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AWARENESS IN VERBAL NONOPERANT CONDITIONING: AN APPROACH THROUGH DICHOTIC LISTENING[1]

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The problem of awareness in verbal conditioning was approached by using dichotic listening to influence accessibility to reinforcers and to time for forming hypotheses. The *S*s listened to words, some of which were reinforced. The Control group received them in the attended ear and random GOODS in the unattended. The 1-Channel group received both words and GOOD contingent upon human nouns in the attended ear. The 2-Channel group had words in the attended ear, and GOOD contingent upon human nouns in the unattended. The measure was the number of human nouns emitted when *S*s were later asked to say words. The 1- and 2-Channel groups emitted more such nouns than the Controls and did not differ from one another. Postexperimental interviews showed 55% of the 1-Channel and 5% of the 2-Channel *S*s aware of the contingency. Results were interpreted as supporting an automatic strengthening hypothesis.

Early studies of verbal operant conditioning (Greenspoon, 1955; Sidowski, 1954; Verplanck, 1955; Wilson & Verplanck, 1956) appeared unanimous in their claim that conditioning takes place without awareness of the contingency on the part of *S*, or at least that awareness is not essential. However, more recent studies (DeNike, 1964; Dulany, 1961; Spielberger & DeNike, 1966), which employed elaborate checks on awareness, and which were designed to test the automatic-strengthening versus cognitive interpretations, report that only *S*s who were aware of the response-reinforcement contingency increased the use of the reinforced class of words. Sallows, Dawes, and Lichtenstein (1971) found that only aware *S*s who considered the reinforcer pleasant showed performance gains. Several S–R theorists (e.g., Krasner, 1962; Thaver & Oakes, 1967) have challenged accounts of verbal conditioning involving cognitive mediation on grounds that awareness was suggested to *S*s in the retrospective interview or through *S*s' writing their "thoughts about the experiment" in the course of the conditioning procedure. The latter technique was developed by DeNike specifically to counter another criticism, i.e., that awareness is a consequence of performance gains (Postman & Sassenrath, 1961). The cognitive position is summarized by Dulany: "Subjects under selective reinforcement tend to form behavioral hypotheses . . . [which] tend to be accompanied by corresponding self-instructional sets . . . leading to selection of the corresponding response classes [p. 252]."

It is obvious that if *S* is to be able to hypothesize about the contingency, he must have sufficient time and opportunity. As he produces words ad libitum, some of which are reinforced, this self-pacing gives him the needed time to speculate about experimental objectives, to form hypotheses, and to test them. Procedures employed thus far have not effectively minimized *S*s' opportunity to engage in this covert cognitive activity (Dixon & Oakes, 1965, seem to have made the best attempt). Also, researchers have attempted to make discrimination more difficult by reinforcing relatively complex operant classes (opinion statements, travel words, etc.). Making the discrimination task more difficult, however, in no way interferes with the opportunity for hypothesis-testing activity on *S*'s part.

In addition, the reinforcer itself has commonly been made fully "accessible": *S* has not been obstructed in any way from

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perceiving it. He has not had to make an effort in order to expose himself to the reinforcer and thus expend some of the time which would otherwise have been used for hypothesizing about contingencies. The point being suggested is obviously not that of completely preventing *S* from perceiving the reinforcer; rather, the reinforcer should be presented in such a way that he can discern it if he chooses to do so, while, on the other hand, his attention is diverted from it by the method of presentation and the task instructions. The situation is one where the reinforcer is objectively present and discriminable, but *S* is discouraged from processing it. Alternatively, if he chooses to process it completely and be fully aware of it, he will have reduced the time available for hypothesis testing.

This is what was attempted in the present experiment through employment of the two-channel listening technique. The *S* was presented with a list of words containing members of the reinforced category in the ear to which he was told to pay attention. The reinforcer contingent upon occurrence of a member of the critical class in the attended ear was presented in the other ear, which *S* was instructed to ignore. Although by no means unanimous, the literature on selective listening allows formulation of hypotheses about what should happen in this situation. Early experiments (Broadbent, 1958; Cherry, 1953; Moray, 1959) established that although most of the material presented to the unattended ear is ignored, a limited amount of information is received. Treisman (1964, 1965) and Moray (1969), among others, were able to specify more closely the type of material and the conditions which facilitate reception. As Neisser (1967) put it,

> irrelevant, unattended streams of speech . . . are analysed only by the passive mechanisms, which might be called 'preattentive processes'. . . . They can establish localization, form crude segments, and guide responses to certain simple situations . . . [but] their capacity for detail is strictly limited [p. 213].

In order to give conditioning an opportunity to occur, the reinforcer should be discriminable and not buried in a stream of irrelevant material. It therefore was decided to have nothing but the reinforcer (GOOD) played in the unattended ear; it would immediately follow each occurrence of an instance of the critical word class in the attended ear. If *S* completely ignored the unattended ear, this would approach an ideal test of the automatic-strengthening hypothesis: the reinforcers are undoubtedly present in the situation, "fed" into *S*'s system, but he is not aware of them. In that situation, if information received in the unattended ear is analyzed only by the passive mechanisms or the preattentive processes, would performance be influenced? If it were, the cognitive case would be weakened, for it would require considerable argument to stretch the notion of "preattentive processes" to include active formation and testing of contingency hypotheses. Alternatively, *S* may willingly or unwillingly "switch" from one ear to another and thereby fully register the reinforcer. Even if this should occur, *S*'s opportunity and time remaining for hypothesis testing would be greatly attenuated, since switching itself requires processing time and effort. The question is, therefore, whether conditioning occurs even when the opportunity for forming and testing of contingency hypotheses is minimized by manipulating the accessibility of the reinforcer.

In order to employ this procedure it was obviously necessary to modify the usual verbal conditioning paradigm. Since reinforcers were to be presented in the unattended ear, it would be difficult to have *S* produce words and also listen to a message in the attended ear, except by resorting to a shadowing task. However, since verbal production in shadowing is often distorted, words omitted, etc., serious control problems would arise. Therefore, rather than have *S* produce words actively, he was required to listen passively to words in the attended ear and received reinforcements (GOOD) in the unattended ear. For lack of a better term, we called this verbal nonoperant conditioning, implying that *S*'s subsequent performance, when he is asked

to say words ad libitum, should be influenced by such prior exposure. It might also be appropriate to think of the process in terms of "modelling," i.e., *S* using the response class which he observed being reinforced. ("Observed" does not necessarily have a cognitive-mediational connotation in this context.) Additionally, quite apart from the specific theoretical question at issue here, it is felt that this technique is of experimental interest in its own right.

The basic structure of the experiment and the specific predictions being made will now be described. All *S*s listened to the same string of heterogeneous words, with reinforcers interspersed, and were afterwards required to produce words themselves. The degree of accessibility of the reinforcer was varied by its mode of presentation and by the instructions. In the 2-Channel Control group the words were played in the attended ear, and the reinforcers randomly distributed in the unattended. The *S*s in this group should subsequently emit the least number of critical words. In the 1-Channel Contingency group, both the words and the reinforcers contingent upon the critical words were played into the same, attended ear. This is also a control group in the sense that it is an approximation to the usual verbal operant conditioning paradigm. The *S*s should have no problem regarding awareness of the reinforcers, as they are easily accessible. Since they thus have more time to form hypotheses, *S*s in this group are expected subsequently to emit a substantial number of critical words. This group should also produce a high degree of awareness of the contingency. The main experimental group was the 2-Channel Contingency condition, where words were played in the attended ear and reinforcers contingent upon the critical words were played in the unattended ear. Either because *S*s in this group will completely ignore the unattended ear, or because the switching necessary for *S*s to register the reinforcers will consume much of their time, it is expected that this group will yield a low degree of awareness of the contingency. Should this expectation be vindicated, and should this group subsequently produce more critical words than the randomly reinforced controls, this finding would constitute support for a version of the automatic-strengthening hypothesis. It would imply that "passive mechanisms" or "preattentive processes," are sufficient to account for the performance change and that it is unnecessary to postulate higher order cognitive-mediational processes. Conversely, if this group should not differ from control *S*s in their use of critical words, it would mean that performance changes do not occur without full awareness of the contingency.

METHOD

Subjects and design.—The *S*s were 53 female and 7 male high school students, undergraduates, and graduates, who had taken no psychology courses and whose mean age was 18.9 yr., with a range of 13 to 27. They were solicited by telephone and advertisements, and paid $1 for participating. The mean age and range were comparable for the two groups of 30 who participated in the original experiment and a subsequent exact replication. Within each replication, the 30 *S*s were randomly assigned to one of three conditions, 10 per condition.

Procedure.—All *S*s were run individually. Instructions given orally to the 2-Channel Control and the 2-Channel Contingency groups were as follows:

> This is an experiment dealing with memory and the power of concentration. Therefore, you should listen very carefully to what will be played in your right ear, for you will be required to recall these words later on. There might be something played in the other ear, but you should completely ignore it and regard it as interference with your memory task. So, concentrate on what is played in the right ear and ignore the left.

The instructions were varied insofar as for each group half of the *S*s were randomly chosen to attend to one, and half to the other, ear.

The 1-Channel Contingency group was given the same instructions except that no mention was made of the other ear; they were simply told to concentrate on what was presented to the right (left) ear.

Stereoearphones were placed appropriately on *S*'s head. A prerecorded list of 180 words was presented to the attended ear (the only ear through which information was received by the 1-Channel Contingency group). The rate of presentation was 50 words/min, and the entire list took 3'38". Sixty words, randomly distributed among the 180, belonged to the critical class of human nouns (such as ARCHITECT, CATHERINE, IDEALIST, CAESAR, REGIMENT); 20 of these were plural. The remaining 120

words were 20 nonhuman nouns, 31 adjectives, 25 adverbs, 30 verbs, 9 pronouns, and 5 "other." The three groups differed only in the manner in which they received the 60 occurrences of the reinforcer GOOD, which had been recorded by a voice different from the one reading the words. The loudness of GOOD in playback was adjusted so as to be at the same level as that of the list words. GOOD was pronounced in an even, flat manner. The 2-Channel Control group received GOOD in the unattended ear, randomly distributed over the 3'38", but always directly following a word. In 21 out of 60 instances GOOD followed a human noun. The 1-Channel Contingency group received both the list and the GOODS in the same ear, with nothing to the other ear. A GOOD immediately followed the occurrence of each of the 60 human nouns. For the 2-Channel Contingency group the 60 GOODS were similarly contingent upon human nouns, but were played in the unattended ear.

After the list had been presented, all *S*s were told the following:

> What I would like you to do now is *not* the memory task I mentioned before. All you have to do is say words, any words at all that cross your mind. The only restrictions are that you don't organize your words into sentences and that you don't count; also avoid repeating words. You may use the words you heard on the tape, but you don't have to. It's completely up to you—any words will do. So, just keep on saying words into the microphone until I stop you. The number of words I want is reasonable.

Each *S* was stopped after emitting 150 words. The *E*, facing away from *S*, kept a covert count of the emitted words and did not interrupt or react in any way during *S*'s production phase. The dependent measure was the number of human nouns emitted, transcribed from the tape recording, irrespective of whether they were from the list or not.

Postexperimental interview.—Immediately after the experiment proper, *S* was asked a carefully designed series of questions which had been developed in a pilot study. These progressed from rather general ("What was the purpose of this experiment?"; and "Was anything played in your right ear?") to very specific ones ("Did you establish any connection between these GOODS and the words played in the other ear?"; "What kind of connection? With what kind of words?"). The questions were aimed at revealing the degree to which *S* was aware of the presence and the nature of the second voice, of the reinforcer, and of the contingency. The protocols of these interviews were examined and rated, apart from *E*, by two other judges independently. The judges had only minimum information about the experiment and had no contact with *S*s. At the end of the experiment, the hypotheses and rationale were explained to each *S*.

RESULTS

The appropriate model for analysis of the data called for inclusion of a replication factor. The design thus became a 2×3 factorial; the 2 levels of the first factor are the original experiment and its replication, and the 3 levels of the second factor are the different modes of presentation of the reinforcer. Since the effects of both the replication factor and its interaction with conditions were nonsignificant and negligible, one is justified in thinking in terms of 20 *S*s in each of the three experimental conditions.

Awareness.—On the basis of the pilot study an eight-category classification was used to assess the degree of awareness of the reinforcer and the contingency. The categories were as follows: heard nothing at all (1), heard something, no specification (2); mechanical sound (3); human voice, no specification (4); human voice "goo," "ugh," etc. (5); heard GOOD (6); related or incomplete contingency hypothesis (7); and correct contingency hypothesis (8). By ordering categories in this way, awareness of both the reinforcer and the contingency were included in the same continuum. Each of the three judges independently rated every protocol and placed it in one of the categories. The judges achieved a high degree of agreement: all three agreed fully for 52 *S*s; two out of three agreed for 7 other *S*s, the third judge placing a particular *S* one step above or below that assigned by the other two. In only one case was a protocol put into three different, but neighboring, categories.

Nine out of 20 *S*s in the 2-Channel Control group reported hearing GOOD (Category 6) in the unattended ear; of the rest, 2 was in Category 5, 7 in 4, and 2 in 3. No *S* in this group was aware (7 or 8).

In the 1-Channel Contingency group, six *S*s stated the correct contingency (8), while five others gave a related or incomplete hypothesis (7). Five heard the word GOOD (6) but had no notion of the contingency, two were in Category 5, and two in Category 4.

In the 2-Channel Contingency group not a single *S* stated the correct contingency (Category 8), and only 1 had a related hypothesis (Category 7.) Ten *S*s, however, heard the word GOOD (Category 6).

TABLE 1

NUMBER OF AWARE AND UNAWARE SUBJECTS PER EXPERIMENTAL CONDITION

Ss	2-Channel Control			1-Channel Contingency			2-Channel Contingency		
	Exp. 1	Replication	Total	Exp. 1	Replication	Total	Exp. 1	Replication	Total
Aware[a]	0	0	0	5	6	11	1	0	1
Unaware[b]	10	10	20	5	4	9	9	10	19

[a] Correct or related contingency hypothesis.
[b] No contingency hypothesis.

Of the rest, 1 was in Category 5, 6 in Category 4, 1 in Category 2, and 1 in Category 1.

By assigning 1 point to Category 1, 2 to Category 2, etc., so that an *S* who stated the correct contingency received 8 points, it was possible to obtain an estimate of the distribution of *Ss* in the three conditions across all categories. The mean scores achieved were: 2-Channel Control, 4.90; 1-Channel Contingency, 6.55; 2-Channel Contingency, 4.95. Analysis of variance of these data revealed a highly significant difference among the groups, F (2, 57) = 9.90 $p < .01$, attributable to the higher levels of awareness reached in the 1-Channel condition. The Control and 2-Channel groups did not differ.

The judges also used a more straightforward method of classification. They divided the protocols dichotomously into those which showed a related or correct hypothesis of the contingency (7 and 8), and those which did not (1–6). Such a division disregards information about *Ss*' registration of the reinforcer and focuses solely upon the critical question of awareness of the contingency. Using this criterion, the three judges were in complete agreement in 59 out of 60 cases. One *S* in the 1-Channel Contingency group was judged unaware by two judges, and aware by the third. For purposes of analysis he was conservatively classed as unaware. Table 1 summarizes the data.

Analysis of the totals for the three groups revealed a highly significant $\chi^2(2)$ of 23.12, $p < .01$. Since, for the 2-Channel Control group, the presentation of the reinforcer had not been contingent on human nouns, a more telling comparison was that between the totals for the 1- and 2-Channel Contingency groups. These groups differed considerably in awareness of the contingency, $\chi^2(1) = 11.90$, $p < .01$.

Taken together, these results are quite convincing. Presentation of the reinforcer to the unattended ear produced far fewer *Ss* aware of the contingency in comparison to the case where it was presented to the attended ear.

Nonoperant conditioning effects.—As mentioned previously, the replication factor was included in the model and the data were analyzed accordingly. Nonoperant conditioning effects in the three groups are reflected by the data seen in Table 2.

The outcomes are straightforward. Analysis of variance showed significant differences in the emission of human nouns among the three groups, F (2, 54) = 6.26, $p < .01$. Since both the replication factor and the interaction of this factor with conditions yielded F ratios of less than 1, their sums of squares were pooled with the error term. Using this pooled error the results were virtually unaltered, with the conditions factor highly significant, F (2, 57)

TABLE 2

MEAN NUMBER OF HUMAN NOUNS EMITTED PER EXPERIMENTAL CONDITION

Exp.	2-Channel Control	1-Channel Contingency	2-Channel Contingency
I	10.20	18.20	17.00
Replication	11.50	18.30	20.40
Overall $\bar{X}$	10.85	18.25	18.70

Note.—n = 10 per cell.

= 6.48, $p < .01$. Both the 1-Channel and 2-Channel Contingency groups differed significantly from the Controls in the use of human nouns. The 1-Channel Contingency versus Control comparison yielded an F (1, 54) of 8.82, $p < .01$, whereas the F (1, 54) for the 2-Channel Contingency versus Control comparison was 9.93, $p < .01$. The two Contingency groups obviously did not differ one from another.

Although low frequencies at some category levels precluded statistical analysis, inspection of the data showed the following. The mean numbers of human nouns emitted by those *S*s who did not report hearing GOOD (Categories 1–5) were 11.45, 15.75, and 14.11 for the Control, the 1-Channel, and the 2-Channel groups, respectively. Means for those *S*s who at least reported hearing GOOD (Categories 6–8) were 10.11, 18.87, and 22.45 for the same groups, respectively. This pattern of results suggests that even without awareness of the reinforcer, members of both contingency groups emitted more critical items than did the no-contingency controls. For those *S*s who at least reported hearing GOOD, the performance was even further enhanced.

To summarize the findings of the experiment, the presentation of a reinforcer contingent on human nouns, either to the attended or to the unattended ear, resulted in a greater use of this class of words in comparison to that of the Control group. However, while presentation of the reinforcer to the attended ear produced a substantial degree of awareness of the contingency, presentation of the same reinforcer to the unattended ear produced virtually none.

Discussion

The results strongly question the causal relationship often postulated between verbal operant conditioning and the awareness of contingency. With regard to the outcome of the present experiment, awareness could not have caused the obtained performance effects, as the cognitive mediation hypothesis would have it, nor could the performance gains themselves have caused the awareness (Postman & Sassenrath, 1961). Both of these conclusions follow from the fact that *S*s in the 2-Channel Contingency group were not aware of the contingency, yet they emitted just as many human nouns as those in the 1-Channel Contengency group, over one-half of whom were aware. Therefore, it is possible to speculate that conditioning and awareness are parallel and, under some circumstances, unrelated phenomena.

It remains unexplained why half of the *S*s in the 2-Channel Contingency group (about as many as in the 2-Channel Control group) actually reported hearing GOOD, and did not form contingency hypotheses, although they later emitted significantly more human nouns than the Controls. Two explanations are possible. First, it may be that an *S* instructed to ignore one of the ears nevertheless switches to that ear on several initial occasions when GOOD appears, and after a few such switches, when he realizes it is always the same word, he stops all conscious processing of that input. These few initial exposures to GOOD are not sufficient for the emergence and testing of contingency hypotheses (indeed, the very use of independent channels would give *S* less reason for even *seeking* a rational connection between the inputs), but do enable a report of having heard GOOD. Presumably, even after *S* stops switching, the inexorable temporal characteristic of GOOD, i.e., its following human nouns, continues to be processed by passive learning mechanisms, which accounts for the subsequent increased use of human nouns compared to the Controls. The other possibility is that *S* switches from one ear to another throughout the duration of the list, but that this takes much of the time that would otherwise have been used to form and test hypotheses (which is what *S*s in the 1-Channel Contingency group are doing). The outcome of this process would be essentially the same as in the former case: The *S* reports GOOD, is unaware of the contingency, but his performance is nonetheless affected.

It should be stressed again that because of the nature of the process under investigation, GOOD had to be reasonably distinguishable, that is, discriminable when attended to. For this reason alone, GOOD had to be interpolated between words rather than being presented simultaneously with them. Further obstructions, such as hiding the GOODS in a stream of masking sounds, or presenting words at a very fast rate (which would make it impossible to squeeze GOOD in without interference), might have achieved almost total unawareness of the reinforcer at the cost of rendering the procedure meaningless. Therefore, the reinforcer

was presented in a manner which almost guaranteed that many *S*s would indeed perceive it by switching willingly or unwillingly. Indeed, it could have been predicted on the basis of the dichotic listening literature (personal communication with Neville Moray, September 1971) that the majority of *S*s would become aware of the presence of the reinforcer. However, the time spent on switching, which enabled *S* to register GOOD, meant that the time remaining for formation of hypotheses was considerably reduced.

A possible criticism, of the *E*-demand type, should be anticipated at this time. This would be to the effect that *S*s in the 2-Channel Contingency group might have withheld the reporting of awareness of the contingency because they wanted to show to *E* that they dutifully followed instructions and did not "eavesdrop" on the unattended ear. The data do not seem to sustain such an interpretation since 10 out of the 20 *S*s did, in fact, say that they heard GOOD, and only 1 reported hearing nothing at all. Thus, the objection cannot be completely valid.

In all, it would seem that this nonoperant conditioning technique is a useful tool for examining processes relevant to verbal operant conditioning. Although it is operationally distinct from the standard operant conditioning paradigm, the present procedure is nevertheless pertinent to the latter, since awareness of the reinforcer and of the contingency is an issue common to both.

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