concerned primarily with the effects of several drugs on peripheral nerve, the fact that most of these drugs block synaptic transmission as well as axonal conduction suggests that a similar ion-binding process may also participate at the synapse (*17, 18*).

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8 April 1966

Scaling of Musical Preferences by the Mentally Retarded

Abstract. *The ability of institutionalized retardates in scaling musical preferences was compared with that of normals. The retardates' scale values and scale forms obtained by two kinds of scaling procedures are very similar to those of normals. Deficits, however, are observed in their lower internal consistency and relative uncertainty and in higher response polarization and perseveration.*

The scaling of musical preferences, a matter of linking the number system to a preference schema, is possible only when a person is reasonably familiar with the properties of numerical series and has developed his preference schema for music. Moreover, there must exist a certain degree of isomorphism between these two personalized systems. We have tried to assess the ability of mentally retarded adults in scaling musical selections, to clarify the nature of scale forms and response patterns, and to infer the underlying numerical and preference structures, comparing them with those of normal adults.

The subjects were 106 institutionalized retardates (54 men and 52 women), 54 aides in a state hospital (24 men and 30 women), and 42 college students (23 men and 19 women). The mean chronological ages, mental ages, and Stanford-Binet IQ's for the retardates were, respectively, 35.9 years (σ, 6.9), 8.5 years (σ, 1.2), and 56.4 (σ, 7.3) for men; and 35.7 years (σ, 6.4), 8.9 years (σ, 1.4), and 59.4 (σ, 9.2) for women. Retardates whose mental age was less than 6 years were excluded. The causes of retardation were: familial, 38; uncertain, 65; and infection, 3. The mean age and education for the aides were 45 years (σ, 10.3) and 10 years (σ, 2.3). The college students were mostly freshmen and sophomores.

Thirty vocal excerpts selected from a previous study (*1*) were presented by tape recorder to groups of 10 to 15 subjects; they included opera singing, folk songs, college songs, and stage music, with instrumental backgrounds; each excerpt lasted about 60 seconds. Both category- and magnitude-scaling procedures, which yield ordinal and ratio scales, respectively, were employed (*2*). For the category scale, each subject was instructed to assign to each excerpt one of seven (for retardates) or nine (for normals) ordered responses ranging from most pleasant, through indifferent, to most unpleasant, in accordance with his impression. For the magnitude scale a standard excerpt was played first, and the subject was instructed to indicate his reaction to each subsequent excerpt by assigning a number proportional to that for the standard piece. The group scale value of each excerpt for the category scale is the mean category number; that for the magnitude scale is the geometrical mean of the assigned numbers. Both procedures were administered in a single sitting, with two presentations of each of the 30 excerpts. Extensive explanation of the procedures and some practice were necessary for the retarded groups.

The retardates' (as a group) preference for vocal selections closely resembled that of the normals. The product-moment correlations between retardates and aides and between retardates and students for the category scale range from .88 to .92; those for the magnitude scale are .84 to .94; correlations between aides and students are .86 to .98. In all groups the women tend to show higher correlations, but the sex differences are not significant. The correlations between men and women among the retardates (.86, .89) are slightly lower than among the normals (.94 to .97).

Since two different kinds of scaling procedure were applied to the same 30 excerpts, preference agreement between these two scales could serve as a measure of internal consistency. The retardates, as a group, again show high inter-scale correlations comparable to those of the normals (Fig. 1). In order to

examine the internal consistency of the individual subjects, the category and magnitude reactions of each subject to the 30 excerpts were dichotomized at the median, and the tetrachoric correlation between the two scales was computed for each subject. The medians for the retarded men and women are .40 (Q, .36) and .80 (Q, .13), respectively; those for the normals range from .85 to .93. In all three groups the women's scaling shows higher internal consistency, but the sex difference is significant only with the retardates (the median test: χ^2, 11.20, $P < .001$). The median of the retarded women is not significantly different from that of the normals. The tetrachoric correlations between this measure of internal consistency and the mental age are .48 for the retarded men and .35 for the retarded women.

The relation between category and magnitude scales in all six groups (Fig. 1) is "concave downward" and roughly logarithmic—a feature of prothetic continua (*3*). The regression line relating the category scales to the log magnitude scale is approximately straight for all groups. In order to determine whether this concave relation on linear coordinates also describes the reactions of each individual, a figure similar to Fig. 1 was drawn for each subject. Two judges independently classified these

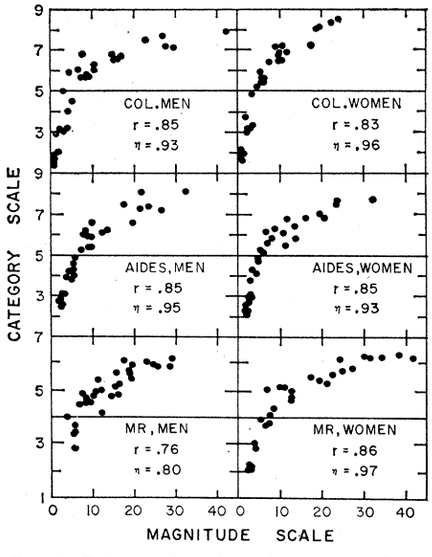

Fig. 1. Relation between the means of the category assignments and geometric means of the magnitude estimates for pleasantness-unpleasantness of 30 vocal selections. The product-moment correlation and the correlation ratio between the two scales are also indicated for the college students, hospital aides, and mentally retarded adults separately. *MR*, mental retardates.

figures into three categories: "concaved downward," "straight," and "no relation" (the data contained no instance of "concave upward"). The average for the two judges (agreement: 93 percent for the normals, 82 percent for the retarded) indicates that the percentages of the above three categories are, respectively, 65, 11, and 24 percent for the retardates and 90, 8, and 2 percent for the aides and students combined. If the category of "no relation" is eliminated, it becomes more evident that downward concavity is predominantly present in the individual functions, including those of the retarded.

The reason for this nonlinearity between the two classes of scales is still largely a matter for speculation. The asymmetry of discrimination over the scale range, subjective variability that tends to grow as the subjective magnitude increases, and the amount of variability or "noise" involved are some of the underlying processes suspected (*4*); whatever the processes may be, retardates share them with normals.

It is, however, the response pattern rather than scale form and scale value that differentiates most of the retardates from the normals. The category assignments by the retardates form a U-shaped distribution (Fig. 2), whereas those by the aides and students are inverted U-shapes with a mode at "mildly pleasant." The combined percentages of the two extreme categories are 56 and 59 percent for the retarded men and women, respectively, although those for the normals are only 16 to 18 percent.

Since the degree of uncertainty or structure in the subject's categorical system is a function of the number of categories he uses and of the rectangularity of the item distribution over categories (*5*), the average uncertainty (H) was computed in order to express the retardates' category polarization. Because of the difference in maximum number of categories allowed for retardates and normals, the relative uncertainty (H/H_{max}) computed is .86 for the retarded (men and women) and .96 to .97 for the aides and students. When this relative uncertainty is computed for the individual subjects, the medians for the retarded men and women become .63 (Q, .21) and .72 (Q, .16), respectively, while the medians for the normal groups range from .84 to .89. The retarded men and women both show significantly lower relative uncertainty or higher structure

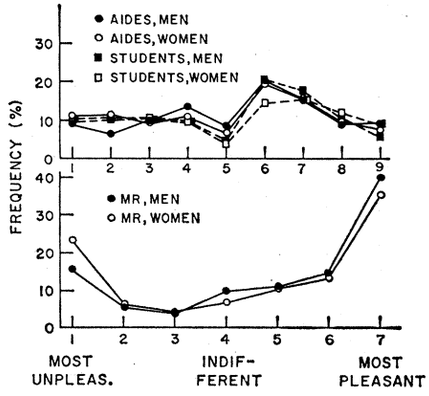

Fig. 2. Frequency of each category used by the aides and students and by the retardates in category scaling. *MR*, mental retardates.

than the normal groups (median test, $P < .001$). Tetrachoric correlations between mental age and relative uncertainty are .35 for the retarded men and .63 for the women.

Response variability or response shifting in successive category assignments is another measure that distinguishes retardates from normals. Figure 3 reveals that retardates tend to repeat the same category (0 shift), or to shift to the opposite end (6-step shift) if they shift. The normals, on the other hand, tend to avoid repetition of response. This response perseveration is significantly greater in the retarded men than women (χ^2, 37.14; df, 1, $P < .001$). If the chance shift is taken as a reference, the shift patterns of the aides and students are much closer to the chance pattern (Fig. 3).

Although the measures of response patterns just presented are not necessarily independent of each other, they all suggest a relatively undifferentiated

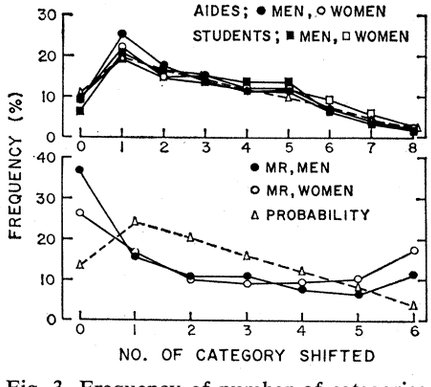

Fig. 3. Frequency of number of categories shifted in successive category assignments. The response shifting that is possible by chance is also indicated—separately for the aides and students and for the retardates. *MR*, mental retardates.

preference structure and a deficiency in modulation of preferential reactions by the retardates. The use of numerals in estimation of magnitude, however, does not offer an immediate explanation. The median number of numerals used by the retardates for the 30 excerpts is 15 (Q, 6.1) for the men and 10 (Q, 4.1) for the women; for the normals, 11 to 12 (Q's, 1.3 to 2.4). Since the various number concepts (such as equalization and seriation) of the retardates include a mixture of Piaget's first three developmental stages (*6*), the large variability of our retardates in the use of numerals may reflect the heterogeneity of these intellectual processes. This measure, however, does not correlate with the mental age or internal consistency. Although only few retardates seem to reach Piaget's stage of abstract operation, clearly they can express meaningfully and consistently their musical preferences by means of numerals.

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Stimulus Control in Pigeons Based on Proprioceptive Stimuli from Floor Inclination

Abstract. *Two groups of pigeons trained to peck a dimly illuminated disc in an otherwise dark experimental chamber with the floor horizontal (0° tilt) or inclined 30° to the left, respectively, show decremental generalization gradients of response rate when the floor inclination is varied from its training position. Discrimination training in which food reinforcement is available under one floor tilt condition but not under another steepens the slope of such gradients. In a second experiment, pigeons reinforced for pecking when the floor was tilted 10° or 20° and not reinforced under the alternative condition showed steep gradients with maximal responding displaced from the reinforced stimulus.*

Proprioceptive feedback is widely assumed to play a significant role in mediating many types of learned behavior. Hull (*1*) posited proprioceptive stimulation as vital to serial learning. Hefferline (*2*) has shown that proprioceptive feedback can function as a source of discriminative stimuli. More recently, attention has focused on the relative contribution of proprio- and exteroceptive stimuli in controlling behavior in the free operant situation. Hearst *et al.* (*3*), Blough (*4*), and Thomas and Switalski (*5*) have suggested that flatter stimulus generalization gradients along an exteroceptive dimension result when reinforcement schedules are used in which response-generated stimulation becomes a discriminative stimulus for further responding. Presumably, internal and external stimuli compete for the control of responding, and thus schedules which emphasize the significance of response-produced stimulation necessarily do so at the cost of reduced external stimulus control.

The use of different reinforcement schedules is one way of manipulating proprioceptive stimulation. An alternative procedure for investigating stimulus control by proprioceptive feedback is to produce postural adjustments by changing the inclination of the floor on which the animal stands and observing subsequent changes in behavior. By training birds to respond in a dark chamber when the floor is inclined a specified degree, and then testing under other positions of tilt, it should be possible to measure the control gained by these postural cues alone.

The apparatus consisted of a standard Grason-Stadler pigeon chamber, except that the floor, a refrigerator shelf covered with ½-inch (1¼-cm) hardware cloth, was mounted on a shaft running lengthwise through the midline of the chamber from the rear wall to the front panel, on which the pecking disc and feeder were mounted. An external gear arrangement permitted the floor to be smoothly rotated into any angle of inclination between 0° and 30° in either direction from horizontal. In the first experiment, only changes in one direction were used, that is, the left side lowered (and right raised) the specified angular distance from horizontal.

Seventeen experimentally naive homing pigeons were trained to peck an illuminated disc in an otherwise completely dark chamber for variable-interval reinforcement with a mean inter-reinforcement period of 2 minutes (V.I.–120 seconds). For eight of these birds the floor of the chamber was always inclined 30° to the left, while for the other nine the floor was in the typical horizontal position. Initial magazine training and response-shaping took place on the designated floor tilt. Daily training sessions were approximately 30 minutes in duration. After approximately 13 days of V.I.–120 seconds training, time-out periods were introduced during which the chamber was in complete darkness and reinforcement was not available (*6*). Time-out periods of 60 seconds were randomly alternated with stimulus presentation periods of 60 seconds. During the periods of stimulus presentation the same V.I.–120 seconds schedule remained in effect. After 3 days of time-out training, the subjects were tested in extinction for generalization to floor inclinations of 0°, 10°, 20°, and 30°. After a 5-minute warm-up period under the original training condition, these four stimuli were randomized in a series, and 12 different random series were presented to each subject. Stimulus presentation periods were for 60 seconds with intervening 15-second time-out periods. These time-out periods permitted the experimenter to record responses and to adjust the floor inclination for the next test period, while allowing subjects time to recover from possible emotional and vestibular effects of the movement of the floor.

After the stimulus generalization test, the subjects were given discrimination training with the previous conditioned stimulus as the positive stimulus (S^+) and the alternative condition (0° or 30°) as the negative stimulus (S^-). In daily training sessions each floor position was presented 15 times for 1-