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DISCRIMINATION REVERSAL LEARNING IN ROUNDTAILED
GROUND SQUIRRELS (Citellus tereticaudus) AND
WHITE-THROATED WOODRATS (Neotoma albigula)

by

Willis W.^{ade} Rees

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GRADUATE COLLEGE

I hereby recommend that this dissertation prepared under my direction by Willis W. Rees entitled Discrimination Reversal Learning in Roundtailed Ground Squirrels (*Citellus tereticaudus*) and White-Throated Woodrats (*Neotoma albigula*) be accepted as fulfilling the dissertation requirement of the degree of Doctor of Philosophy

James E. King
Dissertation Director

4/16/68
Date

After inspection of the final copy of the dissertation, the following members of the Final Examination Committee concur in its approval and recommend its acceptance:*

<u>Ronald H. Pool</u>	<u>4/16/68</u>
<u>Jack Garhart</u>	<u>4/16/68</u>
<u>L. W. Dewhurst</u>	<u>4/17/68</u>
<u>Raymond E. Reed</u>	<u>4/17/68</u>
<u>Cecil A. Rogers, Jr.</u>	<u>4/26/68</u>

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ABSTRACT

Five roundtailed ground squirrels and five white-throated woodrats were tested in the Wisconsin General Test Apparatus on 25 criterial discrimination reversal problems. The data were analyzed in terms of errors on acquisition (A), errors on reversal (R), and the repeated reversal index (RIR) which was defined as the mean of the individual subject and problem R errors divided by the corresponding A errors. The squirrels showed a decrease in RIR values as a function of successive problems while both A and R values remained relatively constant. For the woodrats, there was a decrease in A and R with successive problems while RIR remained constant. Although the two species showed an initial difference in RIR scores, they both approached an asymptote of 0.95 during the last problem blocks. Moreover, the species variable interacted with problem blocks for both A and R errors but not for RIR. The usefulness of the RI procedure for intertaxonomic comparisons was discussed.

INTRODUCTION

One noticeable characteristic of the history of comparative mammalian learning has been the continued search for a paradigm which would produce reliable quantitative differences among mammals in a somewhat preconceived Darwinian manner.¹ During the historical period, the search has been impeded by five major problems. First, the over-all learning differences among mammals are confounded with differential abilities to adapt to the laboratory environment and the testing apparatus, with differences in sensory capacities, with highly differing emotional patterns, with dissimilar response abilities, etc. In other words, can meaningful quantitative comparisons among gorillas, marmots, and bats on the same learning task be obtained when it is currently impossible to quantify the motivational, emotional, sensory, and motor differences among these mammals? Second, even if there were numerous experiments on many divergent species in which the experimental methods were held constant, there would still be very few investigations with invaring independent variables. This lack of consistency across experiments has

¹"It is interesting to observe that the reversal index is found to increase as one descends the phylogenetic scale successively from adult human to the monkey, the cat, and the rat and thus conform remarkably closely to the pattern of phylogenetic development." (Rajalakshmi & Jeeves, 1965, pp. 206-207).

been partially responsible for the unqualified comparisons of interexperimental data and the premature generalizations that certain methods are or are not useful for assessing interspecies diversity (Warren, 1965).

Another problem is that of slight modifications in the apparatus or procedure for a given species. If there are slight modifications which facilitate learning in a given species which theretofore displayed an inability to learn, then can the modified experiment on species X be compared to the unmodified experiment on species Y? This problem is rarely discussed in the comparative literature.

The fourth major problem is the use of the term "species". Behavioral differences among monkeys, cats, and rats are usually referred to as species differences even though the comparative values also represent inequalities in orders, superfamilies, families, subfamilies, and genera. The use of the term species in this very general way is frequently quite confusing because a given learning task may be quite useful for comparing different orders or superfamilies but of little or no value for comparisons within genera.

Finally, the statement that there are certain differences among monkeys, cats, and rats when in fact the animals under investigation were rhesus monkeys, domestic cats, and laboratory rats and when the species or genera were not randomly and independently sampled from their respective orders or families, certainly represents a highly premature and unnecessary generalization.

In short, it appears that comparative psychologists have been searching for a paradigm which would be relatively independent of the physiological differences among mammals, which would be somewhat independent of the differences among quite dissimilar experiments, and which would enable them to draw conclusions about orders from a few nonrepresentative species. In view of the above, it is not surprising that Warren (1965) recently concluded that simple conditioning, probability learning, reversal learning, delayed response, double alternation and oddity paradigms have not proven useful in providing quantitative differences among mammals. The only learning models which appear to be useful for comparing a limited number of orders or superfamilies are some of the patterned strings problems and the discrimination learning set procedure (Warren, 1965). However, neither paradigm is useful at or below the family classification level (see Rumbaugh & McCormack, 1966).

Perhaps the recent proposals for manipulating existing data reflect a certain amount of dissatisfaction with paradigm searching. Rajalakshmi and Jeeves (1965) have proposed the reversal learning index (RI) while Rumbaugh and Pournelle (1966) proposed the reversal-acquisition ratio (R/A). These indices are defined as ratios of the original discrimination learning (acquisition) and its reversal. The former is determined by dividing the number of reversal errors by the acquisition errors while the latter involves dividing the percent correct during reversal by the complementary acquisition value. Since RI is based on

the criterial method for defining intraproblem learning, it is assumed to be applicable to the entire mammalian class. In contrast, R/A uses the more difficult fixed trial procedure and is limited to primates. Another important difference between the indices is that RI (hereafter referred to as RI_1) is a single index based on one problem while R/A may be single or multiple and is obtained from many problems. Since intra- and inter-problem variability is decreased and the reliability of the data is increased with multiple problems, it would seem reasonable to conclude that some variation of the two indices would be more useful. In the present paper, the criterial property of RI_1 will be retained along with the additional advantage of multiple problems and RIs will refer to multiple reversals of the same discriminanda while RIr will refer to successive reversals with different discriminanda.

On the surface, it would appear as though RI, RIs, RIr, and R/A are precisely defined; i.e., reversal errors divided by acquisition errors. However, closer inspection reveals that RI values may in fact be determined in the following ways: 1) by dividing the individual subject (S) and problem reversal error value by the same acquisition value, summing over all S s and problems, and dividing by the number of S s and problems, 2) by dividing, for each S , the total number of reversal errors within a block of problems by the number of acquisition errors in the same block, summing over S s, and dividing the obtained value by the number of S s, and 3) by dividing the total number of reversal errors, summed across

problems and \underline{S}_s , by the total acquisition error value. It should be noted that the three computational methods are applicable to separate problem blocks or across problem blocks and that each method produces different RI values for a given problem block. The author of the present paper assumes that the developers of the RI concepts used methods two and three to obtain values for comparative purposes. One of the aims of the present research was to examine the advantages and disadvantages of the different computational methods for obtaining RI values.

By using computational methods two and three for determining RI_1 , and RIs values, it was possible to obtain comparative data for laboratory rats and several species of squirrels (Sciurus griseus, Sciurus niger, and Citellus tereticaudus) from existing research. A summary of the inter-family RI values is presented in Table 1. This table shows that neither the RI_1 nor RIs differences are beyond what would be expected on the basis of chance alone. Therefore, the second purpose of the present experiment was to investigate the mean RIr differences between roundtailed ground squirrels and woodrats.

Table 1. The Mean RI for Problem One (RI_1) and for Successive Reversals (RIs) for Both Rats and Squirrels

Experimenter	Rats		Squirrels	
	RI_1	RIs	RI_1	RIs
Gonzalez & Shepp ^a	1.315	.605		
Gonzalez & Shepp ^a	1.026	.263		
Rajalakshmi & Jeeves ^b	2.770			
Rajalakshmi & Jeeves ^b	2.890			
Kay & Sime ^c	3.313	1.606		
Kay & Sime ^c	2.753	1.223		
Flaningam ^d			1.520	1.061
Rees ^e			.991	1.077
Rollin ^f	3.039	1.045	4.380	1.314
Mean	2.443	.948	2.297	1.150

^a1961.

^b1965.

^c1962.

^d1968.

^eUnpublished data.

^f1965.

METHOD

Subjects

The subjects (Ss) were one male and four female roundtailed ground squirrels (Citellus tereticaudus) and two male and three female white-throated woodrats (Neotoma albigula). The squirrels were collected at the mouth of Sabino Canyon while the woodrats were collected at the north end of Campbell Road. All animals were trapped at a very young age and were raised in the laboratory. Prior to reversal training, all Ss had received 80 discrimination learning-set problems.

Both the white-throated woodrat and the roundtailed ground squirrel are distributed throughout Northern Mexico and Southern Arizona. The woodrat's distribution area is, however, a great deal more extensive (including most of Arizona, New Mexico, and Texas). The habitat of both species includes the middle desert bushland areas. The squirrel is also found in the low desert while the woodrat's habitat includes high desert areas and rocky cliffs.

The outstanding identifying characteristic of the roundtailed ground squirrel is that it has no noticeable markings. In contrast, the woodrat's stomach, throat, and paws are white and its side, back, and top parts are dark grey. Both species have a head-body length of about

6 in. while the woodrat's tail is 3 in. longer (6 in. total) and its mean body weight is greater (7-1/2 oz. versus 6 oz.).

The behavioral differences between the two species in their natural environments are even more striking than distribution or anatomical differences. Outside the home area, the woodrat is active during the early evening hours while the squirrel is active during the late morning and late afternoon hours. The roundtailed squirrel digs an extensive burrow system while the woodrat constructs a beaver type dwelling (2 to 3 ft. high). The squirrel has a high-pitched vocal signal system which is used to signal the presence of predators. The woodrat, on the other hand, has no known warning system. The woodrat, however, has a recordable emotional response which involves the thumping of the hind legs. This behavior is seldom observed in the squirrel. The diet of both species includes seeds, mesquite beans, and cactus.

In the laboratory, the squirrel readily adapts to captivity. This animal will eat as long as there is food in the cage and will continue to gain weight until it can no longer move. The woodrat, however, is slow to adapt to the laboratory cage, hoards large quantities of food, builds nests, and does not overeat. It should be noted that the woodrat requires prickly pear cactus in order to survive in captivity.

In a testing apparatus, the roundtailed squirrel displays no signs of emotional behavior (fear or avoidance) and can be trained to perform a simple task within a few trials. In contrast, the woodrat is highly

emotional and very difficult to train. For example, the squirrel will approach a cup containing food after a few minutes of exploration while it may take the woodrat 10 or more hours to respond to the same food cup.

Apparatus

The testing of both species took place in a modification of the Wisconsin General Test Apparatus which has been described in detail by Harlow and Bromer (1938). The test compartment (12 in. wide by 10-1/2 in. long) displaying the stimulus objects and the object presentation tray was separated from S's transport cage (6 in. wide, 10 in. long, and 7 in. high) by manually-operated opaque and plexiglas screens. The former prevented S from observing the tray during the intertrial interval while the latter prevented S's escape from the transport-test cage and allowed S to respond to the objects. The experimenter (E) was separated from the test compartment by and observed S's responses through a stationary one-way mirror (8 in. long by 4 in. high). The object tray was 11-1/2 in. wide by 6 in. deep and contained two 1-in. diameter foodwells separated by 3-1/2 in. from center to center. A 3/8-in. diameter hole ran horizontally from the back of the tray up to the foodwell and retained the reinforcers equidistant from the foodwells. E was able to move the reinforcer up to the foodwell with a 3/8-in. diameter dowel. The tray's speed and movement were controlled by two weights attached to a pulley-cord arrangement and were thus independent of E's movements. An optimal tray speed of 1/3

ft. per second was used on all trials (Rees and King, unpublished data). Attached to the bottom of the opaque-screen tracks was a microswitch which started a Hunter Timer to signal the onset and duration of the inter-trial interval.

The stimulus objects were constructed from junk and hardware items (small toys, bottle caps, pencil parts, costume jewelry, etc.) and mounted on 1-3/4-in. squares of 1/4-in. multicolored wood. Each object pair varied in multiple dimensions. During testing, the objects were behind plexiglas barriers (base, 2 in. by 2 in., height, 1 in.) which prevented Ss from touching the objects and thereby imparting odors to the objects or from responding to olfactory differences between the objects. The position of the barriers on the test tray remained constant. A response was recorded whenever the object was pushed back to a line 1/4 in. behind the objects.

Procedure

Ss were placed on 24-hour food deprivation schedules and trained to enter a transport-test cage. Then they were trained to displace a single neutral object covering one of the foodwells to procure a preferred reinforcer. All Ss were offered sunflower seeds, currants, corn, and wheat grains to determine individual preferences. The preferred food for the woodrats was currants while the squirrels chose sunflower seeds. After 40 single object adaptation trials, Ss were presented with a two-object

discrimination problem in which the reward values of the objects had been randomly determined. The position of all objects during pretraining and testing was determined by a Gellermann (1933) sequence.

The procedure employed during the testing of both species on 25 reversal problems was as follows: At the start of each trial, E raised the opaque screen and allowed the stimulus tray to roll up to S. After S had displaced an object, the screen was lowered, the tray retracted, and the objects either actually or simulatively switched in order to control the intertrial interval noise. Each S was presented with 40 trials per day and the noncorrection procedure was used throughout the testing. After S made nine out of 10 correct responses on the acquisition of a problem, the reward values of the stimulus objects were reversed and Ss were retested to the same criterion.

RESULTS

The mean RIr values computed by the three different methods for both species are presented in Table 2. This table shows that there are large differences between methods one and two or three while the differences between methods two and three are slight. Moreover, the interspecies differences on method two was not significant ($F = 1.33$, $df = 1/8$, $p < 0.20$;) while the method one differences approached significance ($F = 5.17$, $df = 1/8$, $p < 0.06$). It should be noted that a two-way analysis of variance of the method two data failed to reveal any significant relationships and that the method three data are not statistically analyzable.

Since it was assumed that the most useful method for determining RI values was method one, this method was used for all interspecies comparisons. The interproblem RIr curves with successive blocks of problems (five problems per block) and species as variables are presented in Figure 1 and summaries of the inferential analyses of these data are denoted in Tables 3 and 4. The mean RIr for woodrats was 0.84 (SD = 0.548) while the corresponding squirrel value was 1.76 (SD = 2.588). As stated above, this difference approached significance while both the blocks effect and the species by blocks interaction failed to approach significance ($F = 2.23$, $df = 4/32$, $p < 0.10$; $F = 1.50$, $df = 4.32$, $p < 0.75$).

Table 2. The Mean RIR Values for Squirrels and Woodrats as Computed by Three Different Methods

Species	Method	Blocks				
		I	II	III	IV	V
Squirrel	1	4.31	1.73	0.85	1.04	0.90
	2	0.79	0.76	0.47	0.68	0.41
	3	0.72	0.64	0.49	0.61	0.40
Woodrat	1	1.10	0.80	0.64	0.60	1.07
	2	0.52	0.55	0.36	0.49	0.59
	3	0.54	0.54	0.35	0.40	0.50

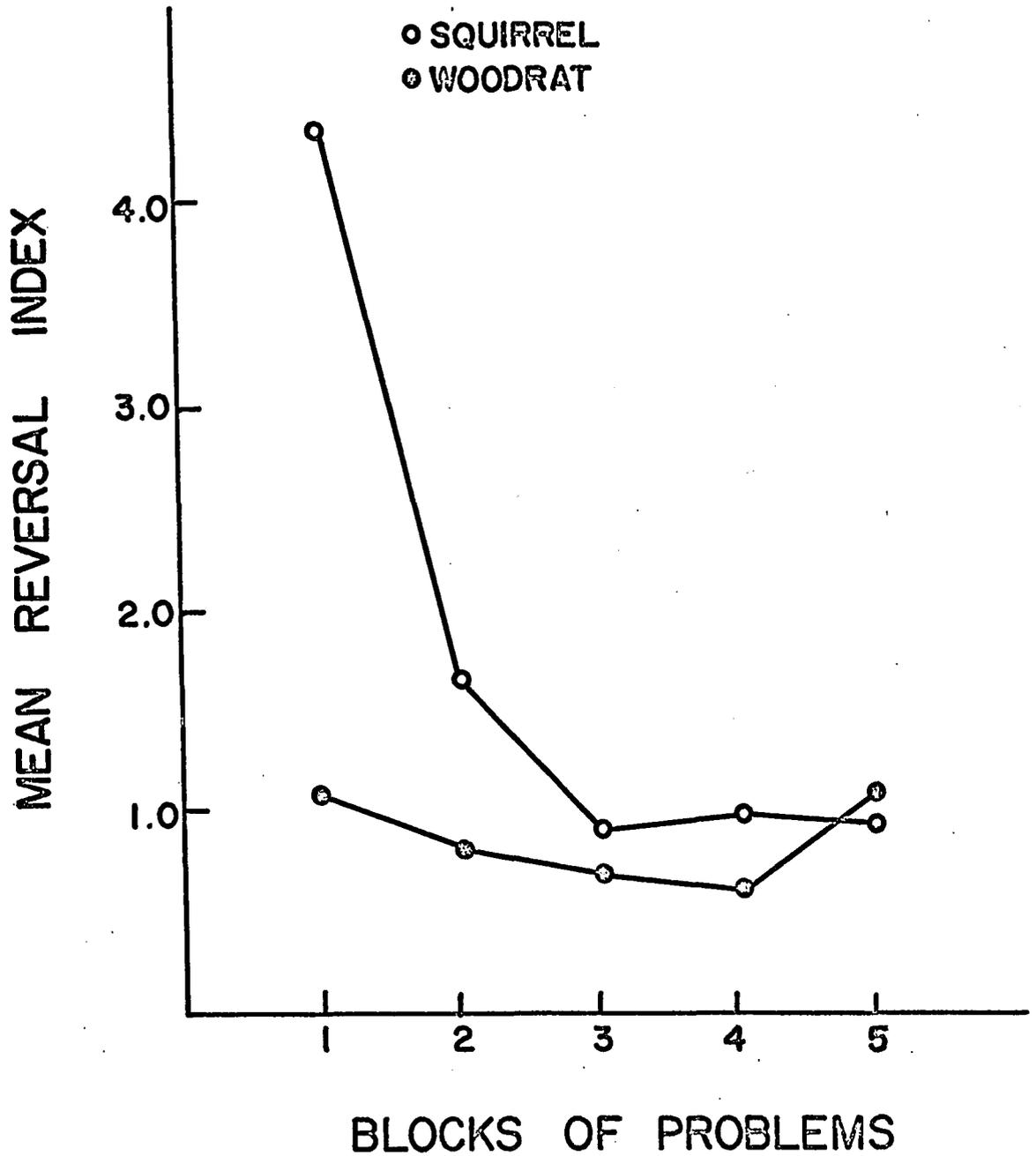


Fig. 1. The mean R_{Ir} values for woodrats and squirrels as a function of successive blocks of problems

Values near 1.0 signify positive intraproblem transfer while higher values are indicative of negative transfer.

Table 3. A Summary of the Two-Way Analyses of Variance for the Reversal Indices, the Number of Errors to Criterion on Acquisition, and the Number of Errors to Criterion on Reversal^a

Source of variance	SS	df	MS	F	Sig. ^b
<u>Reversal index</u>					
Between subjects	27.87	9			
Species	10.92	1	10.92	5.17	NS ^c
<u>Ss</u> within groups	16.95	8	2.11		
Within subjects	136.70	40			
Blocks	25.99	4	6.49	2.23	NS
Species x blocks	17.53	4	4.38	1.50	NS
Blocks x species within groups	93.18	32	2.91		
<u>Acquisition errors</u>					
Between subjects	5510.86	9			
Species	4527.71	1	4527.71	55.88	0.001
<u>Ss</u> within groups	1296.43	16	81.02		
Within subjects	20121.16	40			
Blocks	9913.91	4	2478.47	25.08	0.001
Species x blocks	6712.57	4	1678.14	16.98	0.001
Blocks x species within groups	6323.29	64	98.80		
<u>Reversal errors</u>					
Between subjects	991.87	9			
Species	678.59	1	678.59	8.37	0.05
<u>Ss</u> within groups	1296.43	16	81.02		
Within subjects	8545.43	40			
Blocks	4240.32	4	1060.08	10.72	0.001
Species x blocks	1476.50	4	369.12	3.73	0.01
Blocks x species within groups	6323.29	64	98.80		

^aThe error terms for the acquisition and reversal analyses were pooled.

^bLevel of significance.

^cNonsignificant.

Table 4. A Summary of the One-Way Analyses of Variance for Squirrels and Woodrats^a

Source of variance	SS	df	MS	F	Sig. ^b
<u>Squirrels:</u>					
Reversal index					
Total	147.64				
Blocks	105.23	4	10.60	9.05	0.001
Error	47.11	40	1.17		
Acquisition errors					
Total	3311.84				
Blocks	539.28	4	134.82	1.20	NS ^c
Error	4482.20	40	112.05		
Reversal errors					
Total	1599.25				
Blocks	1032.59	4	141.74	2.17	NS
Error	2604.56	40	65.11		
<u>Woodrats:</u>					
Reversal index					
Total	4.74				
Blocks	0.04	4	0.01	0.01	NS
Error	47.11	40	1.17		
Acquisition errors					
Total	17792.48				
Blocks	16082.84	4	4020.71	35.88	0.001
Error	4482.20	40	112.05		
Reversal errors					
Total	7187.47				
Blocks	5149.87	4	1287.46	19.77	0.001
Error	2604.56	40	65.11		

^aThe error terms for the separate conditions were pooled.

^bLevel of significance.

^cNonsignificant

The one-way analysis of variance for each species as a function of problem blocks is shown in Table 4 and indicates that the mean interproblem RIr values for squirrels decreased significantly over blocks ($F = 9.05$, $df = 4/40$, $p < 0.001$) while the woodrat RIr values did not change significantly ($F = 0.008$, $df = 4/40$, $p < 0.75$). The interspecies difference on problem block I was, however, statistically different ($t = 7.580$, $df = 8$, $p < 0.001$) while the remaining block differences were not significant ($t = 1.417, 0.608, 2.594, \text{ and } 0.479$).

The interproblem learning curves for each species on problem acquisition and reversal as a function of problem blocks are presented in Figure 2. The condensed analyses of variances of these data are conferred in Tables 3, 4, and 5. The three-way analysis, Table 5, demonstrated the following significant relationships: 1) The woodrats made more total errors than the squirrels ($p < 0.001$). 2) There was an over-all decrease in errors as a function of problem blocks ($p < 0.001$). 3) There was a significant decrease in errors from acquisition to reversal ($p < 0.001$). 4) The species differences are a function of the problem block ($p < 0.001$). 5) The species by acquisition-reversal interaction was a result of a greater decrease in errors for woodrats than for squirrels ($p < 0.001$). And 6) all three variables were simultaneously interacting. Moreover, on the separate two-way analyses of variance, all species by blocks interactions were significant (acquisition, $F = 16.98$, $df = 4/64$, $p < 0.001$; reversal, $F = 3.73$, $df = 4/64$, $p < 0.01$).

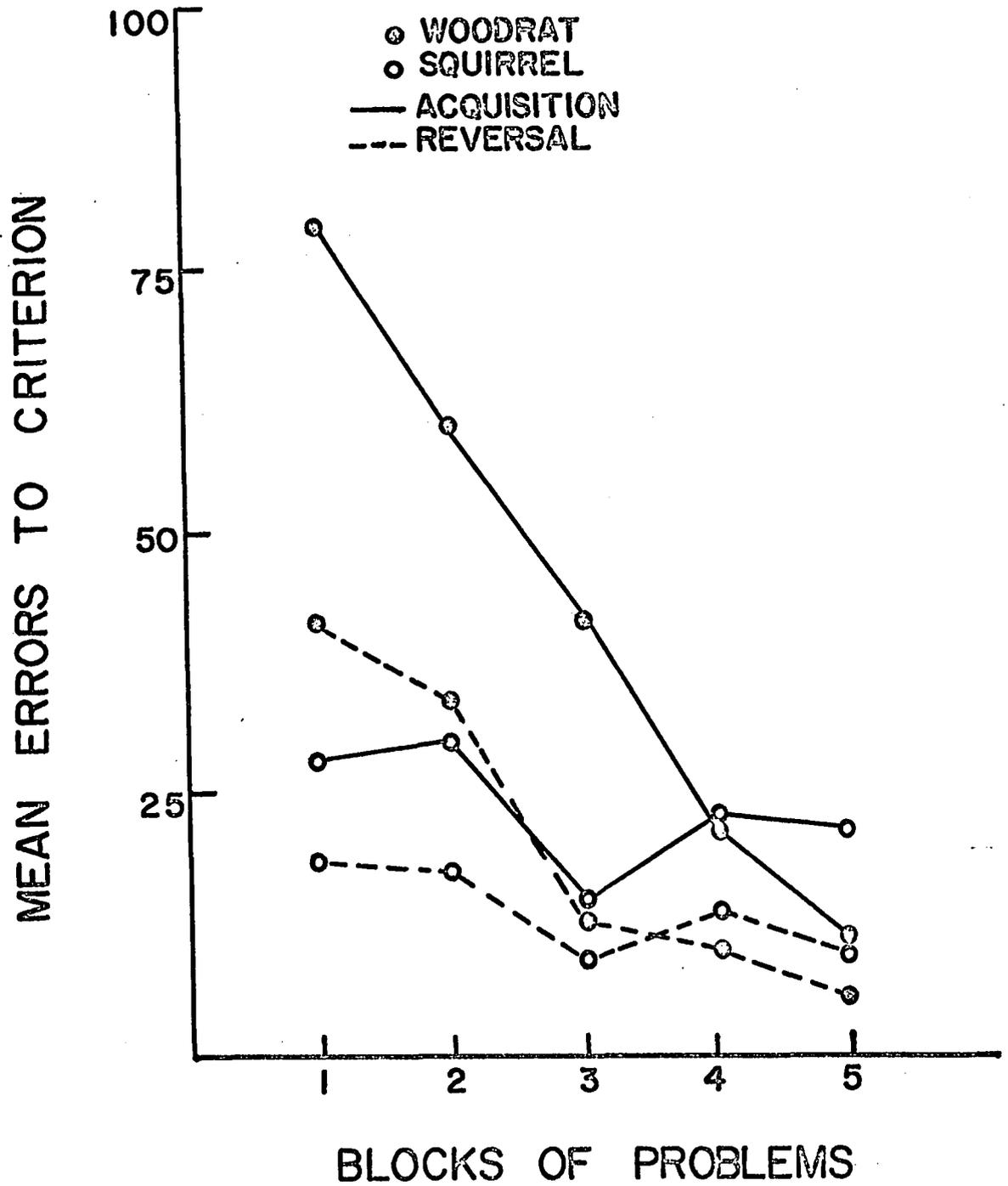


Fig. 2. The mean number of errors to criterion on acquisition and reversal for woodrats and squirrels as a function of successive blocks of problems.

Table 5. A Summary of the Species by Blocks by Acquisition-Reversal Analysis of Variance

Source of variance	SS	df	MS	F
<u>Between subjects</u>	5405.98	9		
Species	4356.00	1	4356.00	33.19 ^a
<u>Ss within groups</u>	1049.98	8	131.24	
<u>Within subjects</u>		90		
Blocks	36059.38	4	3364.70	25.02 ^a
Blocks x species	7106.77	4	1776.69	13.21 ^a
Blocks x <u>Ss within groups</u>	4303.64	32	134.48	
Acquisition-reversal (A-R)	6368.04	1	6368.04	206.75 ^a
Species x A-R	850.30	1	850.30	27.60 ^a
A-R x <u>Ss within groups</u>	246.46	8	30.80	
Blocks x A-R	695.42	4	173.85	2.85 ^b
Species x blocks x A-R	1082.30	4	270.57	4.44 ^c
Blocks x A-R x <u>Ss within groups</u>	1947.64	32	60.86	

^aLevel of significance = 0.001.

^bLevel of significance = 0.05.

^cLevel of significance = 0.01.

The acquisition and reversal two-way analyses of variance also revealed that the changes over blocks on both variables were highly significant ($p < 0.001$). However, by reducing the complexity of these analyses to that of a one-way design, Table 4, neither the decrease in acquisition errors nor reversal errors for the squirrels were significant while both changes for woodrats were highly significant.

By taking the acquisition-reversal difference on each problem and for each S, additional intraproblem transfer data were obtained and analyzed. The results of this analysis are presented in Table 6. All Ss demonstrated significant positive transfer over the 25 problems and the significance of this transfer for squirrels was greater than that of the woodrats.

Although the RI_1 procedure is assumed to be limited to naive animals on problem one, the RI_1 and RI_2 (problem 2) values for the sophisticated Ss of the present experiment were computed by method one to assess their usefulness for interspecies comparisons. The mean RI_1 values for woodrats and squirrels were 2.80 and 0.44 respectively. These values did not significantly differ ($t = 1.43$, $df = 8$, $p < 0.10$). Although the RI_2 relationship was the converse of the RI_1 (1.19 versus 10.94), this relationship was also nonsignificant ($t = 0.27$, $df = 8$, $p < 0.60$). The standard deviations of the RI means for woodrats and squirrels on RI_1 , RI_2 , block I RI_r , and block V RI_r all signified a decrease in variance with

Table 6. A Summary of the t Tests on Each Individual Animal's Total Transfer Over the 25 Reversal Problems^a

Species	Subject	t value	Level of significance
Woodrat	21	3.547	0.001
	22	2.559	0.020
	23	3.636	0.001
	24	2.313	0.050
	25	2.563	0.010
Squirrel	11	37.337	0.001
	12	16.182	0.001
	13	22.176	0.001
	14	16.165	0.001
	15	52.028	0.001

^aAll S_s showed significant positive transfer.

additional training (woodrats, 0.61, 0.33, 1.99, and 1.29; squirrels, 4.43, 1.27, 9.95, and 1.23).

DISCUSSION

The present experiment has demonstrated that the usefulness of the RI concept for intertaxonomic comparisons is dependent upon the method of determining RI values. The individual S and problem method for obtaining these values was found to be the only method that produced reliable differences between woodrats and ground squirrels. However, it should be noted that the RI theory would predict lower RI values for squirrels than for woodrats. In the present experiment, the woodrat's RI values were either lower than the squirrel's or the differences were not significant. This statement is true for all computational methods and for all points (problems or blocks) of comparison. A comparison of RI values for tree squirrels (Sciurus niger) and roundtailed ground squirrels (Flaningam, unpublished data) was also found to be the converse of what the RI theory would predict (2.11 versus 0.73).

Since it was assumed that the RI_1 values that were reported by Rajalakshmi and Jeeves (1965) were obtained by methods two and three, the interspecies RI values of the present experiment cannot be related to their values nor to other experiments. Therefore, intertaxonomic comparisons will be limited to the results of the present experiment.

The RI_1 values for sophisticated roundtailed ground squirrels and woodrats do not appear useful for comparative purposes unless the sample

sizes are greatly increased. In addition, since there is a decrease in the RI means and standard deviations with successive problems, individual problem RI differences would tend to approximate each other and thus progressively decrease their comparative utility. This approximation can be seen in the present experiment since both species tended to approach an asymptote of 0.95 with extensive practice on repeated reversal problems.

Although all individual Ss of the present experiment demonstrated significant intraproblem positive transfer (see Table 6), and although the initial block RIr interspecies difference was significant, only the squirrels demonstrated a reliable change in RIr as a function of successive problem blocks. The total RIr difference for the two families was based on five Ss per group and for all practical purposes should be considered to be significant ($p < 0.06$). The nonsignificant species by blocks interaction for RIr would tend to support, if one can fail to reject the null hypothesis, the assumption that RI values are relatively independent of anatomical species differences (Rajalakshmi and Jeeves, 1965).

For the roundtailed ground squirrels, there was a significant decrease in RIr values as a function of successive problems even though the number of errors on both acquisition and reversal remained somewhat constant. Conversely, the woodrat's errors on acquisition and reversal decreased with successive problems while RIr remained relatively constant. If it can be assumed that the rate of change in RIr is a more

meaningful statistic than over-all RIr values, then the roundtailed ground squirrel's performance would be superior to that of the woodrat. Under this assumption, the RIr procedure for intertaxonomic comparisons might possibly be more sensitive than RI_1 . Moreover, the RIr method would be more reliable and would tend to decrease interspecies variability.

Even though Warren (1967) has pointed out that the RI_1 analysis is no more sensitive to "interspecies" differences than the separate acquisition and reversal analyses, the significant interactions among acquisition, reversal, and species of the present study certainly render the acquisition and reversal analyses more ambiguous than that of the interaction free RIr procedure. Moreover, Warren found that RI_1 values for domestic cats and rhesus monkeys were functionally related to the number of errors on acquisition. The present experiment demonstrated that RIr varied for squirrels while acquisition and reversal remained constant and the RIr values for woodrats remained constant even though acquisition and reversal errors decreased. Both of these results differ from Warren's findings. It should be noted that Warren did not specify the method by which he determined the RI values.

From the data of the present experiment, it would certainly be unjustified to conclude that the rat family's RIr values are below those of the squirrel family when one species of rat and one species of squirrel were tested. However, to state that there is a species difference in RIr values is also confusing because the term species should be restricted to

different animals of a given genus. Therefore, the author recommends that comparisons either be restricted to the animals under investigation or that the term "intertaxonomic" be substituted for the more confusing terms.

It is reasonable to conclude that there are noticeable differences in RI_1 values for rhesus monkeys (1.33), domestic cats (1.82), and laboratory rats (2.89) (Rajalakshmi and Jeeves, 1965) but that these relationships do not necessarily conform "to the pattern of phylogenetic development." In addition, the use of single RI_r or RI_s values for different groups of animals does not appear useful for studying the phylogeny of learning or transfer. Perhaps the usefulness of all of the RI indices can be assessed when they are more explicitly defined.

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