GRADIENTS OF AUDITORY GENERALIZATION FOR BLIND, RETARDED CHILDREN[1]

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Severely retarded, blind children were conditioned to respond differentially to two intensities of a pure tone. Gradients of auditory generalization were obtained that were reliable and similar to those for normal adults, but often asymmetric and non-monotonic.

The auditory generalization gradients presented in this article permit assessment of the nature and extent of discriminative control of responding obtained, with operant conditioning techniques, from institutionalized children whose prior discriminative conditioning was restricted by severe retardation, aphonia, and blindness since birth.

METHOD

The subjects (*Ss*) were three severely retarded children, blind since birth. A résumé of their personal data and experimental treatments is presented in Table 1. The *Ss* served individually in daily sessions of up to 50 min held in a classroom at the institution where they resided.[3]

The auditory stimuli employed were 500-cps tones, 1.2 sec in duration, recorded at 4-sec intervals on magnetic tape. In discrimination training, 140 tones were presented to *S* in random order, half at 56 db and half at 74 db sound pressure level (SPL). In generalization testing, 110 stimuli were presented, 10 at each of 11 intensity levels spaced at 3 db intervals over the range 50-80 db (SPL). This

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Table 1

Résumé of *Ss* and treatments in a study of auditory generalization in retardates.

Subject	*S.P.*	*L.G.*	*S.B.*
Age	9 yr 11 mo	9 yr 6 mo	7 yr 2 mo
Sex	F	F	M
I.Q.	30 (Stanford-Binet)	20 (Kuhlmann)	10 (Cattell)
Age at institutionalization	3 yr 6 mo	4 yr 7 mo	5 yr 9 mo
Clinical diagnosis	cerebral defect, congenital	premature birth	meningitis
Vision	bilateral blindness	bilateral blindness	bilateral blindness
Discrimination training	1. Two-response [20]* 2. Two-response [17] (hands reversed) 3. Replicate 2. [23] 4. Single response [16]	1. Single response [44] 2. Replicate 1. [14]	1. Single response [37] 2. Replicate 1. [18]

*The numbers in brackets tell how many sessions were required to meet the discrimination criteria described in the text.

series had 10 blocks, each comprising the 11 stimuli in a different sequence, so that each stimulus followed every other exactly once; the blocks were in irregular order.

The apparatus included a tape recorder (Wollensack) that presented the tones monaurally over a calibrated binaural headset (Grason-Stadler, TDH-39). The operanda were two buttons (Arrow-Hart, 3392), mounted 1 ft apart on the edge of a table facing the *S*. Stimulus intensity was coded in binary form with sensitive relays of differing thresholds (Barber-Colman, AYLZ) and represented, along with responses, on an events recorder (Esterline-Angus). The experimenter (*E*) monitored the record during discrimination training and presented reinforcement—3 sec of recorded children's music—during the interstimulus interval following a response.

The procedure had three phases: habituation in the experimental space, discrimination training, and generalization testing. From two to five daily sessions were required before *S* wore the headset without removing it and remained seated in front of the table for 30 min. Multiple-response discrimination training was employed with one *S*; single-response training was later given to that *S* and two others. Either procedure was begun by depressing the right hand of the *S*, on the right hand button, each time a tone in the training series occurred. This response was always followed by reinforcement. The force that *E* exerted was gradually reduced; eventually, *S* responded to each of the 140 tones in the series without assistance.

In multiple-response discrimination training, this procedure was replicated with the left hand and left button. Following this, both hands and buttons were employed, first with *E*'s assistance, later without. The 56-db tone was the S^D for the left-hand response (R_L) and S^Δ for the right-hand response (R_R); conversely the 74-db tone was S^D for R_R and S^Δ for R_L. Incorrect responses, as well as failing to press, or pressing both buttons concurrently, had no effect. Correct responses were regularly reinforced until *S* responded without error throughout one series of 140 tones. In subsequent training series, every third correct response, on the average, was reinforced; however, R_L and R_R were reinforced an equal number of times. When *S* responded without error, under partial reinforcement, throughout two presentations of the series of training stimuli, the 110 tones in the generalization series were presented.

In single-response training, the initial procedure was followed by extinction of R_R to the 56-db tone; regular reinforcement of R_R to the 74-db tone was maintained. After *S* completed one series without responding to the 56-db tone, partial reinforcement was introduced; on the average, every third response to the 74-db tone was reinforced. When *S* completed two training series under partial reinforcement, without ever responding to the 56-db tone, the generalization-testing series was presented.

RESULTS AND DISCUSSION

An Observation on Auditory Reinforcement

At the outset of discrimination training with our first subject, S.P., each right-hand button press following a tone was reinforced with 3 sec of music. The rate of responding increased abruptly, with presses occurring during and between tones. After 10 min, *E* stopped presenting stimuli and reinforcements. Now the only effect of the response was tactile and proprioceptive stimulation from button press and an audible click from the events recorder. Responses continued to occur at a rate of about 40 per min for over 20 min. Finally, *E* unplugged the events recorder and noted responses manually. The response rate declined to zero within 3 min. In subsequent sessions the events recorder remained outside the experimental room and *E* monitored a bank of lights when presenting reinforcement.

The Generalization Gradients

Gradients of response frequency as a function of tone intensity, obtained from the three *Ss*, are shown in Fig. 1. Inspection of the entire figure confirms that common conditioning procedures, employed with normal infrahuman and human *Ss* to yield gradients of stimulus generalization, also yield similar gradients with blind, severely retarded children.

The first gradient, for Subject S.P. (Fig. 1a), shows a non-monotonic change in response probability and marked asymmetry. (These two properties recur in most of the other gradients obtained.) In order to examine the

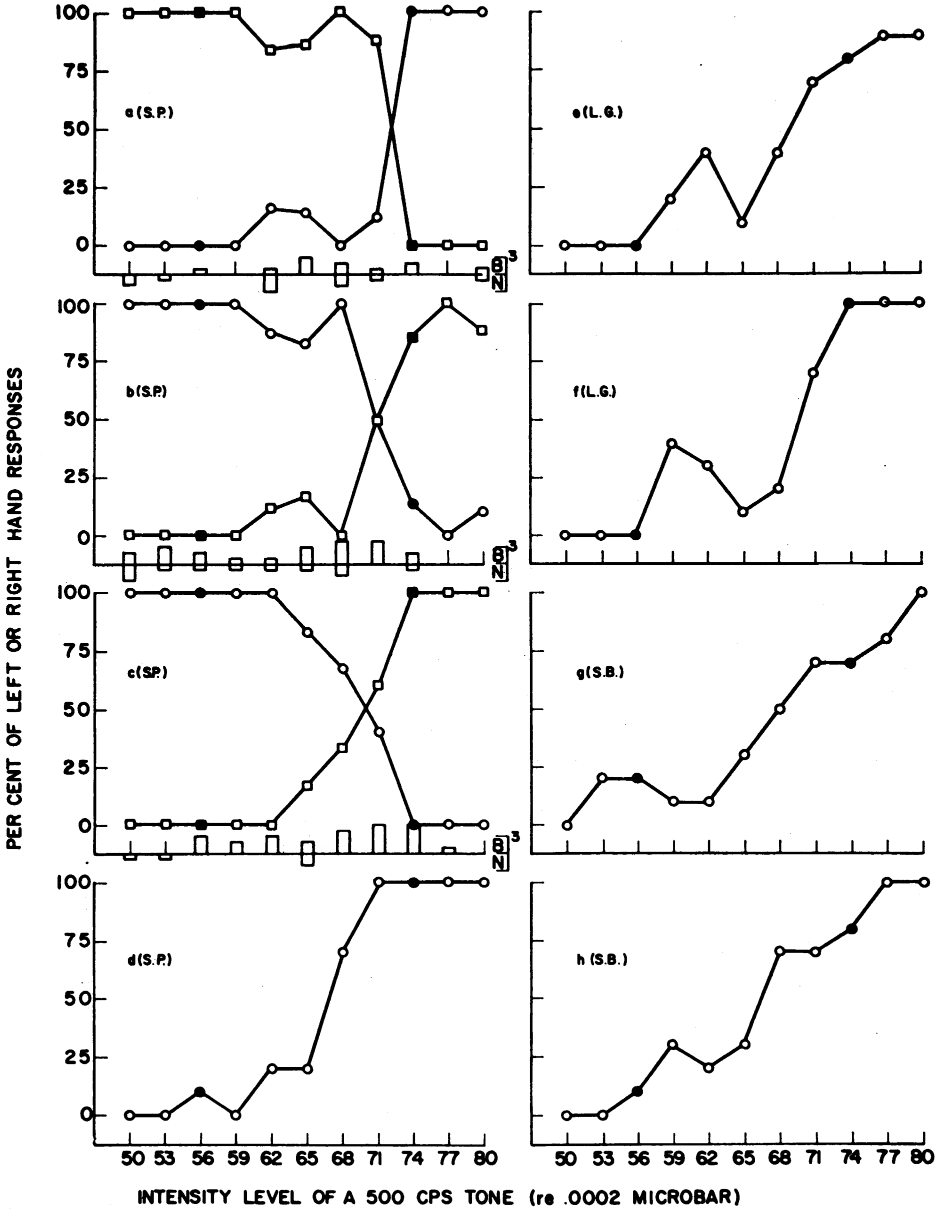

Fig. 1. Gradients of auditory generalization for three retarded *Ss*. Each point in Fig. 1a-1c shows the relative frequency of left-hand (squares) or right-hand (circles) responses evoked by 10 presentations of the corresponding stimulus intensity. These values, expressed in per cent, do not reflect occurrences of both responses concurrently, or neither response, following a stimulus; the latter are shown by histograms above and below the abscissae, respectively. Each point in Fig. 1d-1h shows the number of right-hand responses evoked by 10 presentations of the corresponding stimulus intensity, expressed in per cent. The filled points correspond to S^D or S^Δ intensities used in discrimination training. Figure 1b represents a replication of the procedure that yielded Fig. 1a, but with the intensity-hand correspondence reversed in discrimination training. Figure 1c represents a replication, one month later, of the procedure that yielded Fig. 1b. Figure 1d shows the gradient obtained after single-response discrimination training with this *S*. The same procedure with a second *S* gave the gradient shown in Fig. 1e; Fig. 1f is the outcome of a replication one month later. Similarly, Fig. 1h replicates Fig. 1g for a third *S*.

reliability of the form of the gradient and whether the asymmetry was due to handedness, we reconditioned the discrimination two weeks later, with the intensity-hand correspondence reversed (R_L to 74-db, R_R to 56-db tones). Figure 1b shows that the form of the gradient was remarkably stable, with the inversions and asymmetry persisting. A replication of the latter procedure, a month later, gave the gradients shown in Fig. 1c. Now the inversions are no longer present, although the asymmetry is still clear.

The frequencies of pressing both or neither button following a tone are shown above and below, respectively, the abscissae of Fig. 1a-1c. Both buttons seem to be pressed slightly more often when response probabilities approach equality. A temporal analysis of "both" and "neither" responses during testing also failed to show a clear trend.

Figure 1d shows the generalization gradient of Subject S.P. following single-response discrimination training. It is similar in form to the corresponding gradient obtained after multiple-response discrimination training. There is a reduction in the asymmetry of the generalization gradient for S.P. with each successive reconditioning and testing (Fig. 1a-1d). A pair of single-response gradients is also shown in Fig. 1 for each of the other two *S*s. The two determinations for each *S* were separated by about a month and followed the same conditioning and testing procedures. The inversions and asymmetry characterizing the gradients persist to a large degree from the initial determination to the replication.

When the gradients in Fig. 1 are compared to those obtained with normal college students in an experiment by Cross and Lane (1962), which used the same stimulus series as the present study but presented the training series only once, the indications are that normal *S*s also show some asymmetry, and that this finding is more marked and uni-directional in the retardates.

REFERENCE

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