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STIMULUS GENERALIZATION ALONG A DIMENSION BASED ON A VERBAL CONCEPT

ROBERT W. HOWARD

UNIVERSITY OF QUEENSLAND, AUSTRALIA

The present study examined generalization along a dimension based on a verbal concept of occupational status. The status dimension was scaled by students who placed occupation names into five status categories, Category 1 representing highest status and Category 5 the lowest status. In two experiments, key presses by students were occasionally reinforced when a slide showing an occupation name from Status Category 3 was present. For half the subjects, key presses were not reinforced during a name from Category 1; for the other half, presses were not reinforced during a name from Category 5. Occupation names from all status categories were later singly presented. In this generalization test, subjects typically divided the dimension into two parts, responding alike to all names within each part. The results suggest that generalization along a dimension in humans is mediated by a subject's verbal classifications of stimuli.

Key Words: stimulus generalization, conceptual dimensions, categorical generalization, occupational status, key press, university students

Several patterns of generalization along a stimulus dimension may occur. Animals usually show decremental generalization gradients where a peak of responding occurs at or near the stimulus correlated with reinforcement (S+) and progressively fewer responses occur at stimulus values farther from S+ (e.g., Guttman & Kalish, 1956). When responses are reinforced at one point on a dimension and extinguished at another point, a peak shift (Hanson, 1959) may occur. The peak of responding is displaced from S+ in a direction away from the stimulus correlated with extinction (S−).

Human stimulus generalization may be mediated by a subject's classifications of stimuli. For example, Nicholson and Gray (1971, Experiment 1) reinforced lever presses by children on a variable-interval (VI) schedule when a picture of a rocket oriented vertically was present. Presses were not reinforced when the picture was absent. When pictures of the rocket tilted from the vertical were later presented in a test, response rate to all novel tilts was the same, and much lower than the rate to S+. The subjects apparently divided the dimension into two categories, S+ and not S+.

Virtually all studies of generalization along a dimension have used physical dimensions such as wavelength, orientation, tonal frequency, or intensity. Little is known about generalization along dimensions based on abstract concepts.

A concept is an abstraction from stimuli. No specific physical stimulus controls behavior; some abstract properties of stimuli do (Gagné, 1970). For example, the concept of "three" can be abstracted from any set of stimuli such as three elephants, three glasses, or three rocks. A concept can either name a class of stimuli or an abstract quantity which varies in magnitude. For example, the concept of "musical instrument" names a class. The concept of "quality" names an abstract quantity which can vary in magnitude from, say, "perfect" to "appalling." A given position on a quality scale may be assigned to many different stimuli. For example, "perfect" might be assigned to stimuli as different as the taste of an orange and the sight of a physical environment. A conceptual dimension is defined

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here as a scale along which an abstract quantity such as "quality" or "beauty" is ordered from low to high magnitude.

What patterns of generalization occur along conceptual dimensions? Are these similar to those that occur along physical dimensions, and are conceptual dimensions therefore functionally equivalent to physical dimensions? Do phenomena such as peak shift occur along conceptual dimensions? Honig (1965), in one of the few studies in this area, studied the conceptual dimension of stimulus difference. Pigeons were trained to discriminate a difference of 10 nm between pairs of wavelength stimuli from a 40-nm difference. The birds showed generalization gradients when pairs with other nm differences were subsequently presented. Honig demonstrated that the birds had acquired the concept of stimulus difference by showing that the difference discrimination transferred to wavelength pairs not presented in training.

Several studies with humans have looked at generalization along a dimension based on the verbal concept of "hostility," initially scaled by Buss (1961). Buss had students place words into one of nine categories according to the amount of "hostility" each depicts. Words such as "murder" and "mutilate" were placed in the highest hostility category, and apparently milder words such as 'controversy' were in the lowest category. Subjects acquired a verbal response to words in one of the end categories. When words from other categories were later presented, the group trained at the low-hostility category showed a flat gradient and the other group showed a sloping gradient with a peak at S+. Geer and Buss (1962) obtained similar results with the same dimension using a lever-pulling response. Lang, Geer, and Hniatiow (1963) found a categorical generalization pattern when using a classically conditioned response and a hostility scale with four categories representing different magnitudes of hostility. Subjects were first exposed to pairings of words in one hostility category with electric shock. When words from other categories were later presented in a test, average galvanic skin response (GSR) magnitude was about equal and was lower than the average GSR magnitude to the S+ category words.

The studies using the hostility dimension presented only grouped data. It is not clear whether these group curves were representative of individual performances. In addition, training was given at only one category on the dimension.

The aim of Experiments 2 and 3 of the present study was to determine the effects of discrimination training for individual subjects on generalization along another dimension based on a verbal concept (occupational status). The occupational status dimension was used for several reasons. First, occupational status should be a fairly similarly ordered dimension for all subjects. Studies have shown a basically similar status ordering of occupations regardless of subjects' country of origin (Congalton, 1953; Inkeles & Rossi, 1956) or socioeconomic characteristics (Congalton, 1953; Reiss, 1961). Second, it is probably necessary to use a categorical scale to ensure that each subject acquires the concept the dimension scales and not just individual words. Occupational status may be a continuous dimension (Blau & Duncan, 1967) but it can easily be made into a categorical scale. There are many occupation names available to construct a categorical scale.

EXPERIMENT 1

The purpose of Experiment 1 was to generate a category occupational status scale for use in the generalization studies and to explore some properties of the status dimension. Five status categories were decided as the minimum number needed for an extended dimension. Using more than five might have made status discriminations between categories too difficult.

Part A: Constructing the Category Status Scale

Subjects

Eighty-one students taking a second-year course in experimental psychology at the University of Otago, Dunedin, New Zealand, served.

Procedure

The students were given a questionnaire during class. They placed each of 115 occupation names into one of five status categories. The highest status names were to go into Category 1, the next highest into Category 2, and so on. To eliminate occupations that were

Table 1

The category status dimension. Training and test occupations in each status category. The first six occupation names in each category were used in the test. The number on the left of each test name is its position in the test sequence.

Status category				
(1)	*(2)*	*(3)*	*(4)*	*(5)*
4 Lawyer	3 Psychologist	1 Secretary	2 Taxi-driver	5 Dishwasher
7 Architect	8 Physiotherapist	6 Printer	9 Telephone operator	10 Roadsweeper
12 Magistrate	11 Economist	15 Carpenter	13 Milkman	14 Parking lot attendant
19 Doctor	16 Secondary School teacher	18 Cabinet maker	22 Shop assistant	17 Ditchdigger
24 Cabinet minister	20 Personnel officer	23 Plumber	27 Freezing worker	21 Grocery delivery boy
29 NZ ambassador	28 Chemist-pharmacist	26 Electrician	30 Library book shelver	25 Coin machine attendant
University professor		Boatbuilder	Bus driver	Car wash worker
Dentist		Receptionist	Welder	Garbage collector

inconsistently categorized, only the eight occupations in each category which were most consistently placed into the category were used.

Results

The occupation names retained and their categories are presented in Table 1. At least 50% of the students placed each occupation (except *Welder,* which had a modal placement of slightly less than 50%) into the category shown in the table.

Discussion

The category scale in Table 1 is an average scale taken over many subjects and is probably not the same as any one individual's scale. However, individuals may perceive two status dimensions; their own and one which they see most people as having. To take an extreme example, some individuals assigned *Cabinet Minister* and *Ambassador* low status while reporting that most people assign these occupations high status. The average dimension in Table 1 is probably fairly similar to the scale that individuals see most other people as holding, since the scale is an average of many subjects' data.

Part B: Exploring Some Properties of the Status Dimension

This study had two main aims. The first was to see if occupational status is like a physical dimension in that status ordering holds under a variety of scaling procedures. The second aim was to gain some indication of the metric distances along the dimension that the categories in Table 1 cover and the metric distances between categories.

Subjects

One hundred and four first- and third-year students at the University of Queensland, Brisbane, Australia, served. The first-year students participated to fulfill a course requirement; the third-year students were volunteers.

Procedure

The subjects completed a questionnaire based on the occupation names in Table 1 except for three which were changed to their nearest Australian equivalents: *Cabinet Minister* to *Federal Cabinet Minister, NZ Ambassador* to *Australian Ambassador,* and *Freezing Worker* to *Slaughterman.*

On the questionnaire, each subject scaled the status of the occupations by four different scaling procedures: by ranking them from 1 to 38 (of 38 occupational names), by placing each into one of five status categories, by Thurstone-paired comparisons, and by Stevens magnitude estimation (see Engen, 1971, for details). For the paired comparisons, the occupations were divided into two equal groups to reduce the number of comparisons and therefore reduce fatigue effects. Each occupation name in each group of 19 names was paired with every other in the group. Paired comparison data were treated as described by Engen. In the magnitude estimation scaling, subjects were given a standard magnitude (*Secretary* = 10) and judged the status magnitude of the other occupations in relation to this standard. The median magnitude assigned to each occupation was then used as the scale value of each.

Results and Discussion

The Australian students had a different modal category from the New Zealand students for only three occupations (*Architect* went into Category 2, *Welder* into Category 3, and *Slaughterman* into Category 5). The results with Australian students are therefore comparable to those New Zealand students might generate since their status ordering appears to be similar. All occupations had at least 45% of the Australian sample place it into its modal category.

It was clear that occupational status is comparable to a physical dimension in that equivalent status ordering holds under several different scaling procedures. Mean rank orders by category assignment and ranking from 1 to 38 (derived from the sum of ranks or categories assigned for each occupation divided by *N*) and by the paired comparison and magnitude estimation procedures were correlated by a Spearman rank-order correlation. The lowest rank-order correlation between status orderings by any two procedures was over .97.

Figure 1 presents the status scale from the magnitude estimation procedure. The status ordering of occupations corresponds exactly to the modal categories of these occupations by assignment into five status categories. For example, the seven occupations with the highest amount of status in Figure 1 are all of those placed into status category 1.

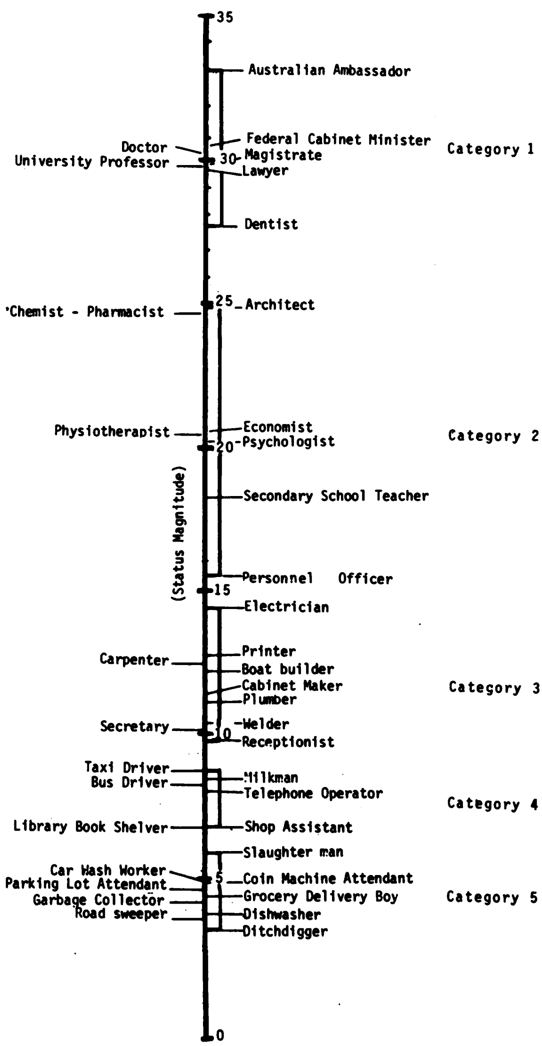

Fig. 1. The occupational status scale developed by the Stevens magnitude estimation procedure. The scale value for each occupation is the median value of data from 104 subjects.

EXPERIMENT 2

Method

Subjects

Ten volunteer male and female students taking an introductory psychology course at Otago University served. Most were between 18 and 20 yr old.

Apparatus

The subject sat alone at a table in a small room. A telegraph key, an add/subtract digital counter, and a small red signal light were mounted on a board on the table. A 19-cm by 19-cm screen was located 80 cm in front of the subject and 40 cm above the table. Words could be rear-projected onto the screen by a slide projector located in an adjoining room, where electromechanical control equipment was also located.

Procedure

Discrimination Training. A subject was seated and given the following typewritten instructions:

> You can earn money in this experiment by pressing the key. Sometimes a press on this key will add one point to the counter. You will receive ten cents for every point

on the counter at the end of the session. The red light will flash each time you earn a point. Sometimes, however, presses on the key will subtract points from the counter. Please remember that points will only be available at irregular intervals. Sometimes you will be able to obtain a point one or two seconds after obtaining one, sometimes this interval may be 30 or 40 seconds or even a number of minutes. Since you will not be able to predict which particular response will produce a point, your best strategy is to respond at a steady rate.

Words will be displayed one at a time on the screen. Please look at the screen and the words on it throughout the experiment. You will find these words will help you predict when responses add points to the counter and when they subtract points.

The key is inoperative when the light in front of you is off and no word is displayed on the screen so please press the key only when it is on and there is a word displayed.

One final instruction; after a while you may see some new words that did not occur before. These words do not signal a new problem to be learned. Please use whatever strategy you used with the original words when deciding how to respond to the new ones.

When a subject indicated understanding the instructions, the experimenter read the instructions aloud. The subject was then left alone and the experiment began.

During discrimination training, the following conditions were in effect. All subjects were expoed to names of 16 occupations from 2 status categories. All saw the eight from Status Category 3. Five subjects saw the eight from Status Category 1 as well; the other five subjects saw the eight from Status Category 5. Occupation names were presented one at a time for 30 sec each. Each name was followed immediately by the next in the sequence after about 1 sec which it took the slide to change. Each of the 16 training names occurred 3 times in an irregular sequence in which no name appeared in succession. The presentation of the entire 48-stimulus sequence constituted a block of trials. Blocks of trials were separated by a 90-sec interval in which the red light was off, no name was on the screen, and key presses had no scheduled consequences.

Responses during each occupation name in Status Category 3 (S+) were reinforced by points on a VI 1-min schedule. In the first block of trials, the VI schedule was in effect during every name in Status Category 3. In subsequent blocks of trials, a procedure operated to ensure that most names in Status Category 3 were correlated with reinforcement. At any one time, the VI schedule operated only during names in one of five subsets of names from Category 3. These subsets are presented in Table 2. For example, if the second subset was in effect, the VI schedule operated only when one of *Boatbuilder, Secretary,* or *Printer* was present. The VI schedule would operate during presentations of only these names until a reinforcer was obtained in the presence of one of these. When this occurred, the VI schedule would continue to operate for the duration of the presentation of the name. The VI schedule then would operate only during each name in the next subset in the sequence of five subsets. The aim of this procedure was to increase the probability that a subject acquired the status concept. The subsets of names were composed such that a subject had to respond in at least six of the eight S+ names to continue receiving reinforcers. If he or she responded in the presence of five or less names, eventually he or she would come to a subset which contained none of

Table 2

The subsets of S+ occupation names in which reinforcers were available at any one time and the sequence in which they occurred.

Position in sequence				
1	*2*	*3*	*4*	*5*
Electrician	Boatbuilder	Cabinet maker	Plumber	Electrician
Cabinet maker	Secretary	Carpenter	Secretary	Carpenter
Plumber	Printer	Boatbuilder	Receptionist	Printer
Receptionist				

those five (or less) occupations and no responses would be reinforced until he or she responded in the presence of one of the other three names.

During all blocks of trials, responses during names in the S− category sometimes subtracted points from the counter. The intervals at which points were subtracted were determined by a VI 2-min schedule which operated until a reinforcer was available.

Training and testing were given in one session which lasted about 108 min. The VI schedules consisted of 14 intervals constructed from the progression given by Fleshler and Hoffman (1962).

Generalization Test. A subject was tested after completing two blocks of trials after the first block in which a discrimination criterion was met. At least 90% of the blocks responses had to occur during names in the S+ category. All subjects met this criterion in the first two blocks after Block 1. All therefore received a total of three training blocks.

During the test, six names from each of the five status categories were presented singly for 30 sec each. The test names and the sequence in which they occurred are presented in Table 1. Each subject completed the test sequence twice. A 90-sec interval similar to that between training blocks separated the two sequences. No points were added or subtracted.

After the test, subjects were asked their basis for discriminating between training words and for responding during the test. Each then placed each occupation name in Table 1 in one of five status categories so that each subject's status ordering of the occupations could be compared with the average dimension.

Total test responses during the six names in each test status category were recorded on digital counters, and a six-pen event recorder provided a graphic record of responses in each test name.

Results and Discussion

Seven subjects (AC, PD, KS, SB, QC, GC, and NH) reported using occupational status as the basis to discriminate between occupa-

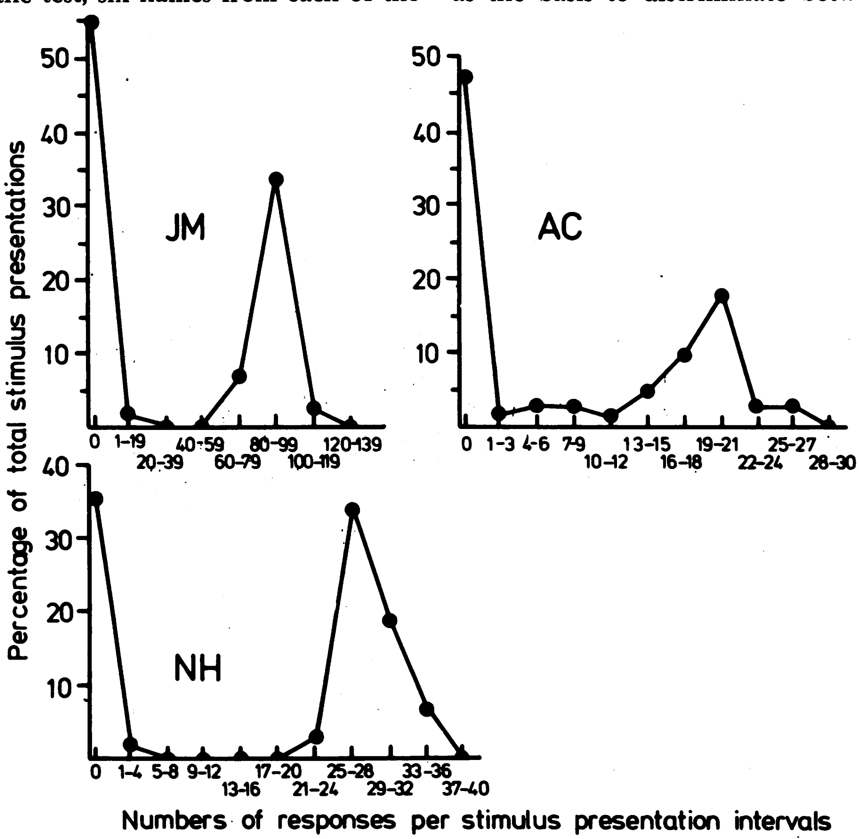

Fig. 2. All-or-none responding by three representative subjects in Experiment 2. The graph shows a nonresponse mode and a response mode.

tion names in training and during the test. Their scaled dimensions were quite similar to the average dimension. No subject placed more than 10 occupations into a different category from its average category. Two subjects (JM and CH) reported using "amount of training required for an occupation." For example, becoming a doctor or lawyer requires much more training (education) than becoming a printer or secretary. They were therefore asked to scale occupations according to amount of training. Their scaled dimensions were quite similar to the average status dimension. CH placed only 4 and JM placed 11 occupations into a different category from the average category. The 10th subject (AB) reported using "extent to which an occupation had a practical application" but could not clarify this basis any further. AB was not asked to scale the occupations according to this basis.

Event records showed an all-or-none pattern of responding in the test. Subjects typically responded in an occupation name throughout its presentation or not at all. One subject showed a somewhat different pattern. AC responded at a high rate of about 200 responses per min for 6 to 10 sec after a name first appeared, then at the much slower rate of 10 to 20 responses per min for the rest of the name's presentation. If a subject responded to one name in an average status category, he or she typically responded to all in that category.

This all-or-none pattern is clearly shown in the frequency distributions of numbers of responses in a stimulus presentation presented in Figure 2. These data are from three representative subjects. The figures each show a similar bimodal frequency pattern with a response mode and a nonresponse mode. One mode is at the 0 responses per stimulus presentation interval, and the other mode lies in a roughly symmetrical distribution. The two distributions do not overlap at all.

Figures 3 and 4 present mean response rate in each average status category for individual subjects. The average categories were used for two main reasons. First, a generalization test

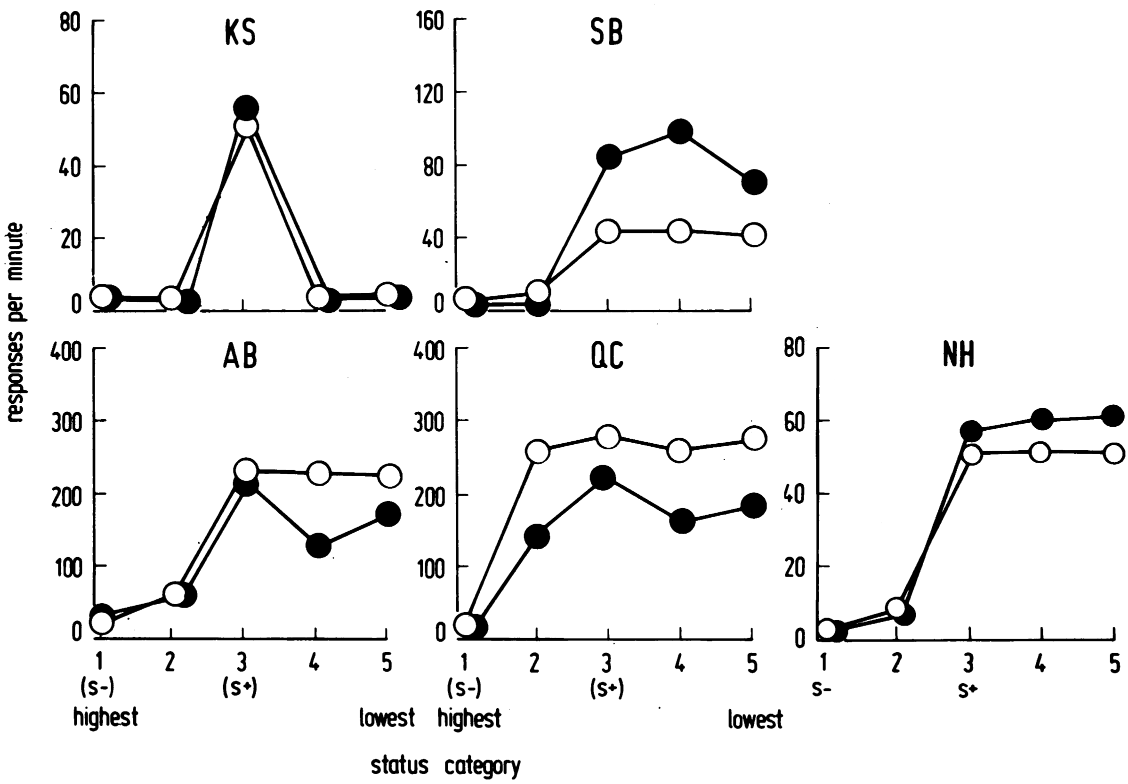

Fig. 3. Generalization test data for individual subjects in one group in Experiment 2. Each point represents the mean response rate in the six occupation names in each status category of the averaged status dimension. Open circles represent data for the first test sequence; closed circles represent data for the second sequence.

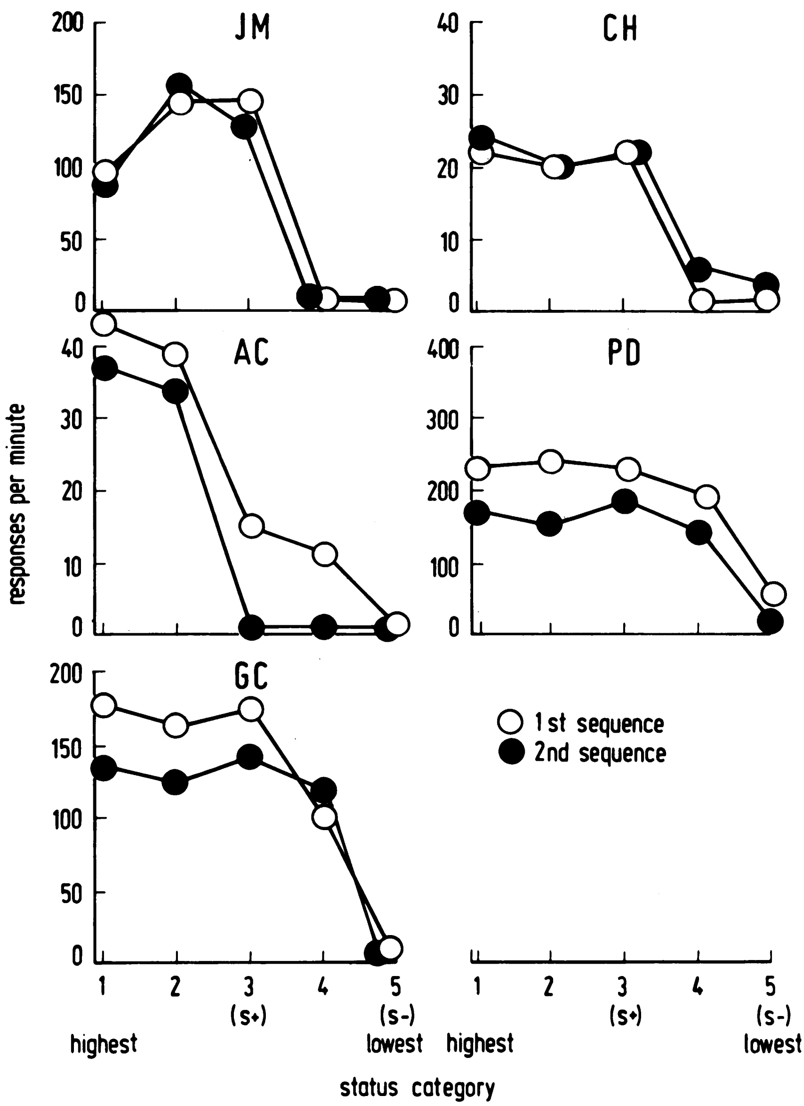

Fig. 4. Generalization test data for individual subjects in one group in Experiment 2. Each point represents the mean response rate in the six occupation names in each status category of the averaged status dimension. Open circles represent data for the first test sequence; closed circles represent data for the second sequence.

necessarily tests for generalization to stimuli not presented before. If a subject's own scaled dimensions were used on the x-axis, discrepancies between these and the average dimension would result in test names being mixed in training status categories and training names mixed in test categories. Discrepancies between subject's own and the average dimension were usually small and made little difference except as noted below, however. Second, it is hard to specify whether the controlling dimension is the subject's own or the average one. The training procedure seems more likely to bring behavior under the control of the average dimension if it is at all discrepant with the subjects' own.

Figures 3 and 4 show a categorical pattern of generalization. All subjects except AC dichotomized the dimension, responding virtually alike to names in status categories in either part of the dichotomy. Five subjects (JM, CH, SB, AB, and NH) treated the category in between S+ and S− similarly to S−. The slightly higher rate AB showed in this intermediate category was due to a high rate in *Physiotherapist* in both sequences; rate to all other names in this category was zero. PD and QC treated the category intermediate between S+ and S− similarly to S+.

Both JM and GC showed a decrement in response rate away from S+. JM showed a lower rate in Status Category 1 than in S+, and GC showed a lower rate in Status Category 4 than in S+ in the first sequence. Both these effects suggest a generalization decrement but were due to discrepancies between each subject's dimension and the average dimension. JM reported using "amount of training." On his posttest scale sheet, he classed two occupations in the average Status Category 1 (*NZ Ambassador* and *Cabinet Minister*) as requiring little training. He responded to neither name during each test sequence. On his scale sheet, GC classed four occupations in the average Status Category 4 (*Taxi-driver, Telephone Operator, Milkman,* and *Shop Assistant*) in Status Category 3. He placed the other two occupations in the average Status Category 4 in Category 4. Response rate to the first four names was high in both sequences but was zero to the second two names in the first sequence. The decrement was due to this. Response rate was high to all names but *Library Book Shelver* in the average Status Category 4 in the second sequence.

KS placed all names into two categories: S+ and not S+. AC appeared to show transposition (Riley, 1968). In the first sequence, response rates in Status Categories 1 and 2 were higher than rates in S+ and remained high during the second sequence. After the test, he reported using the rule "respond to the higher status occupations."

EXPERIMENT 3

These data are presented as evidence against two interpretations of the Experiment 2 results and to extend these results to a concurrent schedule.

The Experiment 2 results might have been due to either one of two instructions. First, subjects were told that their best strategy was to respond at a steady rate. Subjects might therefore have tried to keep rate constant, and this may have prevented decremental gradients from occurring. Second, subjects were told that they might later see words that had not occurred before and to use whatever strategy they used with the original words when deciding how to respond to the new ones. A pilot study found that this instruction was needed to ensure transfer of the discrimination from training to testing. Without it, most subjects treated the test as a new discrimination problem and responded alike to all words. This instruction could possibly have induced subjects to categorize words just as in training —into an S+ and an S− category.

The subjects in Experiment 3 were exposed to a concurrent-changeover schedule (Beale & Winton, 1970). In a concurrent-changeover schedule, stimuli and their associated schedules occur in an irregular sequence. The subject can alternate among stimuli by making a changeover response. This procedure yields three measures of behavior: responses, time spent, and response rate in the presence of each stimulus. Response rate appears to be a rather insensitive measure. Response rates do not differ much in stimuli correlated with different reinforcement rates, but relative responses and time spent do differ markedly (Beale & Winton, 1970; Howard, 1978; Winton & Beale, 1971). The latter two studies showed much sharper gradients of responding and time spent than of response rate along a line-tilt dimension in pigeons.

There is no obvious way in which an instruction to respond at a steady rate could affect the allocation of responses and time to different stimuli in a concurrent schedule. If the only reason for the dichotomous generalization pattern in Experiment 2 was due to that instruction, then subjects exposed to a concurrent schedule possibly could show decremental gradients of responses and time spent.

Two subjects in Experiment 3 were not told that they might later see new words. These were the only two out of several who transferred the discrimination from training to testing without being instructed to do so. If they show a dichotomous generalization pattern, this cannot be due to the previous instruction that they might later see new words.

Experiment 3 was conducted before Experiment 2. One control procedure used in Experiment 2 was not used: Subjects did not scale the dimension after the test.

METHOD

Subjects

Five students with similar characteristics to those in Experiment 2 served.

Apparatus

The apparatus was similar to that in Experiment 2 but with several differences. There were two telegraph keys spaced about 40 cm apart in front of the subject. A press on the left key changed the occupation name on the screen. A press on the right key sometimes produced a point. Points could be added to a counter which had no flashing light.

Procedure

Training. Three subjects (PG, TY, and JW) were given a set of instructions similar to those in Experiment 2 but with the following differences. They were told that they could change the word on the screen by pressing the left key. Points had no monetary value in Experiment 3, so subjects were told that their task was to earn as many points as possible. GS and KJ were given similar instructions but were not told that later they might see new words. Instructions were administered under the same conditions as in Experiment 2.

The stimulus sequences were the same as those in Experiment 2. Training conditions were also similar with some differences. All subjects saw the eight occupation names from Status Category 3 (S+) and those from either Category 1 or Category 5 (S−). Subjects could change between names by pressing the left key. Responses on the right key were reinforced by points on a VI 30-sec schedule. There was a 5-sec changeover delay; responses could not be reinforced until 5 sec after the last changeover press. The subset scheduling procedure was not used with GS and KJ. For the other three subjects, the VI 30-sec schedule operated during each S+ name in the first trial and in subequent trials ran according to the subset procedure. Responses in S− names had no scheduled consequences. All subjects but GS received between 5 and 8 blocks of 48 training trials; GS was given 15 blocks of trials. All subjects were given one or two blocks of trials (never the first or last) in which no points were added to ensure greater resistance to extinction in the test.

Generalization test. A subject was tested after two consecutive blocks of trials in which reinforcers were delivered and in which, in each block of trials, the number of responses in S− was fewer than 10% of the number in S+. Test conditions and the stimulus sequence were identical to those in Experiment 2 except that subjects themselves changed between occupation names. No points were added.

RESULTS AND DISCUSSION

KJ and GS were not asked what basis they used for discrimination. PG and JW reported using status, and TY reported using amount of training.

The instruction to respond at a steady rate evidently did not induce subjects to hold constant responses made and time spent in the presence of names. For example, PG made as few as 6 responses in names responded to and as many as 27, with a mean number over the test of about 17. Time spent in a word ranged from 1 sec to 9 sec, with a mean time of about 3.5 sec. Numbers of responses in the presence of words for KJ ranged from 1 to 12, with a mean number of about 5. Time spent in a name ranged from 1 sec to 12 sec, to a mean time of about 4 sec. The wide distribution of response numbers in stimulus presentations may be seen in PG and KJ in Figure 5.

Figure 5 also shows a bimodal distribution of numbers of responses in a stimulus presentation with a response mode and a nonresponse mode, similar to those that subjects in Experiment 2 showed. The data in Figure 5 are from two representative subjects.

Figures 6 and 7 present mean number of responses and time spent in each average status category for individual subjects. All subjects showed a categorical pattern of generalization. Responses and time spent were similar in S+ and in the two status categories on the side of S+ away from S−, although this effect was less clear for time spent. KJ initially treated names in Status Category 2 the same as S+, then showed a shift over the course of testing until they were treated the same as S−. She responded in progressively fewer names in Status Category 2: in the first sequence to all names in this category, in the second to four, in the third to one, in the fourth to two, and in the fifth to none.

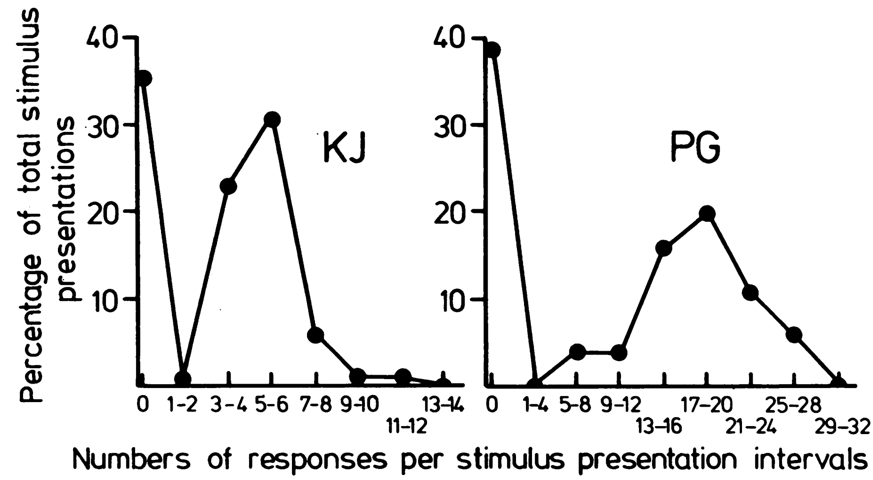

Fig. 5. All-or-none responding by two representative subjects in Experiment 3. The graph shows a nonresponse mode and a response mode.

GENERAL DISCUSSION

The results of both Experiments 2 and 3 may be summarized as follows. Subjects typically showed a categorical generalization pattern along the conceptual dimension. Each divided the dimension into two categories, responding alike to stimuli classed within each category. The categorical pattern occurred when the subjects were trained and tested with either a multiple or a concurrent schedule.

The present study suggests that a conceptual dimension may be functionally equivalent to a physical dimension in that the generalization pattern along the status dimension was similar to that shown along some physical dimensions (Landau, 1968; Nicholson & Gray, 1971). This hypothesis is also supported with pigeon data by Honig (1965). Honig obtained gradients along a conceptual stimulus difference dimension similar to the gradients pigeons usually show along physical dimensions.

Another line of evidence supports the above hypothesis. Several studies have shown a "symbolic distance effect" along labeled physical dimensions (Moyer & Bayer, 1976; Paivio, 1975). This effect occurs when reaction time to compare the magnitude of two stimuli (presented by labels) decreases as distance on the dimension between the stimuli increases. For example, a subject might take longer to decide whether a duck or a goose is larger versus an ant or an elephant.

The symbolic distance effect has been shown along a variety of physical dimensions such as size and has also been shown along some conceptual dimensions such as the smartness or dumbness of animals (Banks & Flora, 1977) and quality (Holyoak & Walker, 1976).

Why should human subjects show similar patterns of generalization along both conceptual and physical dimensions? It may be that humans simply label all new stimuli presented by reference to one or both training stimuli. For example, in the present study, some subjects categorized stimuli as either "S+ or all other stimuli" (e.g., KS in Experiment 2), or "S– and all other stimuli" (e.g., possibly QC in Experiment 2). Others such as CH and NH in Experiment 2 may have labeled stimuli as of either "higher" or "lower" magnitude than S+. Stimuli from any dimension can be labeled in one of the above ways.

An important and unanswered question is whether human subjects ever do show generalization gradients or whether the categorical pattern is typical. If humans do not show gradients, can the principles derived from decades of animal work on stimulus generalization be applied to human subjects? Or do gradients appear in humans under some conditions and categorical generalization in others? Much research is needed to answer these questions.

Many studies with humans have purported to show generalization gradients along a stimulus dimension (e.g., Baron, 1973; MacKin-

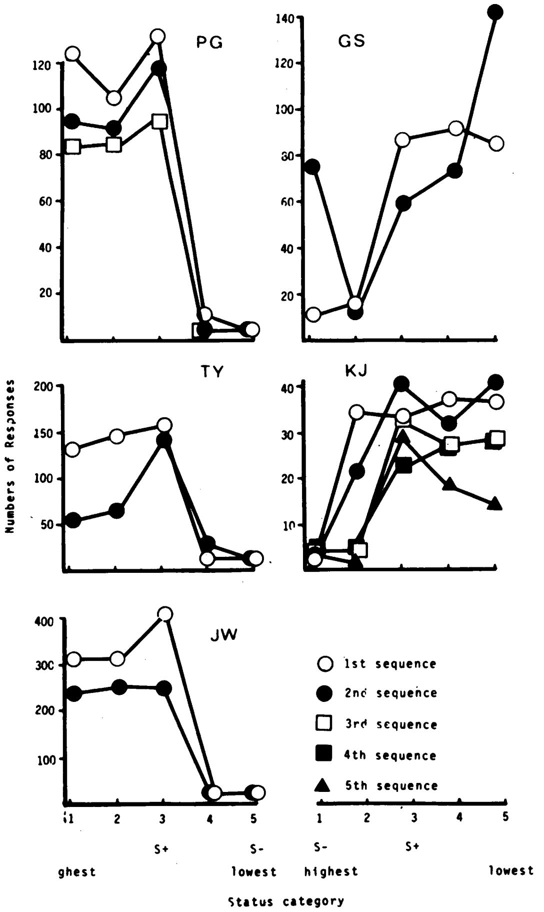

Fig. 6. Generalization test data for individual subjects in Experiment 3. Each point represents the total number of responses in the six occupation names in each status category of the averaged status dimension. Subjects were exposed to different numbers of test sequences.

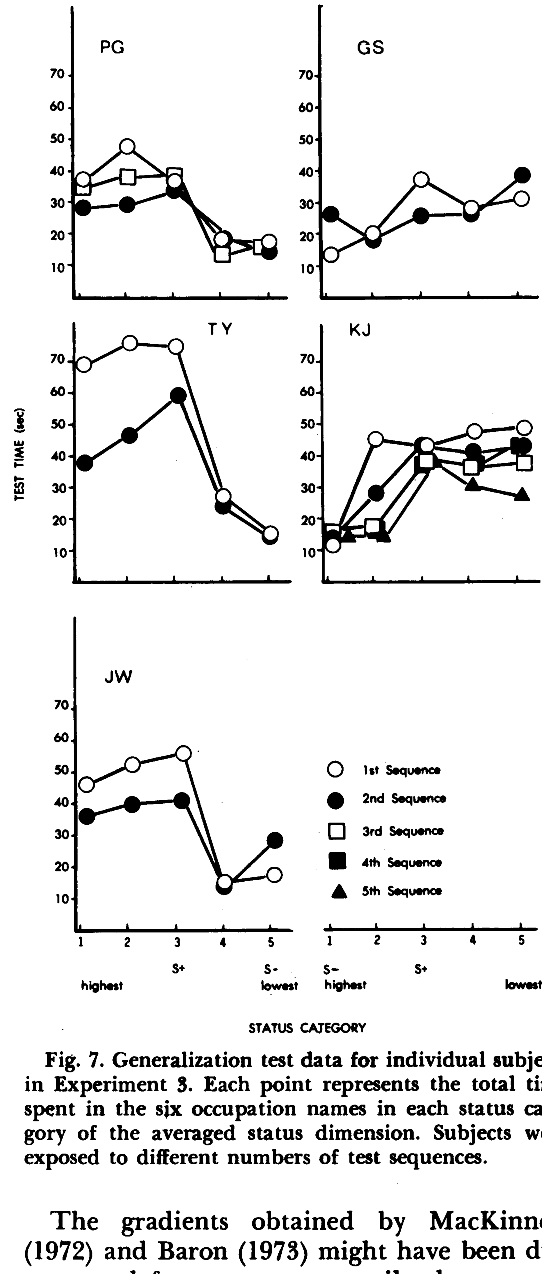

Fig. 7. Generalization test data for individual subjects in Experiment 3. Each point represents the total time spent in the six occupation names in each status category of the averaged status dimension. Subjects were exposed to different numbers of test sequences.

non, 1972; for review, Thomas, 1974). The procedure in such studies is quite different from the present study and from typical animal generalization studies, however. Such studies usually present only data averaged over many subjects. Training is very short. Most important, the subject is usually given the task of *identifying* a training stimulus. He or she is usually instructed to respond only to a training stimulus, not to test stimuli clearly different from training stimuli. In the present study, for instance, such an instruction was not given. Subjects did respond to stimuli easily discriminable from S+ (e.g., to *Doctor* and *Magistrate* after training to *Carpenter* and *Secretary*, and so on).

The gradients obtained by MacKinnon (1972) and Baron (1973) might have been due to several factors not necessarily the same as those producing gradients in animals. A subject's identification of S+ might shift around S+ over the course of testing, or some subjects might shift varying distances in one direction and others shift in the opposite direction. Averaging all these data together might produce a gradient and possibly a peak shift in one direction.

It should be noted, though, that a subject might treat a stimulus he or she can see as different from S+ or the same as S+, depending on how he or she labeled S+ in training. For example, some subjects in Landau's (1968) study treated a nearly horizontal line as S+ (S+ was a vertical line) even though they were instructed to respond only to S+. They may have labeled S+ as "a line" in training instead of "a vertical line." Therefore, the horizontal line may have been also labeled as "a line" and responded to.

Studies such as Baron (1973) and MacKinnon (1972) where subjects are instructed to respond only to S+ are better called studies of stimulus *identification* than of stimulus *generalization*. The term stimulus generalization might best be reserved for procedures in which test stimuli are potentially discriminable from training stimuli and there are no external constraints such as instructions on responding to test stimuli.

There are few data on human stimulus generalization along a dimension by the above definition. Two of the few studies were carried out by Nicholson and Gray (1971, 1972). Generalization patterns were not reported in the 1972 study. However, in the 1971 study, the authors reported categorical generalization after discrimination training between the presence and absence of a vertical orientation (their Experiment 1) and reported gradients and peak shift after discrimination training between two different orientations (their Figure 3 in Experiment 2). A close look at Figure 3 in their Experiment 2 suggests that categorical generalization might have occurred, instead. The subjects may have divided the dimension into three categories or changed the category into which some stimuli were assigned to over the course of testing. For example, S3 shows a zero response rate to six orientations, about the same rate to S+ and the two adjacent orientations, and a lower and roughly equal rate to three other stimuli. S4 showed a zero rate to nine orientations, a roughly equal rate to two other tilts, and the highest rate to S+.

Generalization to verbal stimuli has been studied extensively as semantic generalization (e.g., Feather, 1965; Maltzman, 1968, 1977). It is difficult to relate findings from semantic generalization studies to the questions approached by the present study, however. The main interest in semantic generalization studies is to show that generalization occurred. Average responding of many subjects to semantically related test words is therefore compared to their responding to unrelated words. There is little apparent interest in the *pattern* of generalization. In addition, training and test stimuli are not usually related along any specifiable extended unitary dimension. For example, training stimuli might be instances of a verbal concept (e.g., Oldsmobile, Ford) and the test stimulus, car, the concept name (Brotsky, 1968).

The present study suggests that labeling and categorization play a major role in human stimulus generalization. It seems likely that they play a major role in human stimulus control generally. Their possible influence needs to be investigated. Finally, the influence of labeling and categorization on other aspects of human operant behavior such as schedule performance also needs to be investigated.

REFERENCES

Banks, W. P., & Flora, J. Semantic and perceptual processes in symbolic comparisons. *Journal of Experimental Psychology: Human Perception and Performance*, 1977, **3**, 278-290.

Baron, A. Postdiscrimination gradients of human subjects on a tone continuum. *Journal of Experimental Psychology, 1973*, **101**, 337-342.

Beale, I. L., & Winton, A. S. W. Inhibitory stimulus control in concurrent schedules. *Journal of the Experimental Analysis of Behavior*, 1970, **14**, 133-137.

Blau, P. M., & Duncan, O. D. *The American occupational structure*. New York: John Wiley & Sons, 1967.

Brotsky, S. J. Classical conditioning of the galvanic skin response to verbal concepts. *Journal of Experimental Psychology*, 1968, **76**, 244-253.

Buss, A. H. Stimulus generalization and aggressive verbal stimuli. *Journal of Experimental Psychology*, 1961, **61**, 469-473.

Congalton, A. The social grading of occupations in New Zealand. *British Journal of Sociology*, 1953, **4**, 45-59.

Engen, T. Psychophysics. II: Scaling procedures. In J. W. Kling & L. A. Riggs (Eds.), *Woodworth and Schlosberg's experimental psychology* (3rd ed.). New York: Holt, Rinehart & Winston, 1971.

Feather, B. W. Semantic generalization of classically conditioned responses: A review. *Psychological Bulletin*, 1965, **63**, 425-441.

Fleshler, M., & Hoffman, H. S. A progression for generating variable-interval schedules. *Journal of the Experimental Analysis of Behavior*, 1962, **5**, 529-530.

Gagné, R. M. *The conditions of learning*. New York: Holt, Rinehart & Winston, 1970.

Geer, J. H., & Buss, A. H. Generalization of a nonverbal response to aggressive verbal stimuli. *Journal of Experimental Psychology*, 1962, **63**, 413-414.

Guttman, N., & Kalish, H. I. Discriminability and stimulus generalization. *Journal of Experimental Psychology*, 1956, **51**, 79-88.

Hanson, H. M. Effects of discrimination training on stimulus generalization. *Journal of Experimental Psychology*, 1959, **58**, 321-334.

Holyoak, H. J., & Walker, J. H. Subjective magnitude information in semantic orderings. *Journal of Verbal Learning and Verbal Behavior*, 1976, **15**, 287-299.

Honig, W. K. Discrimination, generalization, and transfer on the basis of stimulus differences. In D. I. Mostofsky (Ed.), *Stimulus generalization*. Palo Alto: Stanford University Press, 1965.

Howard, R. W. Some effects of training conditions on the control exerted by compounded stimuli. *Australian Journal of Psychology*, 1978, **30**, 169-176.

Inkeles, A., & Rossi, P. R. National comparisons of occupational prestige. *American Journal of Sociology*, 1956, **61**, 329-339.

Landau, J. S. Postdiscrimination generalization in human subjects of two different ages. *Journal of Experimental Psychology*, 1969, **76**, 656-663.

Lang, P. J., Geer, J., & Hniatiow, M. Semantic generalization of conditioned autonomic responses. *Journal of Experimental Psychology*, 1963, **65**, 552-558.

MacKinnon, M. M. Adaptation-level theory, anchor theory and the peak shift phenomenon. *Journal of Motor Behavior*, 1972, **4**, 1-12.

Maltzman, I. Theoretical conceptions of semantic conditioning and generalization. In T. R. Dixon & D. L. Horton (Eds.), *Verbal behavior and general behavior theory*. Englewood Cliffs, N.J.: Prentice-Hall, 1968.

Maltzman, I. Orienting in classical conditioning and generalization of the galvanic skin response. *Journal of Experimental Psychology: General*, 1977, **106**, 111-119.

Moyer, R. S., & Bayer, R. H. Mental comparison and the symbolic distance effect. *Cognitive Psychology*, 1976, **8**, 228-246.

Nicholson, J. N., & Gray, J. A. Behavioral contrast and peak shift in children. *British Journal of Psychology*, 1971, **62**, 367-373.

Nicholson, J. N., & Gray, J. A. Peak shift, behavioral contrast and stimulus generalization as related to personality and development in children. *British Journal of Psychology*, 1972, **63**, 47-62.

Paivio, A. Perceptual comparisons through the mind's eye. *Memory and Cognition*, 1975, **3**, 635-647.

Reiss, A. *Occupations and social status*. New York: The Free Press, 1961.

Riley, D. A. *Discrimination learning*. Boston: Allyn & Bacon, 1968.

Thomas, D. R. The role of adaptation-level in stimulus generalization. In G. H. Bower (Ed.), *The psychology of learning and motivation*, VIII. New York: Academic Press, 1974.

Winton, A. S. W., & Beale, I. L. Peak shift in concurrent schedules. *Journal of the Experimental Analysis of Behavior*, 1971, **15**, 73-81.

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