Human eyelid conditioning at detection threshold

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Six Ss were run in a combined signal detection-eyelid conditioning procedure for 15 days each. Performance at asymptote was markedly affected by CS intensities near the detection threshold. The verbal responses and conditioned responses were related in such a way that conditioned responses appeared to be contingent upon Ss' subsequent verbal responses.

In the Pavlovian conditioning situation, three of the most obvious variables which may control performance are the intensity of the conditioned stimulus (CS), the intensity of the unconditioned stimulus (UCS), and the time interval separating them. These parameters have received extensive manipulation, with humans, and the latter two (UCS intensity, and CS-UCS interval) have consistently been found to have marked effects, whereas CS intensity variations have had far less dramatic effects (e.g., Walker, 1960; Beck, 1963; Grice & Hunter, 1964). An examination of these and other studies indicates that relatively high CS intensities have exclusively been used. This is surprising in light of the formulations of Pavlov (1927) and Hull (1952) that minimal or no conditioning should occur with very weak CSs.

One reason for the range of CS intensities selected in the above studies is the limitations set by the procedures adopted, e.g., CSs presented through loudspeakers, untrained subjects. The CS intensity limitations of these procedures can be overcome by utilizing other techniques. One such technique, which we have adopted, is readily suited to determine the effects of very weak CSs—combining a signal detection procedure with an eyelid conditioning procedure and utilizing the Ss' verbal responses to determine CS intensity. This technique also offers a bonus in that the relationship between verbal and conditioned responses (CRs) as indicators of signal detection can be evaluated.

Method

Six paid volunteer male undergraduates were run as Ss. Four of the Ss were run for 15 daily sessions, the first three of which were practice sessions, and the last 12, test sessions. The remaining two Ss had been previously run in a similar experiment and were well practiced. They served in one practice session and the final six test sessions.

The procedure consisted of a combination of signal detection and eyelid conditioning experiments. The Ss wore earphones with a 65 db above threshold (method of limits) white noise (0-20KC) continuously present. Every 10, 15, or 20 sec., a 250 msec. one pound per square inch air puff was delivered to the cornea of their right eye for a total of 180 puffs per session. Ss were instructed to keep looking at a fixation point on the wall in front of them, and when they felt the air puff to state whether the CS-tone immediately preceded it. The CS (1KC) when presented, commenced 525 msec. prior to the air puff, and terminated with air puff termination. Three tone intensities—0 db, i.e., detection threshold (50% detection of the CS with fewer than 1% false positives), 2.5 db above detection threshold, and 12 db above detection threshold and three tone presentation probabilities—25%, 50%, and 75%, were used. For example, on Day 2 of the test sessions (see Fig. 1 and Table 1) Ss received 180 air puffs, 135 of them preceded by tones, to only approximately 67 of which they reported a detection. False positives were discouraged in the practice sessions, and as a consequence, over the test sessions in which 0 db tone was used, fewer than .5% occurred.

During the 525 msec. period preceding the air puff presentation, eyelid movements were recorded. Responses which were 2 mm or greater, and occurring in the interval from air puff onset to 375 msec. prior to air puff onset were scored as CRs. On CS trials, this was the interval 150 msec. after CS onset to air puff onset.

Results and Discussion

The results from this experiment can be seen in Table 1 and Fig. 1. The group means are presented in Fig. 1, and the individual data in Table 1. "Tone-Yes" (To Y) represents those trials on which a tone was presented and the S reported a detection; "Tone-No" (To N) represents those trials on which the tone was presented and the S reported a non-detection; "No Tone-No" (NTon) represents those trials on which the tone was not presented and the S reported a non-detection.

Table 1. Percentage CRs for each subject for the twelve test sessions

	Day1 75%T +12db			Day2 75%T Odb			Day3 50%T +12db			Day4 50%T Odb			Day5 50%T +2.5db			Day6 75%T +2.5db		
	To Y	To N	NTon	To Y	To N	NTon	To Y	To N	NTon	To Y	To N	NTon	To Y	To N	NTon	To Y	To N	NTon
RA	23.7	2.2		6.8	4.7	2.4	25.6		3.3	0	4.0	3.5	8.3	4.7		7.0		4.5
DC	97.8	6.7		31.6	12.3	9.8	83.3		12.2	21.1	11.6	13.4	71.8	11.5		67.2		13.3
WC	99.3	4.4		21.2	4.8	4.9	77.8		2.2	22.5	8.3	1.4	64.7	12.6		61.8		20.9
NG	40.0	3.3		15.7	10.0	4.7	75.6		6.7	9.4	7.5	11.8	34.1	4.5		48.4		11.4
	Day7 50%T +12db			Day8 50%T Odb			Day9 75%T Odb			Day10 75%T +12db			Day11 25%T Odb			Day12 25%T +12db		
	To Y	To N	NTon	To Y	To N	NTon	To Y	To N	NTon	To Y	To N	NTon	To Y	To N	NTon	To Y	To N	NTon
RA	62.2		3.3	9.4	7.4	4.8	22.4	3.2	0	82.2		0	10.5	4.5	6.6	86.7		8.1
DC	88.9	13.3		47.1	22.4	15.3	52.9	16.6	20.0	88.9		13.3	52.6	14.2	17.4	91.1		15.6
WC	66.7	12.2		37.0	12.5	7.6	21.9	25.4	21.6	95.6		17.8	22.2	14.2	11.5	86.7		8.9
NG	84.4	5.6		15.4	11.1	9.4	10.2	5.7	0	89.6		8.9	21.7	5.5	3.3	93.3		11.9
SJ	87.8	13.3		34.7	23.5	17.4	21.2	10.2	8.3	69.6		8.9	36.4	26.3	16.5	80.0		14.8
HW	44.4	16.7		15.2	7.8	9.3	10.0	15.4	9.3	69.6		22.2	17.6	14.2	21.9	60.0		17.8

Fig. 1. Percentage conditioned response during each test session as a combined function of signal presentation and verbal response.

Observation of Fig. 1 and Table 1 indicates that both group and individual data were stable across the test sessions. Only one S (RA) showed any marked variability, but his performance was stable within the first and last six session blocks.

With regard to CS intensity effects, the salient finding was that small variations in CS intensity had marked effects on performance which were independent of order of intensity presentation and of CS presentation probability. The latter finding indicates that performance differences as a function of CS intensity were not caused by differences in the number of detected CSs between high and low CS intensity sessions. Examination of the within-session data showed no systematic performance shifts. Thus, performance changes from session to session were rather immediate. Subtracting CR probability on "No Tone-No" trials from "Tone-Yes" trials, which indicates percentage CRS above base level of responding, and averaging across sessions, Ss made approximately 12% CRS on 0 db sessions, 35% CRS on 2.5 db sessions, and 64% on 12 db sessions. (Examination of Fig. 1 and Table 1, indicates that (with two exceptions in Table 1 involving 0 db and 2.5 db comparisons) there was no overlap between performance to these intensities, and that performance to a given intensity was stable across sessions. Relative to the previous human eyelid conditioning work on CS intensity effects where 50 db CS differences yielded at most 35% differences in conditioning the present results were striking, where differences of 2.5 db and 12 db yielded 23% and 54% differences, respectively. This marked diminution in responding as the detection-threshold is approached strongly supports the Pavlovian and Hullian formulations.

With regard to the relationship between verbal and conditioned responses, the following paradoxical conclusion is suggested: That the elicitation of a CR

appears to be dependent upon the S's subsequent verbal report as to whether or not he heard the tone. The following observations support this view: Percentage CRS when the tone was presented and the S reported a detection was far less than 100%; percentage CRS when the tone was presented and the S reported a non-detection was the same as when the tone was not presented and the S reported a non-detection.

If we assume that our Ss adopted a high criterion for the verbal detection response (Ss had a strong bias to say "No") (Swets, Tanner, & Birdsall, 1961; Luce, 1963), and further that CR elicitation was not a function of the verbal response, but rather of signal presentation, then more CRS would have been given on "Tone-No" trials than on "No Tone-No" trials. This was clearly not the case. It can not be the case that the CR produced the verbal response because more "Yes's" to the tone were given than CRS. One explanation of these phenomena is that the decision criterion a S selects (response bias) affects both verbal and conditioned responses.

References

- Beck, S. D. Eyelid conditioning as a function of CS intensity, UCS intensity, and Manifest Anxiety Score. *J. exp. Psychol.*, 1963, 66, 429-438.
- Grice, G. R., & Hunter, J. J. Stimulus intensity effects depend upon the type of experimental design. *Psychol. Rev.*, 1964, 71, 247-256.
- Hull, C. L. *A behavior system*. New Haven: Yale University Press, 1952.
- Luce, R. D. A threshold theory for simple detection experiments. *Psychol. Rev.*, 1963, 70, 61-79.
- Pavlov, I. P. *Conditioned reflexes*. London: Oxford University Press, 1927.
- Swets, J. A., Tanner, W. P., Jr., & Birdsall, T. G. Decision processes in perception. *Psychol. Rev.*, 1961, 68, 301-340.
- Walker, E. G. Eyelid conditioning as a function of the intensity of conditioned and unconditioned stimuli. *J. exp. Psychol.*, 1960, 59, 303-311.

Note

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