when mirror images are grouped and Trial 1 outcomes are taken into account) were used equally often and in a random order, similar to Kamil and Hunter (1970). This set of 16 sequences may be called a complete sequential set. The position of the objects on Trial 5 remained unchanged from Trial 4 on half of the problems and was changed for the other half, in a random fashion. Throughout the study problems were presented in complete sequential sets, thus balancing the sequential positions of the reinforced object.

Several days before Experiment I-Pretraining began, the Ss were placed in the experimental chamber for habituatuion sessions. During these sessions food was placed in the foodwells and the Ss were allowed to eat. Several sessions were given with plain wooden blocks covering the foodwells and the Ss were required to make the appropriate response to uncover the foodwells.

Experiment I.: Pretraining and Retention Testing, Two Objects

There were several purposes for Experiment I.. The first objective was to test the long-term retention of hypothesis information. The second was to examine the short-term retention of stimulus information. The final purpose was to examine whether the reinforcement outcome on Trial 1 has any differential effect on retention of stimulus information, as found by Bessemer (1966).

Procedure:

Pretraining: During Pretraining each subject received six complete sequential sets, or 96 problems. Problems were presented for 1 session/day for 16 days. Two objects were presented on Trials 1-5, with no RI between trials. Inter-trial intervals were approximately 10 sec. and inter-problem intervals approximately 20 sec. Both objects were baited on Trial 1 for half of the problems, both unbaited for the other half.

Retention Testing: Retention Testing was identical to Pretraining except that an RI of either 0, 2, 4, or 8 min. was

placed between Trials 2 and 3 of each problem. Trials 1 and 2 may be called acquisition trials and Trials 3, 4, and 5 retention trials. In each session the S received each interval once and two intervals twice. Over the entire 96 problems an equal number of problems was presented with each interval, 24 problems/interval. Half of the problems at each interval were both baited on Trial 1, the other half both unbaited.

Results and Discussion:

Many of the results in this Experiment and in the following experiments will be the average data from all 5 Ss. This method of presentation was used when the group data fairly represented the results from individual Ss. Data from individual Ss can be found in the Appendix.

Pretraining: The results of Pretraining offer clear evidence that the ODLS ability of experienced Ss did not deteriorate over a long RI. In order to examine the results of the first problems after the 5 mo. RI, Figure 1 presents the mean percentage correct for Trials 2-5 and the respective

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Insert Figure 1 About Here

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range of results for individual Ss on the first 12 problems. Performance began on Trial 2 at 66.7% correct and increased to 80% correct on Trial 5. The general shape of the curve increases nonlinearly to an asymptote at 80% correct. These results are clearly unlike the performance of naive Ss. Hunter and Kamil (1971) showed that naive Ss did not reach a level of 67% correct on Trial 2 until after at least 100

problems. Another way to analyze the Pretraining data is to compare performance on problems 1-48 and 49-96 to determine whether any interproblem improvement occurred. This presentation of the data, as shown in Figure 2, illustrates no

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Insert Figure 2 About Here

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interproblem improvement throughout Pretraining. Hunter and Kamil found considerable interproblem improvement from problems 1-100 to 101-200 for naive Ss. If the Ss in this experiment had lost hypothesis information over the RI and were relearning how to solve ODLS problems, improvement from problems 1-48 to 49-96 would be expected.

Because there was little if any resemblence of these sophisticated Ss to naive SS after the 5 mo. RI, it can be concluded that hypothesis information was certainly retained over the long RI.

Another result found in Pretraining was that performance on reinforced Trial 1 (R-T1) problems was higher than on non-reinforced Trial 1 (NR-T1) problems. Figure 3 shows performance on Trials 2-5 separated into R-T1 and NR-T1.

Insert Figure 3 About Here

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problems. The ANOVA of these results shown in Table 1 indicates that the effects of both Reward and Trial were

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Insert Table 1 About Here

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significant ($p < .025$ and $p < .001$, respectively). The

interaction was not significant, although the difference between R-T1 and NR-T1 problems appear to be decreasing over trials. This result of a higher percentage correct on R-T1 problems was not found in several previous studies with monkeys. Although they didn't report results of individual trials, but only performance based on Trials 2-6, Harlow and Hicks (1957) found no difference in performance between R-T1 and NR-T1 problems. They mixed single-object and two-object procedures on Trial 1 during each session, however, which may have affected their results. Additional studies with rhesus monkeys by Riopelle (1953) and Behar (1961) found slightly better performance following NR-T1 problems, although Behar used Ss naive to the ODLS task. Kamil and Hunter (1970), on the other hand, found that Myna birds exhibited better performance on R-T1 problems than on NR-T1 problems.

A final treatment of the Pretraining data was to separately analyze the results of problems 1-48 and 49-96 into R-T1 and NR-T1 problems, as shown in Table 2. The most interesting result is that the superiority of Trials 2

Insert Table 2 About Here

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and 3 in the R-T1 problems doesn't occur until problems 49-96. Matched t-tests show that performance on Trials 2 and 3 is significantly higher on R-T1 problems ($t=5.8$, $df=4, p<.01$ and $t=4.05, df=4, p<.02$, respectively). One possible explanation for this result could be some type of

warm-up effect which was occurring on problems 1-48. This warm-up period would not affect hypothesis information, but only the differential performance on R-T1 and NR-T1 problems. Another explanation might be that there is some learning factor involved in the superiority of R-T1 problems. It would not be expected that learning could occur after only 48 problems, although perhaps it is an effect that was not retained over the RI but could be relearned quickly.

Retention Testing: Performance on Trials 2-5 during Retention Testing is shown in Table 3. The mean percentage correct for

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Insert Table 3 About Here

Trial 2 has been calculated for the R-T1 and NR-T1 problems. It is justifiable to average over the RIs, since the RI does not affect Trial 2. Performance on Trial 2 is again higher for R-T1 problems, just as in Pretraining.

Percentage correct on Trial 3, the first retention trial, is shown in Figure 4. Performance on problems

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Insert Figure 4 About Here

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without an RI was almost identical for R-T1 and NR-T1 problems. The Trial 3 superiority of R-T1 problems in Pretraining did not occur in Retention Testing at the 0 min. RI. If there had been lower performance on Trial 3 of NR-T1 problems, it would have been difficult to interpret any differential decrements in performance because of different initial levels. Because there is no difference in

percentage correct on Trial 3 between R-T1 and NR-T1 problems at the 0 min. RI, it is possible to compare directly differences between percentage correct on Trial 3 for R-T1 and NR-T1 problems at other intervals. For the 2, 4, and 8 min. RIs, performance was always higher on R-T1 problems, although the overall level of performance decreased as the RIs became longer. Both curves drop rapidly during the first 4 minutes then seem to reach an asymptote at the 8 min. RI. The ANOVA of these results is shown in Table 4. Both the effects of Reward and Interval are

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Insert Table 4 About Here

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highly significant (p .005 for both), while the interaction is not significant. The high performance at the 0 min. RI is expected, since little stimulus information would be lost. Stimulus information is not retained completely over the 2, 4, or 8 min. RIs, as shown by the lower performance at these RIs. As Figure 4 indicates, the greatest drop in performance occurs in the first four minutes and only a slight further decrement in the last four minutes. This could indicate that almost all the stimulus information has been lost in the first four minutes.

Bessemer (1966) had previously found that differential performance following RIs, dependent on whether Trial 1 was reinforced or nonreinforced, occurs in rhesus monkeys. He suggested that if an S were to lose the stimulus information over an RI, the first retention trial would be similar to a

Trial 1 situation. In the actual Trial 1 situation, Bessemer hypothesizes that the S responds to one of the two objects on the basis of a preference for some quality of that object (e.g. hue, size, etc.) which is usually not known to the E. The object chosen on Trial 1 may be called the preferred object. Thus if an S loses the stimulus information over an RI, the first response after the RI resembles a Trial 1 response and the S again chooses the preferred object. If the preferred object was correct for a given problem, the S will respond correctly on the first trial after an RI regardless of whether stimulus information was retained. If the preferred object was incorrect, the S will respond correctly on the first trial after an RI only if stimulus information is retained, always assuming the S has retained the correct hypothesis information. If this "preference" hypothesis is correct, dirrerential performance following R-T1 and NR-T1 problems would occur whenever stimulus information isn't retained. Performance would thus be higher on R-T1 problems because the preferred object is correct.

Bessemer's preference hypothesis predicts the differential performance on R-T1 and NR-T1 problems found in Experiment I. In Pretraining, the differential performance was found without an RI. Perhaps other tendencies which cause the S to lose stimulus information (e.g. not attending to the stimuli, distraction, other factors unknown to the E) may act on the first several trials of a problem. If there

were such a loss of stimulus information, the differential performance could occur without an RI. The problems in Retention Testing which had 2, 4, and 8 min. RIs clearly showed a loss of stimulus information. The preference hypothesis would use this loss of stimulus information to predict better performance on R-T1 problems which, in fact, occurred.

An alternative explanation to the preference hypothesis might depend on the number of reinforcements received by the S. The procedure used in Experiment I placed two acquisition trials before the RI. An NR-T1 problem could only be reinforced on one of these trials, but an R-T1 problem could be reinforced on both trials. The number of reinforcements was different for R-T1 and NR-T1 problems. If a greater number of reinforcements caused stonger and longer retention of stimulus information, R-T1 problems should show higher performance after the RI. This may be called the reinforcement hypothesis.

Experiment II.: 24 Hour Retention Test, Two Objects

The first purpose of this Experiment was to determine whether any additional loss of stimulus information, as measured by a lower percentage correct, would occur after the 8 min. RI tested in Experiment I. If stimulus information was so short-lived and labile to be completely lost over 8 min., no additional performance decrement would be expected over 24 hours. Second, if the preference for specific objects suggested by the results of Experiment I were

only temporary, it would be expected that there would be a smaller difference in performance between R-T1 and NR-T1 problems after 24 hours. Finally, the 24 hour RI may eliminate the differential performance following the RI if that differential performance were caused by different amounts of reinforcement. The reinforcement hypothesis suggests that R-T1 problems cause better retention of stimulus information. The reinforcement hypothesis would predict no difference between R-T1 and NR-T1 problems if all stimulus information were to be lost. If any additional stimulus information were lost over a 24 hour RI, the reinforcement hypothesis would predict less difference between R-T1 and NR-T1 problems after 24 hours than after 8 min..

Procedure:

The procedure was similar to Experiment I in the placement of the RI between Trials 2 and 3. Because only one RI, 24 hours, was used, it was necessary to have interpolated problems between the acquisition and retention trials (i.e. new problems were introduced during the RIs). Each session began with the retention trials for the preceeding day's six problems, followed by the acquisition trials for the six new problems. The Experiment lasted seven days, the first day being only acquisition trials and the last day only retention trials. A total of 36 problems were presented. It was planned that two complete sequential sets, or 32 problems, would be presented, but by the E's mistake four extra problems were presented.

Results and Discussion:

Figure 5 shows the performance on Trials 2-5.

Insert Figure 5 About Here

Performance is higher on every trial for R-T1 problems, although the difference between R-T1 and NR-T1 decreases on Trials 4 and 5. The higher percentage correct on Trial 2 for the R-T1 problems is identical to Experiment I. The preference hypothesis again predicts higher performance on Trial 2 for R-T1 problems because the S responds to the preferred object in the absence of complete stimulus information. The reinforcement hypothesis predicts better performance of Trial 2 for R-T1 problems because those trials are always preceded by reinforcement.

Performance on the first retention trial is shown in Figure 4. Performance after 24 hours is approximately the same as after 8 min., indicating that no further loss of stimulus information occurred after 8 min.. The better performance on R-T1 problems found for shorter RIs is also found after the 24 hour RI. In the discussion of Experiment I it was shown that the preference hypothesis could explain the better performance on R-T1 problems. If the preference for specific objects were to become weak or switch over a longer RI, the superior performance on R-T1 problems should be decreased or eliminated. The results of this Experiment seem to show that the preference for specific objects is relatively stable, since the difference between R-T1 and

NR-T1 problems does not change over 24 hours. The stable difference would probably not be predicted by the reinforcement hypothesis. That hypothesis depends on the longer and stronger retention of stimulus information on R-T1 problems. Since it is likely that a smaller amount of stimulus information would be retained over a 24 hour RI than an 8 min. RI (if any information is retained at all), the reinforcement hypothesis would predict a smaller difference in performance for R-T1 and NR-T1 problems. This result did not occur.

It is now appropriate to briefly examine the results from Experiments I and II in relationship to the objectives of the entire series of experiments. There were three major purposes of this study. The first was to examine the retention of hypothesis information. The results of Experiment I-Pretraining indicate little loss of hypothesis information over a long RI, which replicates the results of several other studies performed with both primates and birds. It seems clear that once a hypothesis or pattern for responding is learned, the mere passage of time does little to weaken the retention of that pattern.

The second purpose of the study was to examine the retention of stimulus information. The results of Experiment I-Retention Testing and Experiment II both showed relatively fast loss of stimulus information. It was shown that stimulus information decays most rapidly over the first 4 minutes and only slightly more over the next 24 hours, as if almost all stimulus information is lost during the first 4 minutes.

This large difference in the retention of hypothesis information and stimulus information suggests that the two types of information are either learned, stored, or retrieved by different processes. The fact that the results found in this study using bluejays are very similar to those found by others in rhesus monkeys implies that the suggestion of different processes cannot be limited to birds. It will be left for further studies to examine in more detail how the learning, storage, or retrieval processes are different.

The final purpose of this study was to examine the possibility of differential performance on R-T1 and Nr-T1 problems. Experiments I and II have both replicated Bessemer's result of better performance on R-T1 problems. The preference hypothesis and the reinforcement hypothesis have been introduced as possible explanations for this result. The two remaining experiments in the study will examine these hypotheses more closely.

Experiment III.: <u>Pretraining and Retention Testing, One Object</u>

The purpose of this Experiment was to examine more fully the differential retention effect and preference hypothesis discussed in Experiments I and II. Bessemer (1966) has shown that the two-object procedure used in Experiments I and II produced a confounding of the reinforcement value on Trial 1 with the preference value on Trial 1 because the <u>S</u> can be presumed to always choose his preferred object on Trial 1. If the differential performance were due to this confounding, the differential effect should be eliminated when the <u>S</u> is allowed to choose

the preferred object on Trial 1 for only half of the problems, thus unconfounding the reinforcement value and preference value. Bessemer's procedure which presented a single stimulus object on Trial 1 rather than a pair of objects accomplishes this unconfounding. In his single object procedure only one object was presented on Trial 1. The single object presented on Trial 1 was randomly chosen by the E from the two objects in a problem. It was assumed that over a large number of problems, half of the objects chosen would have been the S's preferred object, the other half non-preferred. Again, half of the Trial 1 responses were reinforced. Half of the S's Trial 1 responses are to the non-preferred object, which now has an equal probability of being reinforced as the preferred object. According to the preference hypothesis, the differential retention effect is dependent on the S choosing the preferred object on Trial 1 and should be eliminated by the single-object procedure. This would eliminate the differential performance after an RI if the preference hypothesis were true. The reinforcement hypothesis, however, would not be affected by the single object procedure. The reinforcement hypothesis is based only on the number of times an object has been reinforced. It states that retention of stimulus information is dependent on the number of times an object is reinforced before an RI. Since the objects reinforced on both Trials 1 and 2 have more reinforcement value than objects reinforced only on Trial 2, the reinforcement hypothesis predicts better retention following a reinforced Trial 1,

even in the single-object procedure.

The single-object procedure may, however, cause an increased amount of responding to the object introduced on Trial 2, regardless of the Trial 1 outcome. Harlow (1959) has called this the response shift tendency. It refers to the tendency of Ss to respond to novel or previously ignored stimulus in an ODLS problem, even though the other object in the problem may be the correct one. This tendency has often been discussed as a curiosity for novel or unknown objects.

Thus Experiment III was designed to decide between the preference hypothesis and the reinforcement hypothesis, since the former predicts no differential performance while the latter again predicts better performance on R-T1 problems.

Procedure:

Pretraining: Because of the novelty of the single-object procedure, a Pretraining procedure was given to familiarize the Ss with the procedure. The procedure in Experiment III- Pretraining was similar to that used in Experiment I-Pretraining. The single object presented on Trial 1 was randomly chosen from the two objects in the problem. The object on Trial 1 was placed over the center foodwell. On Trials 2-5 the objects were placed over the side foodwells, using the same procedure to determine reward sequences as described in Experiment I.

The Ss were given two sessions/day for 8 days, making a total of 96 problems. Previous results by Hunter (1971) showed that two experimental sessions/day rather than

one/day did not affect ODLS performance.

Retention Testing: This was similar to Experiment III-Pretraining except that an RI of either 0 or 4 min. was placed between Trials 2 and 3, half of the problems having the 4 min. RI. Again, two sessions were given each day, but for 14 days, making a total of 160 problems.

Results and Discussion:

Pretraining: The results of problems 1-96 of Pretraining are shown in Figure 6. The ANOVA of Pretraining results is shown in Table 5. All effects were significant,

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Insert Figure 6 and Table 5 About Here

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with the effect of Reward, Trial, and the interaction all significant ($p<.005$, $p<.005$, and $p<.01$, respectively). Subsequent matched *t*-tests showed the effects of reward significant on Trial 2 ($t=9.98$, $df=4$, $p<.002$) and approaching significance ($p<.10$) on Trials 3 and 5. The superior performance on the NR-T1 problems is probably due to the response shift tendency. This tendency would cause an *S* to choose on Trial 2 the object not present on Trial 1. If the object present on Trial 1 were incorrect, a Trial 2 response to the novel object would be correct. In very similar single-object experiments with monkeys, Moss and Harlow (1947) and Harlow and Hicks (1957) also found better performance on NR-T1 problems. These studies did not present data for individual trials, but performance was better over Trials 2-6 on NR-T1 problems. In addition, Harlow (in Koch, 1959) reported unpublished data which

showed the response shift tendency to be stronger when the single object on Trial 1 was placed over the center foodwell than when it was placed over a side foodwell. Although Experiment III was designed with Trial 1 over the center foodwell to simplify counterbalencing procedures for the position of reward, it may be necessary in future single object studies to only use the side foodwells in an attempt to decrease the response shift tendency.

Retention Testing: Performance on Trials 2-5 of problems 1-160 is shown in Table 6. Performance on Trial 2 is

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Insert Table 6 About Here

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clearly higher for NR-T1 problems, just as in Experiment III-Pretraining. Performance on Trial 3 is shown in Figure 7.

Insert Figure 7 About Here

Performance at the 0 min. RI is clearly higher for NR-T1 problems. This differential performance makes the interpretation of decrements in performance at the 4 min. RI more difficult. One method to analyze performance at the 4 min. RI would attempt to take into account the differential performance at the 0 min. RI. This method would examine the decrease in performance after 4 min. relative to performance at the 0 min. Another method does not take into account the performance at the 0 min. RI, but only analyzes absolute levels. This discussion will examine only the absolute levels. Although the relative changes after 4 min. will not be reported, these changes

are in the same direction as the absolute changes. Overall performance is again lower at the 4 min. RI. Performance is still higher following NR-T1 problems, although this difference is somewhat smaller at the 4 min. RI. The ANOVA of this data is shown in Table 7. It indicates that the effect of Reward is highly significant (p .001), the Interval effect is also significant (p .01), but

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Insert Table 7 About Here

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the interaction is not significant. The significance of the Interval effect indicates that stimulus information is being lost over the 4 min. RI, just as in Experiment I.

The preference hypothesis predicts no difference in retention for R-T1 and NR-T1 problems. This result certainly did not occur in Experiment III, presumably because of the strength of the response shift tendency. The results of Experiment III do not allow unequivocable conclusions to be stated. One possible explanation for these results could be that the single-object procedure effectively eliminated differential retention, but because the single-object procedure increased the strength of the response shift tendency better performance occurred on the NR-T1 problems. This explanation supports the preference hypothesis. On the other hand, these results do not eliminate the possibility that differential retention was not, in fact, eliminated, but only overwhelmed by a stronger response shift tendency. As long as the response shift tendency is present in an unknown amount, it is not possible to decide whether the single object procedure

eliminated differential retention caused by preference. Bessemer (1966) decreased the response shift tendency by placing the RI after 6 acquisition trials instead of after only 2 trials. He found that with 6 acquisition trials the single-object procedure eliminated the differential performance after a 24 hour RI. In a two-object procedure with the same RI, differential performance had been found. Bessemer's results from the single object experiment support the preference hypothesis. As the results of Experiment III-Pretraining show, the response shift is much smaller or absent after 3 or 4 axquisition trials. In further experiments using the single-object procedure, the RI could be placed after Trial 4 or 5 in order to reduce the response shift tendency. Another result of Experiment III involves the response shift tendency. As noted previously, the difference between R-T1 and NR-T1 problems was smaller at the 4 min. RI than the 0 min. RI, but not significantly. The overall lower performance at 4 min. would indicate that knowledge of stimulus information is decreasing over the RI. If the response shift tendency depends on the S somehow retaining information of which object was the novel object introduced into a problem, it would be expected that retention of that information should also decrease over the RI. This loss of what might be called novel stimulus information, a special case of stimulus information, should cause a decrease in the response shift tendency. In order to more completely investigate this hypothesis, future experiments could include more RIs, both shorter and longer than the 4 min. RI used in this Experiment. Experiment IV was designed to examine performance after an RI long

enough so that no retention of stimulus information would be expected.

Experiment IV.: 24 Hour Retention Test, One Object

The purpose of this Experiment was to determine whether there would be any change in performance following a much longer RI than in Experiment III. If the better retention following an NR-T1 problem shown in Experiment III were due solely to the response shift tendency, a 24 hour RI would be expected to weaken or eliminate the effect. The long RI would not allow novel stimulus information to be retained, thus eliminating the response shift tendency. The preference hypothesis would again predict no difference between R-T1 and NR-T1 performance after 24 hours.

Procedure: The procedure in Experiment IV was identical to Experiment II except that a single object was presented on Trial 1. The Experiment was performed over 14 days with a totel of 64 problems.

Results and Discussion: Figure 8 shows the results of Trials 2-5 for Experiment IV. Trial 2 performance is higher on NR-T1

Insert Figure 8 About Here

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problems, again indicating the effect of the response shift tendency.

Performance on the first retention trial is shown in Figure 7. The overall performance is exactly 50% correct, considerably lower than after the 4 min. RI. It is clear that additional stimulus information was lost over the 24 hour interval.

The superiority of NR-T1 problems is still present after 24 hours. The difference in performance for NR-T1 and R-T1 problems is unexpectedly larger after 24 hours than at 4 min. A matched *t*-test shows this difference to be significant (t=-6.7, df=4, $p<.01$). If novel stimulus information were not retained over the RI, as suggested by Experiment 3, a smaller difference or no difference at all would be expected after a 24 hour RI. In order to determine conclusively that stimulus information is decreasing over time in the single - object procedure, additional experiments should be performed with various RIs between 4 min. and 24 hours. If the results at an RI of 8 min. were to show a smaller difference or no difference between R-T1 and NR-T1 problems and there was a significant interaction between Reward and Interval, then it would be more conclusive that novel stimulus information was being lost over the RI. If all novel stimulus information were lost over the RI, response shift tendency could not cause the higher performance on NR-T1 problems after 24 hours. At the present time there is not enough evidence to propose a worthwile explanation for the higher performance on NR-T1 problems after the 24 hour RI.

General Discussion

This final section will review the major results described above. It has been shown that hypothesis informat-ion was retained over a 5 month RI. This indicates that once hypothesis information is learned it is not lost through disuse over a long RI. In contrast to the long retention of hypothesis information, it has been shown that stimulus

is not retained for more than several minutes of disuse. Experiments I and III have shown that the loss of stimulus information, as measured by the decrement in percentage correct at the 4 min. RI, was approximately the same for both the two-object and the single-object proxedure on Trial 1. This consistancy seems to indicate that the loss of stimulus information is a reliable and stable phenomenom. In order to more fully examine the loss of stimulus information, performance after RIs both longer and shorter than those used in this study should be tested.

These very different durations for the retention of hypothesis and stimulus information suggest that the two types of information may be learned, stored, or recalled differently. Restle (1958) has proposed a theoretical description of the ODLS task that may be useful in discussing the results of this study. He proposes that three types of cues, types a, b, and c, are present during ODLS formation. Type-a cues are valid (i.e. consistently correlated with reward) after the first trial of each problem and are valid for every problem. Type-b cues are concrete properties of individual stimulus objects that are valid within each problem, but not between problems. Type-c cues are not valid within any problem. Type a and b cues are most relevant to this discussion. Type-a cues may be identical to what this study has called hypothesis information. Hypothesis information was considered to be a rule, which if consistently followed in any proble, was always valid. Type-b cues are similar to stimulus information, the knowledge of which stimulus object was chosen on

the previous trial and whether or not it was reinforced. If an S retains the stimulus information and responds to the object reinforced on the previous trial (or avoids a nonreinforced object), then the S will be consistnetly reinforced. Stimulus information, like type-b cues, is valid only within a given problem and becomes invalid when a new problem with new objects is presented. Restle hypothesizes that ODLS ability develops as an S learns to utilyze type-a cues and ignore type-b cues. This hypothesis is consistent with an ability to retain hypothesis information over long intervals but to retain stimulus information only over short intervals. The ability to ignore the stimulus information from previous problems when solving a new problem is necessary for successful ODLS performance. It would be interesting to examine the retention of stimulus information in Ss as they acquire ODLS skill. Perhaps the short retention of stimulus information is something which must be learned during ODLS acquisition, as Restle proposes.

The other major results of this study were that the two-object procedure produced better performance on R-T1 problems while the single-object procedure produced better performance on NR-T1 problems. The results of the two-object procedure in Experiments I and II replicate Bessemer's (1966) results with rhesus monkeys. The preference hypothesis and the reinforcement hypothesis were both presented as possible explanations for this phenomenom. The single-object procedure was meant to decide between these alternative explanations, but interpretation of the single-

object results was made difficult by the response shift tendency. The results of Experiment II did provide some evidence to support the preference hypothesis, although not as conclusive as the single-object procedure might have been. The results of Experiment IV, however, cannot be explained by either the preference or reinforcement hypothesis. In general, the results found in this study do not provide a clear understanding of why performance is different for R-T1 and NR-T1 problems. There may be other methods to distinguish between these two hypotheses. For instance, if it were possible to show that an individual S has a consistent preference for certain objects in a limited pool of objects, this would be evidence to support Bessemer's preference hypothesis. If it were found that in a limited pool of objects some objects were always chosen on Trial 1, some never chosen on Trial 1, and the rest chosen inconsistently on Trial 1 (most preferred, least preferred, and inconsistently preferred, respectively), this would support the preference hypothesis. If any consistent rank-ordering of preferred objects could be determined, further experiments could examine the effects of reinforcement on these preferences.

Table 1: ANOVA for Exp.I-Pretraining Performance

SV	df	SS	MS	F	Sig.(2-tail)
Reward	1	836.3	836.3	18.8	p .025
Trial	3	1829.4	609.8	36.8	p .001
Subjects	4	108.6			
R X T	3	135.2	45.1	1.43	NS
R X S	4	177.8	44.5		
T X S	12	198.6	16.6		
R X T X S	12	378.9	31.6		
Total	39	3664.8			

Table 2: Performance on trials 2-5 of Experiment I.-Pretraining for R-T1 and NR-T1 problems, Problems 1-48 vs. 49-96

R-T1

Problems	Trial 2	Trial 3	Trial 4	Trial 5
1-48	76.7	81.7	91.7	89.2
49-96	82.5	84.8	91.7	93.3

NR-T1

Problems	Trial 2	Trial 3	Trial 4	Trial 5
1-48	70.0	78.4	85.8	83.3
49-96	60.0	70.0	85.9	85.9

Table 3: Performance on trials 2-5 of R-T1 and NR-T1 problems of Exp.I-Retention Testing at RIs of 0,2,4, and 8 min.

R-T1

Retention Interval (min)	Trial 2	Trial 3	Trial 4	Trial 5
0	81.8	88.6	90.4	90.2
2	88.2	86.4	90.0	86.2
4	88.0	73.4	81.8	88.4
8	87.0	70.0	90.2	90.0

$\overline{X}$= 86.3

NR-T1

Retention Interval (min)	Trial 2	Trial 3	Trial 4	Trial 5
0	67.8	88.2	88.4	96.8
2	57.4	68.8	78.6	77.0
4	71.4	58.4	83.2	86.6
8	68.2	51.4	80.2	81.6

$\overline{X}$=66.2

Table 4: ANOVA for Exp. I-Retention Testing Performance

SV	df	SS	MS	F	Sig.(2-tail)
Reward	1	1664.1	1664.1	38.0	p .005
Interval	3	4599.3	1533.1	8.6	p .005
Subject	4	403.9			
R X I	3	538.1	179.4	1.8	NS
R X S	4	175.1	43.8		
I X S	12	2147.0	178.9		
R X I X S	12	1229.6	102.5		
Total	39	10,757.1			

Table 5: ANOVA for Exp. III-Pretraining Performance

SV	df	SS	MS	F	Sig.(2-tail)
Reward	1	1027.2	1027.2	41.2	p .005
Trial	3	889.8	296.6	10.5	p .005
Subjects	4	235.6			
R X T	3	474.4	158.1	6.7	p .01
R X S	4	99.8	25.0		
T X S	12	340.2	28.4		
R X T X S	12	282.5	23.5		
Total	39	3349.4			

Table 6: Performance on trials 2-5 for Exp.III-Retention Testing for R-T1 and NR-T1 problems and RIs of 0 and 4 min.

		R-T1				NR-T1			
		Trial				Trial			
		2	3	4	5	2	3	4	5
Retention Interval (min)	0	69.8	77.2	87.9	88.3	91.4	90.4	92.6	96.3
	4	79.0	66.8	89.3	84.9	90.5	70.4	88.6	92.8

Table 7: ANOVA for Exp. III-Retention Testing Performance

SV	df	SS	MS	F	Sig.(2-tail)
Reward	1	352.7	352.7	153.3	p .001
Interval	1	1155.1	1155.1	24.1	p .01
Subjects	4	69.0	17.3		
R X I	1	118.2	118.2	1.8	NS
R X S	4	9.1	2.3		
I X S	4	191.5	47.9		
R X I X S	4	258.5	64.6		
Total	19	2154.1			

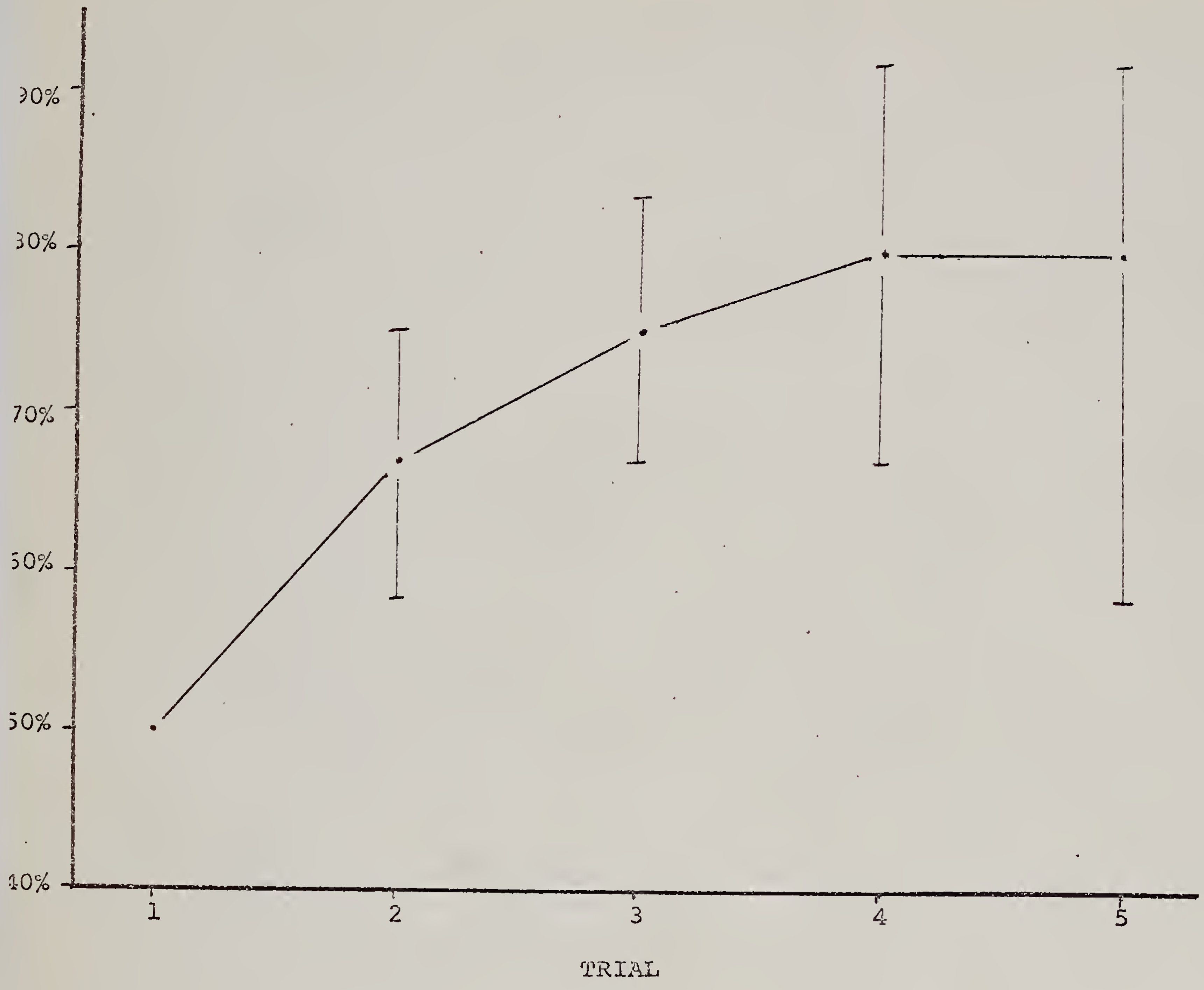

Figure 1: Performance on Trials 1-5 of the first 12 problems of Experiment I-Pretraining (with the ranges for individual subjects)

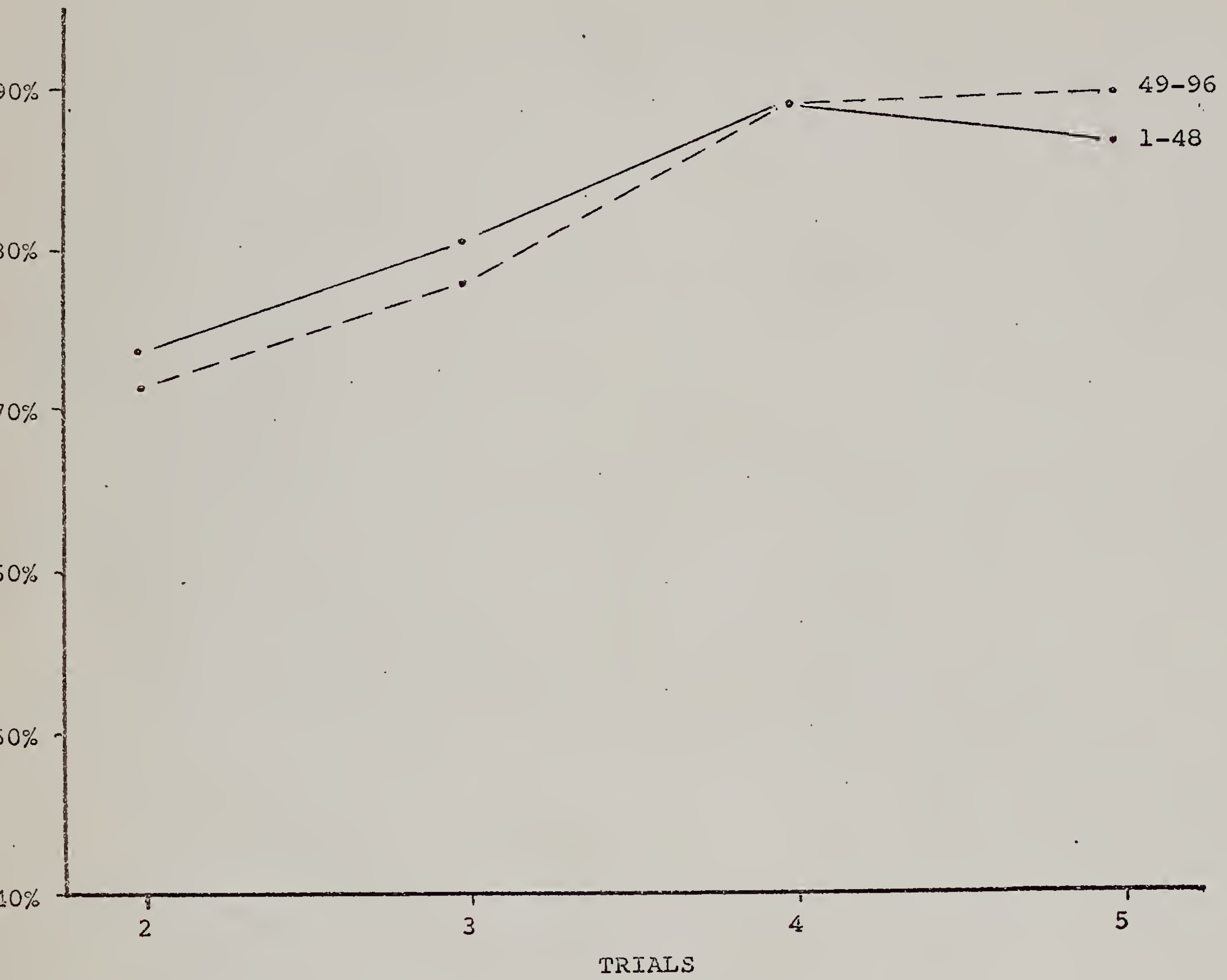

Figure 2: Performance on Trials 2-5 of Exp. I-Pretraining, Problems 1-48 vs. 49-96

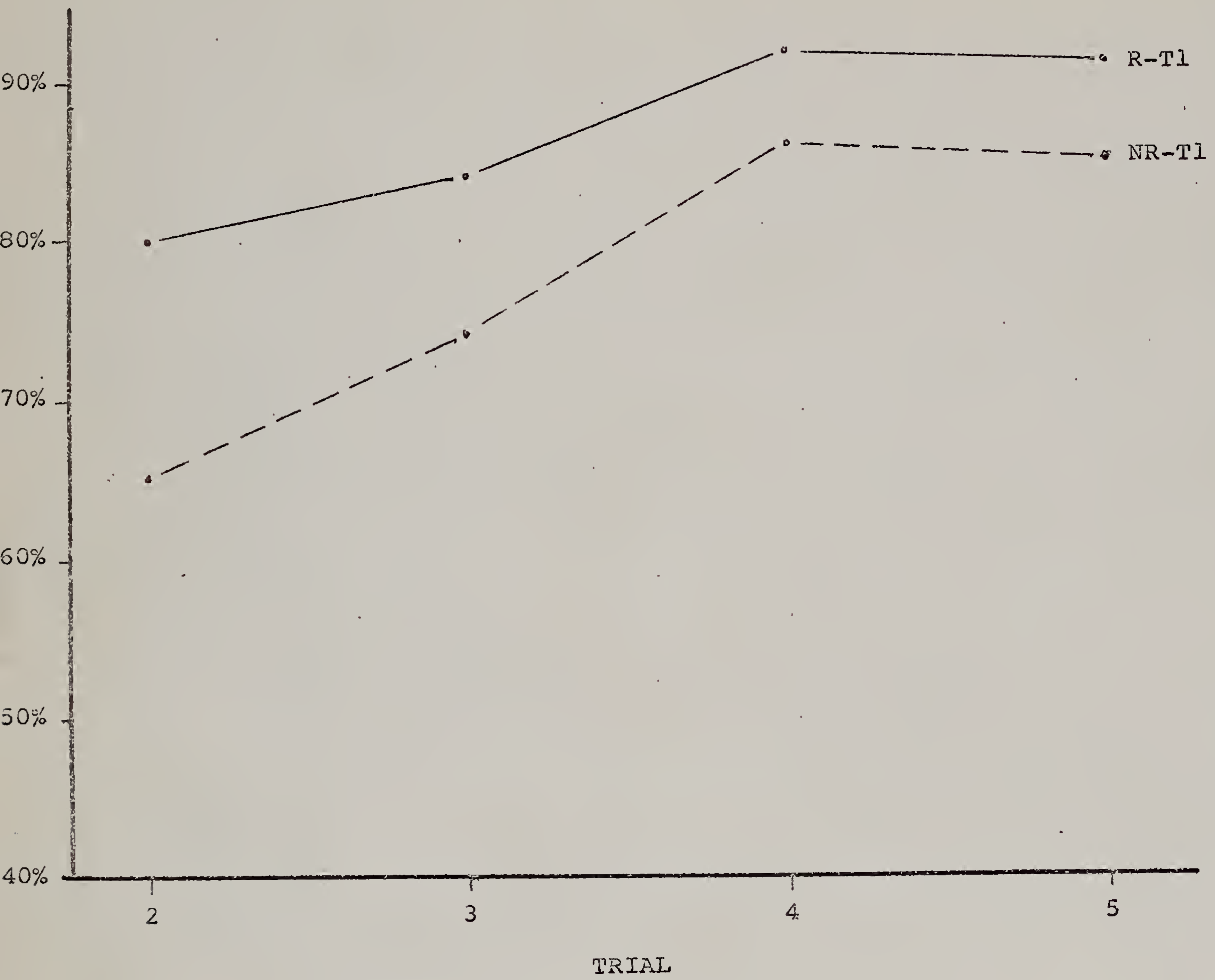

Figure 3: Performance on trials 2-5 of Exp. 1-Pretraining, R-Tl vs. NR-Tl

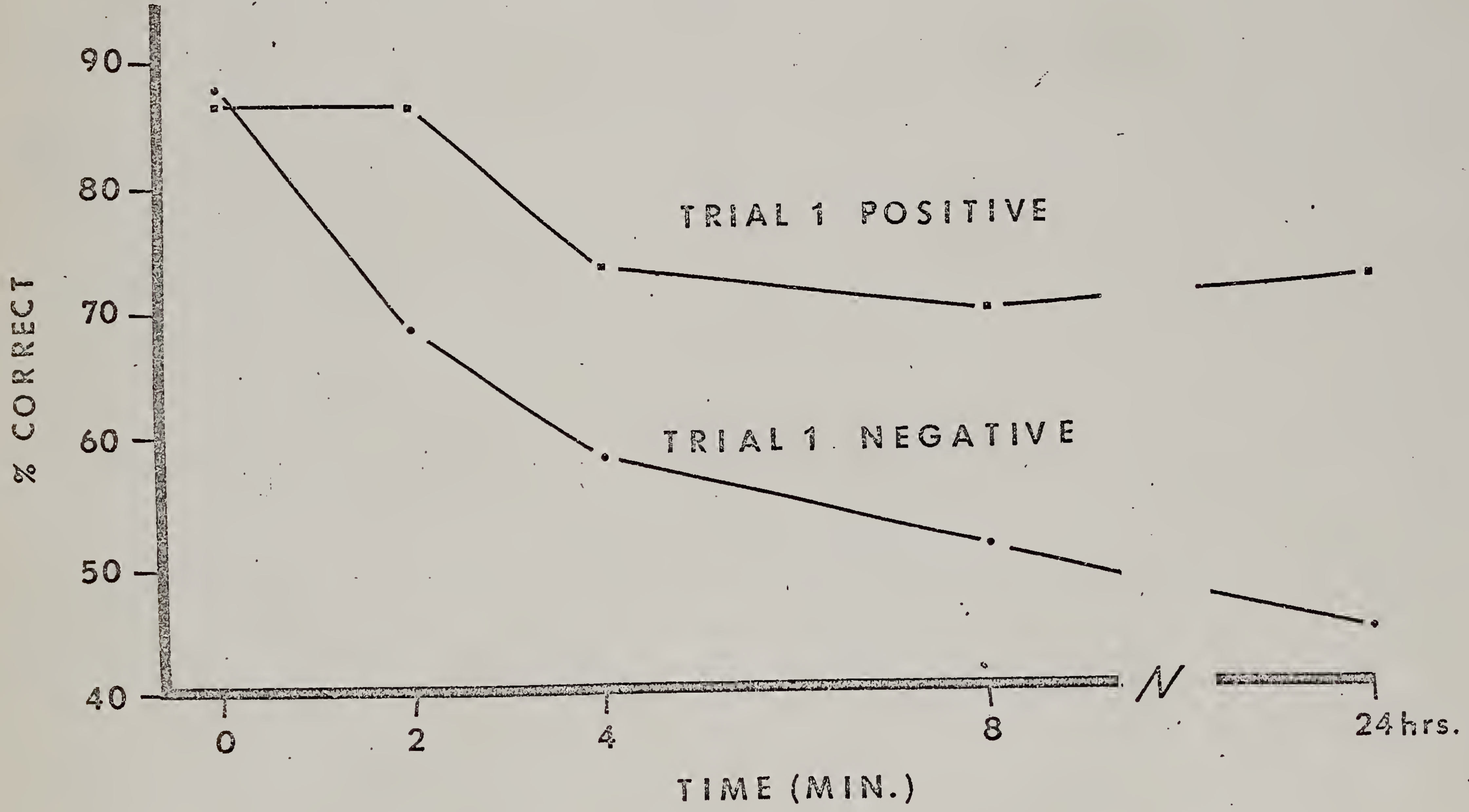

Figure 4: Performance on Trial 3 for Exps. I and II., R-T1 vs. NR-T1, at RIs of 0,2, 4, and 8 min. and 24 hours

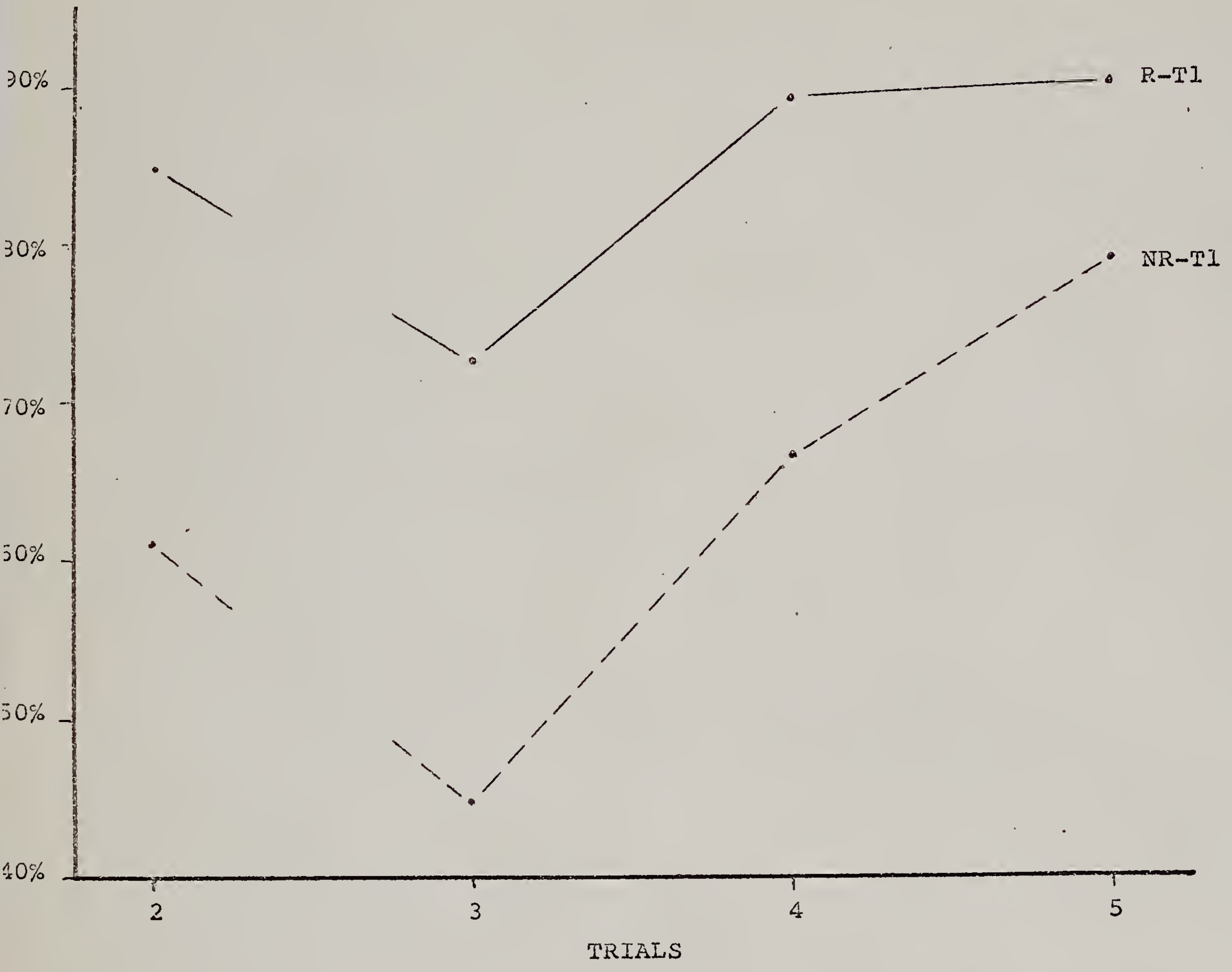

Figure 5: Performance on Trials 2-5 for R-T1 and NR-T1 problems, Exp. 2

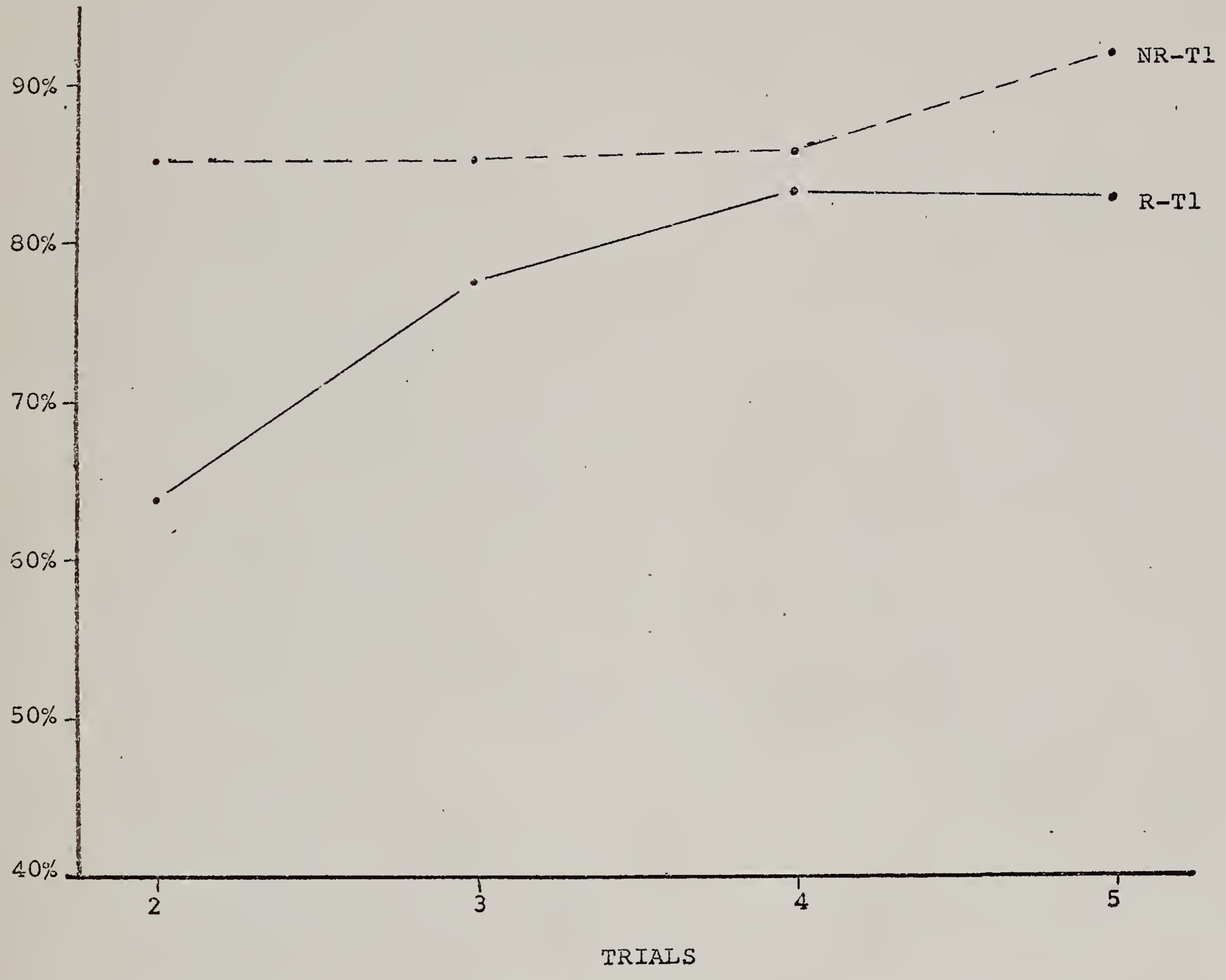

Figure 6: Performance on Trials 2-5 of Exp. III-Pretraining, R-T1 vs. NR-T1

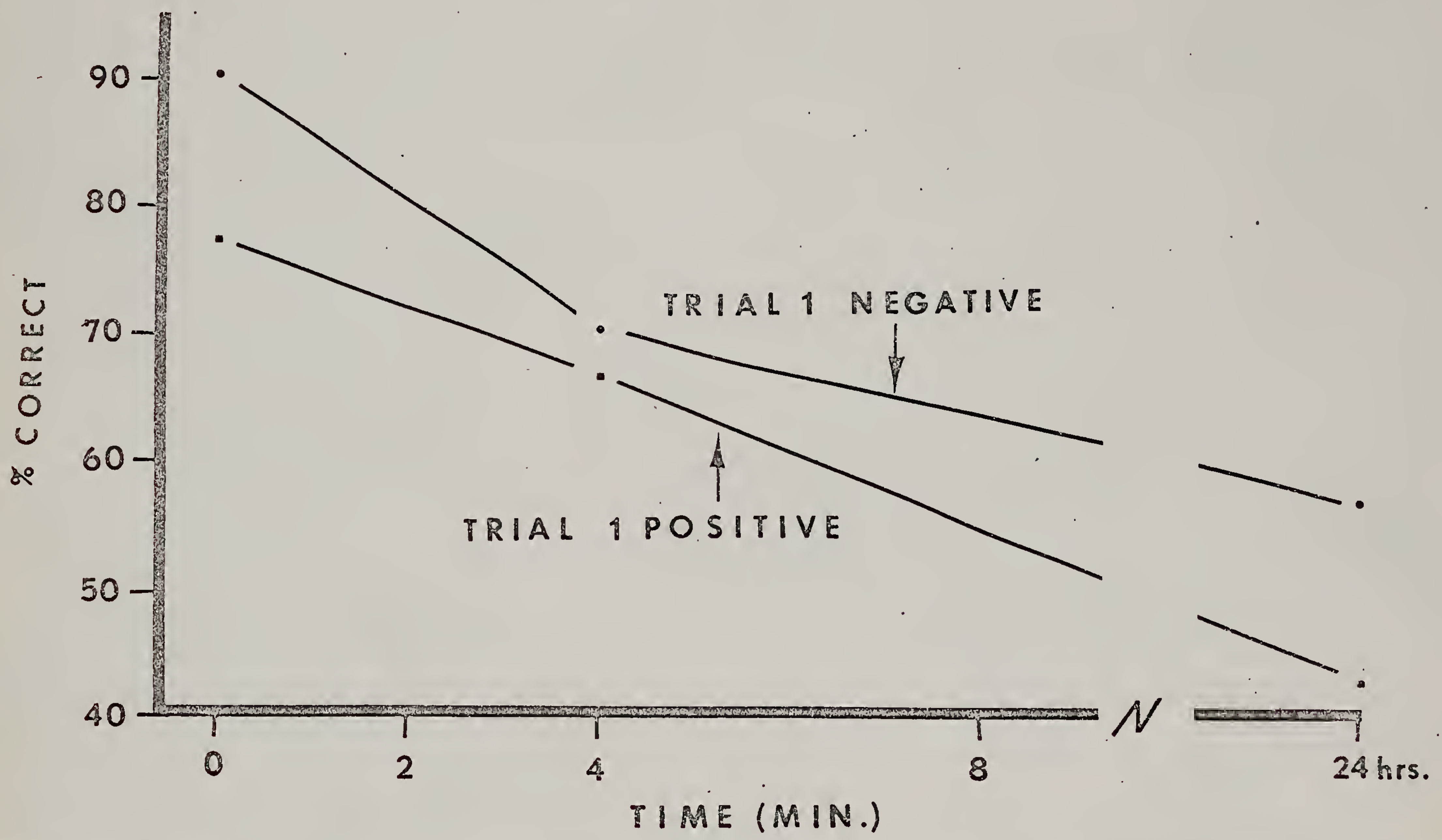

Figure 7: Performance on Trial 3 for Exps. III and IV, R-T1 vs. NR-T1, at RIs of 0 and 4 min. and 24 hours

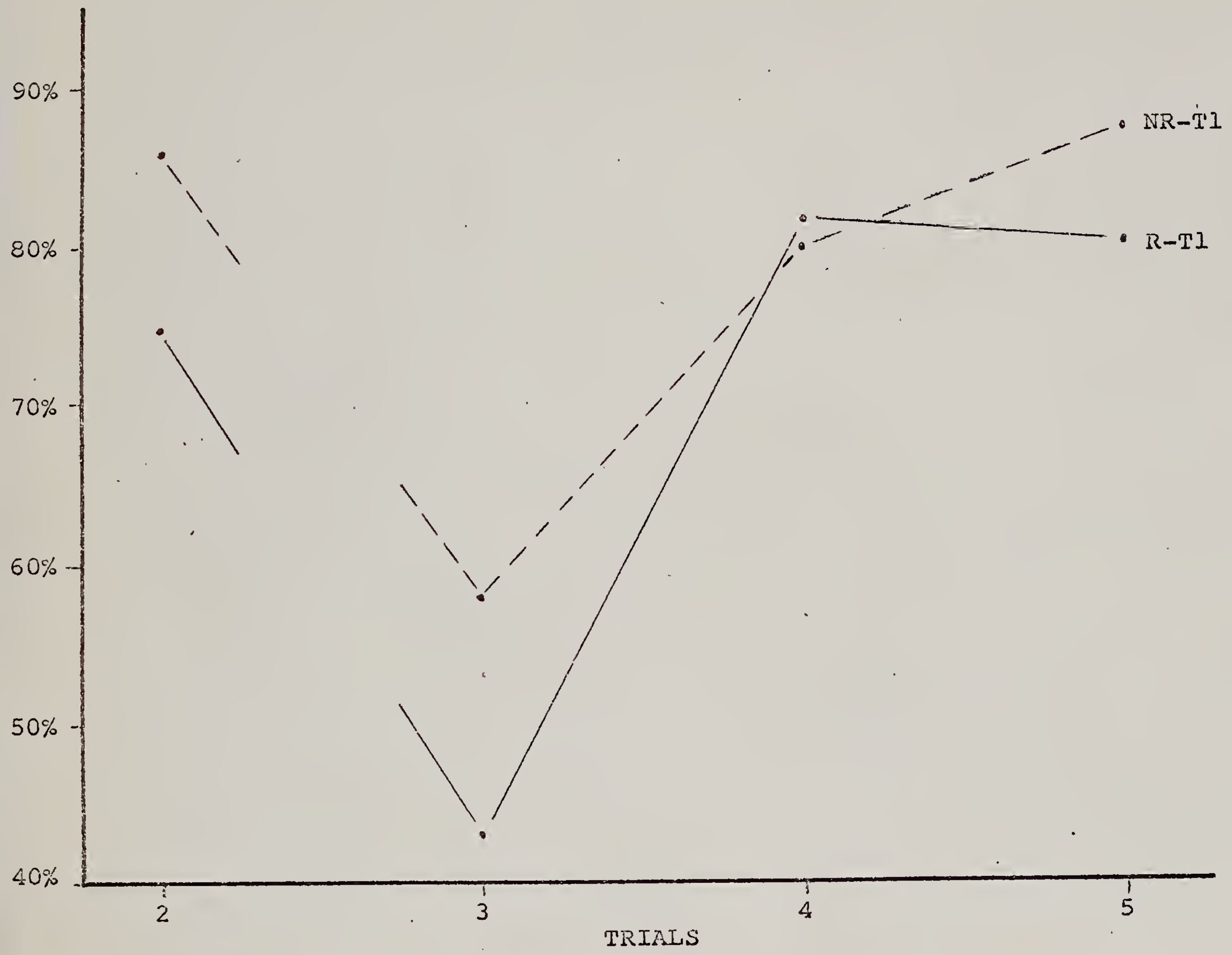

Figure 8: Performance on trials 2-5 of Exp. IV, R-T1 vs. NR-T1

Appendix For Data From Individual Ss

Percentage Correct on Trials 2-5 for R-T1 and NR-T1,

EXP. I-Pretraining, Problems 1-96

		R-T1				NR-T1			
		Trial				Trial			
		2	3	4	5	2	3	4	5
Subjects	11	81.3	85.4	93.8	89.6	64.6	77.1	93.8	87.5
	12	75.0	89.6	83.3	85.4	62.5	75.0	91.7	81.2
	15	75.0	83.6	95.8	97.9	68.8	72.9	83.6	89.6
	29	77.1	74.5	91.7	89.6	66.7	72.9	77.1	89.6
	30	91.7	85.4	93.8	93.8	62.5	72.9	83.3	77.1
	$\bar{x}$=	80.0	83.7	91.7	91.3	65.0	74.2	85.9	85.0

Percentage Correct on Trials 2-5 of R-T1 and NR-T1 Problems

at RIs of 0,2,4, and 8 min., EXP.I-Retention Testing,

Problems 1-96

		Trials				Trials			
	S	2	3	4	5	2	3	4	5
0	11	77	85	85	92	64	91	100	100
	12	83	92	83	92	67	100	92	100
	15	83	100	100	92	92	100	92	100
	17	-	-	-	-	-	-	-	-
	29	83	75	92	83	58	83	75	92
	30	83	83	92	92	58	67	83	92
	$\bar{x}$=	81.8	86.8	90.4	90.2	67.8	88.2	88.4	96.8
2	11	82	82	91	73	54	69	69	77
	12	92	92	83	83	75	83	100	92
	15	92	83	92	92	58	67	83	58
	17	-	-	-	-	-	-	-	-
	29	83	83	92	83	67	67	83	83
	30	92	92	92	100	33	58	58	75
	$\bar{x}$=	88.2	86.4	90.0	86.2	57.4	68.8	78.6	77.0
4	11	83	67	83	75	58	42	75	83
	12	92	67	75	100	75	67	92	83
	15	100	83	92	100	83	50	83	92
	17	-	-	-	-	-	-	-	-
	29	82	75	67	92	83	75	83	75
	30	83	75	92	75	58	58	83	100
	$\bar{x}$=	88.0	73.4	81.8	88.4	71.4	58.4	83.2	86.6
8	11	67	58	75	75	33	58	75	75
	12	92	67	92	100	75	33	67	83
	15	92	83	92	100	83	58	67	75
	17	-	-	-	-	-	-	-	-
	29	92	67	100	92	92	33	92	83
	30	92	75	92	83	58	75	100	92
	$\bar{x}$=	87.0	70.0	90.2	90.0	68.2	51.4	80.2	81.6

Percentage Correct on Trials 2-5 of R-T1 and NR-T1 Problems EXP.III-Pretraining, Problems 1-96

	R-T1 Trial				NR-T1 Trial			
S	2	3	4	5	2	3	4	5
11	68.8	70.1	81.3	91.7	85.5	87.5	87.5	93.8
12	60.4	79.2	81.3	83.4	81.3	87.5	85.4	87.5
15	64.6	75.0	83.4	70.8	85.4	83.4	79.2	93.8
29	52.1	72.9	81.3	83.4	81.3	81.3	91.7	91.7
30	73.0	89.6	87.5	83.4	91.7	85.4	83.3	91.7
$\bar{X}$=	63.8	77.4	83.0	82.5	85.0	85.0	85.4	91.7

Percentage Correct on Trials 2-5 of R-Tl and NR-Tl

Problems, EXP.III, Problwms 1-36

R-Tl

Trial

S	2	3	4	5
11	83.3	72.2	88.9	88.9
12	83.3	61.1	77.8	88.9
15	83.3	77.8	94.4	88.9
29	83.3	77.8	88.9	94.4
30	88.9	72.2	94.4	88.9
$\bar{x}$=	84.4	72.2	88.9	90.0

NR-Tl

Trial

S	2	3	4	5
11	66.7	22.2	50.0	83.3
12	50.0	61.1	94.4	55.6
15	61.1	33.3	72.2	94.4
29	70.6	61.1	77.8	83.3
30	55.6	44.4	61.1	76.5
$\bar{x}$=	60.8	44.4	71.1	78.6

Percentage correct on Trials 2-5 of R-T1 and NR-T1 Problems at RIs of 0 and 4 min., EXP.III-Retention Testing, Problems 1-160.

	S	R-T1 Trial 2	R-T1 Trial 3	R-T1 Trial 4	R-T1 Trial 5	NR-T1 Trial 2	NR-T1 Trial 3	NR-T1 Trial 4	NR-T1 Trial 5
0 min.	11	66.7	66.7	89.7	87.2	92.1	91.7	91.7	100.0
	12	71.8	84.6	80.1	87.8	92.1	86.8	97.4	89.5
	15	66.7	84.6	85.3	87.3	94.8	97.4	89.5	100.0
	29	69.2	77.6	87.2	87.2	89.5	86.8	92.1	94.8
	30	74.4	72.4	89.8	92.3	84.2	89.5	92.1	94.8
	$\bar{x}$=	69.8	77.2	87.9	88.3	91.4	90.4	92.6	96.3
4 min.	11	78.0	70.7	85.4	80.5	90.5	61.9	88.1	95.2
	12	70.8	63.4	95.1	85.4	90.5	73.8	90.5	85.7
	15	87.8	61.0	87.8	87.8	90.5	69.1	92.8	95.2
	29	68.3	65.9	82.9	78.0	90.5	73.3	85.7	90.1
	30	90.2	73.2	95.1	92.7	90.5	73.8	85.7	97.6
	$\bar{x}$=	79.0	66.8	89.3	84.9	90.5	70.4	88.6	92.8

Percentage Correct for Trials 2-5 on R-T1 and NR-T1

Problems, EXP.IV, Problems 1-64

R-T1 Trial

S	2	3	4	5
11	56.3	40.6	81.3	78.1
12	64.5	48.4	80.6	80.6
15	90.6	53.1	84.4	71.9
29	78.1	37.5	71.9	84.4
30	81.3	34.4	87.5	84.4
$\bar{x}$=	74.2	42.8	81.1	79.9

NR-T1 Trial

S	2	3	4	5
11	87.5	59.4	75.0	87.5
12	90.9	57.6	72.7	75.8
15	84.4	71.9	75.0	87.5
29	78.1	46.9	87.5	100.0
30	84.4	50.0	87.5	84.4
$\bar{x}$=	85.1	57.2	79.5	87.0

REFERENCES

Behar, I. Learned Avoidance of nonreward. Psychol. Rep., 1961, 9, 43-52.

Bessemer, D. Retention of object discriminations by learning-set experienced monkeys. Unpublished doctoral dissertation, U. of Wisconsin, 1966.

Braun, H., Patton, R., and Barnes, H. Effects of electro-shock convulsions upon the learning performance of monkeys: I. Object-quality discrimination learning. J. comp. physiol. Psychol., 1952, 45, 231-238.

Chow, K.L. Conditions influencing the recovery of visual discrimination habits in monkeys following temporal neocortical ablations. J. comp. physiol. Psychol., 1952, 45, 430-437.

Chow, K.L. Effects of temporal neocortical ablations on visual discrimination learning sets in monkeys. J. comp. physiol. Psychol., 1954, 47, 194-198.

Harlow, H. Learning set and error factor theory. In Koch, S. (Ed.), Psychology: A Study of a Science, Vol.1, New York: McGraw-Hill, 1959.

Harlow, H. and Hicks, L. Discrimination learning theory: uniprocess vs. duoprocess. Psychol. Rev., 1957, 64, 104-109.

Hunter, M. Latency and hypothesis behavior in learning set by bluejays. Unpublished doctoral dissertation, U. of Massachusetts, 1971.

Hunter, M. and Kamil, A. Object-discrimination learning set and hypothesis behavior in the northern bluejay. Psychon. Sci., 1971, 22, 271-273.

Kamil, A. and Hunter, M. Performance on object-discrimination learning set by the greater hill myna (Gracula Religiosa). *J. comp. physiol. Psychol.*, 1970, 73, 68-73.

Leary, R. The rewarded, and unrewarded; the chosen and the unchosen. *Psychol. Rep.* 1956, 53, 91-97.

Levine, M. Hypothesis behavior during learning sets. In A.M. Schrier, H.F. Harlow, and F. Stolnitz (Eds.), *Behavior of Nonhuman Primates: Modern Research Trends*. Vol.I. New York: Academic Press, 1965.

Moss, E. and Harlow, H. The role of reward in discrimination learning in monkeys. *J. comp. physiol. Psychol.*, 1947, 40, 333-342.

Restle, F. Toward a quantitative description of learning set data. *Psychol. Rev.*, 1958, 64, 77- . Quoted from A.M. Schrier, H. Harlow, and F. Stolnitz (Eds.), *Behavior of Nonhuman Primates: Modern Research Trends*. Vol.1. New York: Academic Press, 1965.

Riopelle, A. Transfer suppression and learning sets. *J. comp. physiol. Psychol.*, 1953, 46, 108-114.

Strong, P. Memory for object discriminations in the rhesus monkeys. *J. comp. physiol. Psychol.*, 1959, 52, 333-336.

Zimmerman, R. Learning set retention in the infant rhesus macaque. Paper read at Eastern Psychological Association. Quoted in D. Bessemer. Retention of object discrimination by learning-set experienced monkeys. Unpublished doctoral dissertation, U. of Wisconsin, 1966.