Conditioning and Generalization of Unconscious Anxiety

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THIS is a report of the first of a series of experimental studies of unconscious anxiety (*1*). Both terms in this concept need definition within the context of this study, which uses the methods of Pavlovian conditioning as an experimental tool.

Anxiety. Schoenfeld (*2*) has ably presented an argument for using conditioning to a painful stimulus as the laboratory approach to the study of anxiety. Anxiety is defined simply by the behavioral changes that follow a signal of forthcoming painful stimulation.

In our experiment, a spoken word is followed by electric shock. As a word and shock are repeatedly paired, evidence of increased disturbance of heart rate, digital blood flow, and sweat gland activity appears in the interval between the presentation of the word and the shock. These physiological changes that occur in anticipation of the shock constitute an operational description of a "state of anxiety."

Unconscious conditioning. The nature of conditioning in human beings is inexplicable without reference to their attitudes and cognitions, as a growing volume of experimental studies attests. This is not the place to review these experiments. A complete bibliography may be secured by referring to Hilgard and Marquis (*3*), Haggard (*4*), and Razran (*5, 6*). Razran, in particular, in his extensive investigations of salivary conditioning, which he has recently reviewed (*6*), has shown the importance of cognitive and attitudinal factors and the ease with which conditioned responses may be formed without the subject's awareness. Unfortunately for our purposes, Razran has not worked with noxious stimulation, nor has he presented data on just what his subjects' levels of awareness were.

In the present study "unawareness" means simply this: the subjects, despite intensive questioning subsequent to the conditioning session, could not report that they knew when the electric shock was coming. They could not use their language mechanisms to identify correctly the conditioned signal.

Our first experimental problem is to determine whether human subjects can develop a conditioned anxiety reaction with this degree of unawareness. Previous experiments have shown, as Miller (*7*) puts it, that "the threshold of awareness is higher than the threshold of discrimination," a phenomenon later called *subception* by Lazarus and McCleary (*8*). Miller also reviews some relevant experiments and points out that unconsciousness or unawareness is of several kinds, which may be fruitfully separated for experimental purposes. In our experiments all stimuli are supraliminal. It is the *relationship* between the conditioned and unconditioned stimulus of which the subject is unaware.

The second aim of this experiment is to study the extension of such unconscious conditioned anxiety reactions to new word-stimuli that have not themselves been paired with painful stimulation. This is the problem of semantic generalization.

Semantic generalization of conditioned responses. A conditioned response will appear, not only to the conditioned stimulus, but also to other stimuli meaningfully related to the conditioned stimulus. For example, if a conditioned salivary or skin resistance response is established to the word *style,* generalization will be found both to the homophone *stile* and the synonym *fashion* (*9*). Critical reviews of the experiments in this area have been presented recently by Razran (*10*) and Osgood (*11*).

Razran (*12*) has demonstrated such word-to-word generalizations of salivary responses conditioned to nonpainful stimuli for a wide variety of semantic relationships. His findings constitute the basis for expecting semantic generalization of an unconscious conditioned anxiety response.

Such is the general background of the present investigation. Two experiments, however, are its direct precursors. Both purport to show that unconscious conditioned anxiety responses may be produced in human subjects, but both studies are open to question.

Diven's experiment. Diven's pioneering experiment (*13*) provides the basic technique of our study. Diven concluded from his experiment that subjects could be unconsciously conditioned to the word *barn,* and that this response generalized to other rural words.

Diven measured skin resistance changes at the time shock was administered, and not during the interval between word and shock, during which time subjects chain-associated to the stimulus word. This, of course, means that the important anticipatory responses were not studied, and that Diven's data are not applicable to the study of anxiety as defined in our experiments.

Because of this technique of measurement, the response to the word *barn* could not be separated from the response to the electric shock. Diven therefore sought evidence for conditioning in the responses made during the second or extinction session, in which, unknown to the subjects, *barn* was not to be followed by shock. He grouped together the percentage ohmic changes occurring at the time shock would have been administered—itself a basic measure that does not

meet today's more exacting requirements (*14*)—of all subjects and for all presentations of the critical word in the extinction session. The same procedure was followed for a so-called "control" group, which had received *no shocks at all.* The fact that the experimental subjects showed greater autonomic reactivity to the word *barn* than did the "control" subjects was taken as proof that a true conditioned response had been formed. This conclusion is invalid in the absence of a demonstration that the experimental group's reactivity to all words was not greater than the control group's. Experience in measuring autonomic responses suggests, and experimental studies of what has come to be known as pseudo-conditioning and sensitization strongly indicate, that the lack of shock in the "control" group may have resulted in greatly diminished autonomic reactivity to all words.

Diven's study of generalization is more acceptable, in that reactions of shocked subjects to urban and rural words were compared. These reactions, however, were also measured at the end of the word-shock interval. Anticipatory autonomic responses, then, were again not evaluated. It must be concluded that Diven's experiment provides no evidence of unconscious conditioned anxiety, in the sense of this paper.

Haggard's experiment. Haggard's study (*4*) utilized Diven's technique to study the effects of cognitive and attitudinal variables upon skin resistance response to the stress of exceedingly painful and traumatic electric shock. The problem of conditioned unconscious anxiety was secondary to the main aim of his experiment. Seven of his 18 subjects were unaware, but they fell haphazardly and unevenly into his main experimental groups. Haggard utilized war words and peace words, and his subjects were shocked on the word *sword,* which was invariably preceded by the word *sharp.* Haggard, like Diven, so read his records that the response to the critical word was confused with the response to the electric shock and, so, apparently also ignored anticipatory changes. While unaware subjects reacted more than aware subjects both to the precritical word and to the critical word-plus-shock, the differences were not statistically significant. Haggard, moreover, showed that unaware subjects reacted to all words more than did aware subjects, and this general trend was significant. Therefore, the higher reaction to the precritical word *sharp* is not evidence for conditioned unconscious anxiety.

In the present study, various modifications of Diven's ingenious and promising technique are used in an attempt to demonstrate conditioned unconscious anxiety and its generalization.

Procedure

The experiment was presented to the subject as a study of mental-motor coordination. He was required to chain-associate to each stimulus word as it was presented until told to stop and, simultaneously, to tap on a telegraph key at an even rate, previously determined by the subject himself during the instruction period. These spontaneously adopted rates varied from 80 to 140 taps/min from subject to subject.

Each association-tapping interval was 15 sec. Intertrial intervals, from the end of one set of associations to the beginning of the next, were 30 sec, during which the subject sat quietly with closed eyes waiting for the next word.

The word list was as follows: plow, clock, book, corn, easy, COW, PAPER, harvest, chicken, soft, PAPER, harvest, easy, COW, gray, haystack, easy, COW, grain, copper, PAPER, harvest, blue, easy, COW, PAPER, harvest, sheep, PAPER, harvest, easy, COW, smooth, tractor, easy, COW, yellow, PAPER, harvest, farmer.

The words *cow* and *paper* are the conditioned stimuli. They are distributed haphazardly in the word list, in balanced temporal order.

The unconditioned stimulus was an electric shock lasting 5 sec, applied to a motor point in the region of the musculo-spiral nerve of the left arm, so as to produce a violent and sustained flexion at wrist and elbow, with rigid extension and adduction of the fingers. The current was automatically maintained at 13 ma (peak-to-peak of an irregular but constant wave shape) despite variations in skin resistance from subject to subject, or within a given subject during the experiment.

For members of experimental group I, the "cow-shock subjects," electric shock was delivered within 0.5 sec after the word "stop" each of the first six times they completed 15 sec of chain-association to the word *cow.* For group II, the "paper-shock subjects," shock was delivered within 0.5 sec after the word "stop" each of the first six times they completed association to the word *paper.*

It should be emphasized that all subjects were exposed to exactly the same word list. The difference between groups was only on what word they were shocked. If unconscious conditioned anxiety responses are formed, cow-shock subjects will show increasingly greater anticipatory responses to the word *cow* than to the word *paper.* Paper-shock subjects, on the other hand, are expected to show more reaction to *paper* than to *cow.* Each subject is his own control, in the sense that the responses of each subject to a critical word and a noncritical word are compared. The compared words appear equally often and in temporally balanced positions. Moreover, contamination of the conditioned anticipatory response—by physiological changes produced by the processes of association and tapping themselves—is as likely for the critical word as for the noncritical word and cannot be a biasing influence.

If semantic generalization of an unconscious conditioned anxiety response occurs, cow-shock subjects will develop greater autonomic response to rural words than to nonrural words, and paper-shock subjects will show the opposite effect.

It is to be noted that the once-repeated rural words (*plow, corn, chicken, haystack, grain, sheep, tractor, farmer*) are all nouns and all with obvious rural con-

notations. The nonrural words (*clock, book, soft, gray, copper, blue, smooth, yellow*), are nouns and adjectives and have nothing obvious in common except by exclusion from, and in contrast with, the rural words. Generalization to the nonrural words, then, implies a very different process from generalization to the rural words. The nonrural words are included in an attempt to extend our knowledge concerning the kinds of unconscious conceptualization human subjects exhibit.

The words were presented by means of a phonograph record and interroom communication system. Recording instruments, phonograph, and experimenter were all in a room separate from the subject's room, with two-way vision provided. The shocks were delivered by remote control from the experimenter's room.

The experiment was divided into four parts: (i) Shock electrodes were properly placed, and the subject was trained in performing the mental and motor tasks properly and in remaining quiet with eyes closed during the intertrial intervals. (ii) The subject was conditioned. The word list was presented once, with electric shock delivered at each presentation of the conditioned stimulus. (iii) The subject was interviewed immediately following the conditioning session. The purpose of the interview was to establish the awareness or unawareness of the subject. (iv) The conditioned response was extinguished. This session was identical with part 2, with the single exception that no shocks were ever given. During this session, however, the shock electrodes were left in place, and the subjects were not informed that they would not receive any more shocks.

Subjects. All 22 subjects were male freshmen at Antioch College, selected on the basis of personality test scores that had been administered by the College Testing Office as a part of the regular battery of placement tests administered upon admission. The personality variables are not discussed in this report.

With the cooperation of Antioch officials, a rather formidable letter was sent to all subjects "inviting" them to serve as unpaid subjects. With some difficulty, 100 percent returns were secured. We are not dealing, therefore, with the usual volunteer sample. In an experiment of this sort, results of a volunteer sample may be markedly biased.

Subjects were assigned at random to the cow-shock and paper-shock groups. Because for two paper-shock subjects there was difficulty in securing adequate blood-flow records, two extra subjects were taken, accounting for the unequal numbers in the experimental groups.

Physiological measurements. Although plantar skin resistance, digital blood flow, and heart rate were all measured, this report is concerned only with heart-rate changes.

Heart rate was recorded by the Fels cardiotachometer, using the standard electrocardiographic Lead II. This instrument records the duration of each cardiac cycle as successive R-waves reach signal level. Each cardiac period is recorded as a vertical displacement on the kymograph record. Two points need to be made concerning our treatment of heart-rate changes: (i) the sampling of heart rates, and (ii) the computation of heart-rate reaction.

Sampling. We averaged the six fastest beats to get a measure of the maximum heart-accelerating effect of the stimulating conditions of the moment. Such averages were taken for the 15-sec period just preceding each association-tapping episode and for the 15-sec period of association-tapping. Since the heart may be beating anywhere from 50 to 150 beats/min under the conditions of this experiment, we checked the adequacy of this sampling by correlating the average of the six fastest beats with the average of all the beats for one word selected randomly. This was the 16th word, *haystack,* and four correlations were computed, one each for the preassociation and the association periods in both the conditioning and extinction sessions. The number of subjects was 64, including all subjects in the entire experiment, which includes more than is being reported on here. The correlation coefficients for the four periods are .983, .984, .990, and .992. It is apparent that the sampling procedure is highly satisfactory.

Computation of heart-rate reaction. Some individuals are very underreactive in heart rate, some are overreactive. This is a consistent attribute of the individual, as previous studies of autonomic response specificity have shown (*15*). It is desirable to have a unit of measurement that will (i) reveal the processes of conditioning and generalization, no matter what the individual's reactivity, and (ii) result in equal numbers for reactions that are physiologically, although not necessarily, numerically equal. One cow-shock subject, for example, responding to the word *cow* with an increase of 20 beats/min and to the word *paper* with an increase of 10 beats/min may be showing no greater differential response than a subject who responds to *cow* and *paper* with increases of 6 and 4 beats/min, respectively. This equivalence of physiological differentiation despite nonequivalent numerical changes arises, not only because of individual differences in reactivity, but also because absolute or percentage changes are dependent upon base level.

In the present study, the correlations between base level and absolute change ranged from $-.24$ to $-.87$, with a median of $-.65$. Eighteen of the correlations were significant at beyond the 1-percent level, one at beyond the 5-percent level, and three were insignificant. Percentage change also correlated with base level. The range was from $-.26$ to $-.88$, with a median value of $-.69$. Two of the correlations were insignificant; one was significant at beyond the 5-percent level, and 19 were significant at beyond the 1-percent level. When temporal trends were eliminated by the technique of partial correlation, the correlations ranged from $-.16$ to $-.88$. The median correlation between base level and absolute change was $-.73$; between base level and percentage change, $-.75$. Four of the 44 correlations were insignificant; 33 were significant at better than the 0.1-percent level of confidence.

The two requirements—of controlling for individual differences in over-all reactivity and of base-free measure of reaction—can be met by an abstract measure of heart-rate response, the *autonomic lability score,* which we devised and tested in previous work (*15*). An adaptation of this score, the *intrasubject autonomic lability score,* is used in the present study.

The technique is illustrated in Fig. 1 which is a plot for one subject of heart rates in the 15-sec interval just before hearing a word in the word list against the heart rates during the interval of chain-association to that word. The straight line of best fit in the least-squares sense, is shown with the so-called "regression" equation $y = 0.80x + 19.8$.

This regression line is the locus of expected, or predicted, or average heart rates for this one subject, who is, incidentally, a subject of very low over-all reactivity. For example, if this subject's heart rate in the 15 sec before a word is presented were 82, we would expect—on the basis of his total performance in this situation—that he would reach a maximum heart rate during association of 85.4 beats/min [$y = (0.80 \times 82) + 19.8 = 85.4$]. For one word, at this base level of 82, the subject actually showed a heart rate of 94 beats/min (the topmost plotted point in the figure). He is obviously tremendously overreactive to this word. Since the standard error of estimate is our best estimation of the standard deviation about the line of regression, this obtained deviation from expectancy is 2.3 sigmas above expectancy ($8.6 \div 3.8$). For convenience, this value is transformed to a T-score of 73. T-scores have a mean of 50 and a standard deviation of 10. A score of 50 means that the level of heart rate during association fell on the regression line; a score of 60 means that the level during association was one standard deviation higher than expectancy; of 45, one-half standard deviation below expectancy, and so on.

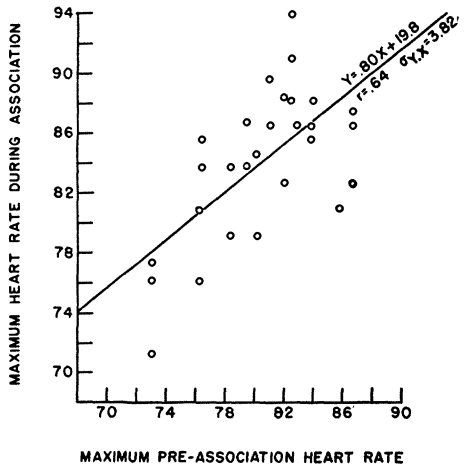

Fig. 1. Relationship for one subject between heart rate in 15-sec period before hearing a stimulus-word and heart rate in 15-sec period of association and tapping, to illustrate process of securing intrasubject autonomic lability scores. The straight line of best fit is shown, with its equation, and the standard error of estimate, $\sigma_{y,x}$, derived from the product-moment correlation **r**.

These deviation-from-regression-line scores are the autonomic lability scores. They are base-free. To satisfy the requirement of controlling individual differences in over-all reactivity, the scores for each individual were based upon that individual's performance; that is, regression equations were computed separately for each individual, using the individual's mean, standard deviation, and correlation.

Such scores can be used with complete accuracy, however, only when certain important statistical assumptions are met; namely, normality of distribution, linearity of regression, and equal variances in the x-arrays. In intersubject autonomic lability scoring, we have shown that these requirements are met (*15*). In the present study, however, the *N* for each scattergram was only 28 (see next paragraph). This is too small to enable appropriate tests of the assumptions. We accepted the assumptions on the basis of inspection of the scattergrams that showed no systematic deviations from the three requirements.

The scattergrams and regression equations were constructed for 28 words in the word list. These 28 words are all 16 of the once-repeated rural and nonrural words in the extinction session and the last-presented 12 of the once-repeated rural and nonrural words in the conditioning session. Omitted from the scattergrams, then, were all presentations of the often-repeated words *cow, paper, easy,* and *harvest* and of the first four words in the conditioning session. The first four words in the conditioning session were not used because reactivity to these initial words is excessive for almost all subjects. By the fifth word, subjects are adapted to the situation.

Reactions to the repeated words *cow* and *paper* were computed on the basis of this scattergram. For certain purposes, to be described later, reactions to the third and fourth words in the conditioning session were also so computed.

Methods of statistical analysis. The data are presented in the form of *response-differences,* since the design of the experiment focuses attention on the differential responses to *cow* and *paper* and to rural and nonrural words. In all cases, the response to *paper* is subtracted from the response to *cow*; and the response to nonrural words is subtracted from the response to rural words. Thus, a cow-paper response difference of +6 means that the response to *cow* was 6 T-units greater than the response to *paper*; a rural-nonrural response difference of −11 means that the response to nonrural words was 11 T-units higher than the response to rural words.

In computing such algebraic response-differences, temporal trends are controlled, since the words compared are always in the same time-segment: the response to the first presentation of *cow* is compared with the response to the first presentation of *paper,* and so on.

Because the development and extinction of the con-

ditioned and generalized responses were irregular, the technique of moving averages in blocks of three trials was adopted to smooth out these irregularities. Thus, in presenting the results for conditioning, the *first block of trials* is the average response-difference for the first, second, and third presentations of the words *cow* and *paper*; the *second block* is the average difference for the second, third, and fourth presentations; the *third block*, for the third, fourth, and fifth presentations, and so on.

The Wilcoxon nonparametric tests (*16*) were used for analysis of the results. Three different tests were applied.

1) *Reliability of between-groups difference.* Wilcoxon's unpaired replicates test is used, as modified by White (*17*) for the case of unequal *N*'s, to test whether cow-shock subjects differ from paper-shock subjects in the cow-paper and rural-nonrural response-differences at the beginning of conditioning, end of conditioning, and end of extinction.

2) *Reliability of within-groups trends.* Wilcoxon's paired replicates test is used. This is a different test of our hypotheses from the first test. The test emphasizes the uniformity with which the subjects in a given group exhibit systematic and progressive changes in their response-differences. Cow-shock subjects are expected to show increasingly larger positive response-differences as conditioning proceeds, whereas paper-shock subjects are expected to show increasingly larger negative response-differences.

3) *Reliability of between-groups trend-differences.* The Wilcoxon-White unpaired replicates test is again used, comparing the two groups' changes. This test asks not whether individuals uniformly develop conditioned and generalized responses but whether the two experimental groups differ in the direction and magnitude of changes they exhibit.

Results

Conditioning. Figure 2 shows the average conditioning curves for the two experimental groups. Beginning with almost identical response-differences slightly in favor of reaction to the word *cow*, the two groups exhibit a progressively increasing differential as a consequence of conditioning. By the end of conditioning (block 4) the between-groups difference is significant at between the .05 and .02 levels of confidence. The groups differ significantly only for block 4.

Despite this group difference, the development of the conditioned response within individuals is not reliable (reliability of within-groups trends) because 3 of the 10 cow-shock subjects and 4 of the 12 paper-shock subjects reverse the group trends. These atypical individuals also render the between-groups trend-differences insignificant.

The break in the procedure for the interview apparently produces a tremendous loss in a tenuously established conditioned response. The index of conditioning drops markedly from block 4 to block 5, for both experimental groups. (The fifth block includes

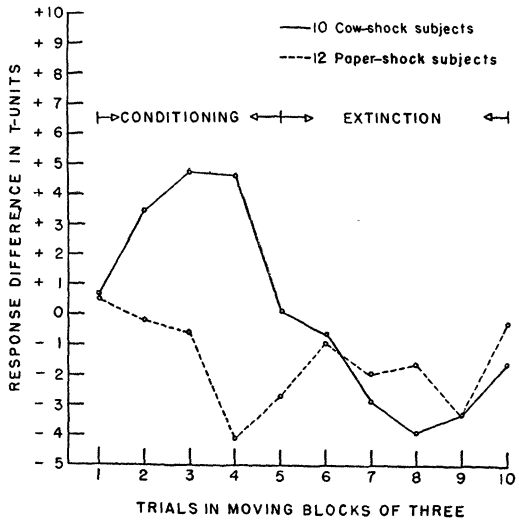

Fig. 2. Curves of conditioning for cow-shock and paper-shock subjects. A positive response-difference signifies greater heart-rate response to *cow* than to *paper*; a negative response-difference, the reverse. To smooth out temporal irregularities, trials are averaged in moving blocks of three.

the last two trials of the conditioning session and the first trial of the extinction session. The latter truly reveals a portion of the conditioned response, because the lack of reinforcement does not occur until the subject's reaction to the word and associated activity has taken place in the association-tapping interval.) This drop is significant at the .01 level (within-groups trend) for the cow-shock subjects and is not significant for the paper-shock subjects. The difference in the magnitudes and directions of this change between the groups, however, is significant at between the .01 and .001 levels.

The changes during extinction are also significant. The within-groups trend for the cow-shock subjects, comparing block 4 with block 10, is significant at the .05 level. The within-groups trend for the paper-shock subjects just misses being significant at the .05 level. Comparing the two groups (between-groups trend-differences), significance is attained at the .01 level.

In summary of these analyses: cow-shock subjects and paper-shock subjects do not differ significantly in their differential response to the words *cow* and *paper* in the first half of the conditioning session but do differ significantly in the second half of that session. The development of the conditioned response within individuals, however, is erratic, with 7 of 22 subjects showing trends in opposition to the group trends. The effects of the experimental procedures are seen much more clearly during the extinction phase of the experiment. Starting from significantly different responses in the latter half of conditioning, the two groups, under an extinction procedure, come together again. The differences in the magnitudes and directions of change in this second phase of the experiment are significant at high enough confidence levels

that we may conclude that there is a real difference between the two groups.

Generalization. Detailed statistical analysis of the results for generalization must take into account the fact that the experimental design permits direct comparison of the two groups only at selected points: namely, after zero (*18*), one, two, five, and six preceding reinforcements, and after one, two, and five preceding extinctions. For the words *grain* and *copper*, for example, the paper-shock subjects received two preceding reinforcements, whereas the cow-shock subjects received three, as can be seen by consulting the word list.

In the following analysis, therefore, data based on moving averages in blocks of three trials are used in statistical analyses of within-groups trends only. For between-groups analyses, the groups are compared (i) at zero preceding reinforcements (reaction to *book* and *corn*), (ii) at five preceding reinforcements (reaction to *smooth* and *tractor*, at the end of the conditioning session), and (iii) at five preceding extinction trials (reaction to *smooth* and *tractor* at the end of the extinction session). Reactions after six previous reinforcements, occurring at the beginning of the extinction session, are omitted because of the apparent contaminating effects of the interview. The average curves for the two experimental groups are shown in Fig. 3.

The progressively increasing differential between the two groups as a result of conditioning is apparent. The two groups do not differ significantly at zero preceding reinforcements, but the difference after five preceding reinforcements is significant at the .05 level of confidence. After five preceding extinction trials, the groups are again insignificantly different. Comparing the trends of the two groups (between-groups trend-differences), this change during conditioning is significant at below the .01 level of confidence; the change during extinction is not significant.

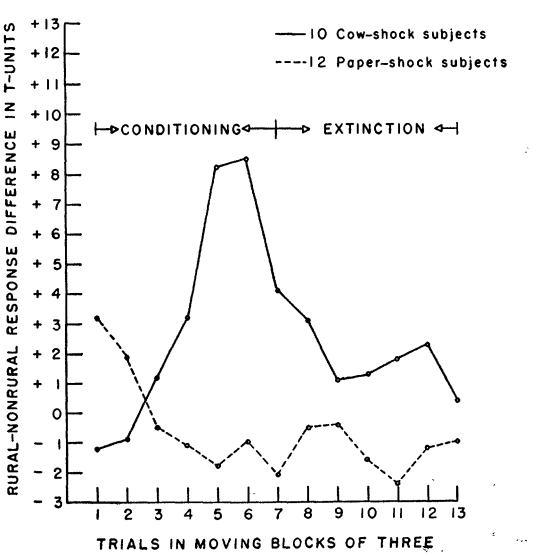

Fig. 3. Curves of generalization for cow-shock and paper-shock subjects. A positive response-difference signifies greater heart-rate response to rural words than to nonrural words; a negative response-difference, the reverse. To smooth out temporal irregularities, trials are averaged in moving blocks of three.

The within-groups trend (Fig. 3) is clear and regular for the cow-shock subjects. Each subject developed a larger positive response-difference from the first to the fifth block of trials. The confidence level is less than .01. From the first to the sixth block 9 of 10 subjects developed larger positive response-differences, with a confidence level of .01. Comparing the first and seventh blocks, the confidence level is .05. Similarly, in extinction, the trend for the cow-shock subjects is clear, the decreasing response-difference from block 5 to block 13 being significant at between the .05 to .02 levels of confidence. However, not all the results for the within-groups trend for the paper-shock subjects were significant.

In summary of the foregoing analyses, we may say that cow-shock subjects and paper-shock subjects clearly differ in the rural-nonrural response-differences they exhibit and in the progressive changes in these differences induced by the conditioning procedure. The development and extinction of the generalized response is clear-cut for the cow-shock subjects but erratic and unreliable for the paper-shock subjects.

Awareness-unawareness. After the conditioning session, each subject was carefully interviewed. The two points of the extensive interview that are relevant to this report are those concerned with the subjects' cognitions of the experimental situation.

The subjects were carefully queried concerning their expectancy of shock. The first question was invariably, "Did you know when you were going to get shocked?" This was followed by many questions designed to elicit the most fleeting and uncertain hypotheses or verbalizations concerning the administration of shock. The subjects who were "aware" instantly and correctly verbalized that shock followed *cow* or *paper*. There were only 6 out of 31 subjects in this category. These subjects, of course, have not been included in our group of 22 unaware subjects (*19*).

Other subjects were vague but could verbalize some partially correct hypothesis. "Oh, after a farm word," or "After the word *harvest*." There were only 3 of these "mixed aware" subjects, and these, too, were not included in the groups discussed in this report.

The majority of the subjects, 22 out of 31, formed no clear verbalizations, despite active attempts to anticipate the shock. Only 2 of the 22 unaware subjects reported a deliberate attempt not to think of any possible plan underlying the shock schedule; the other 20 had clearly attempted to verbalize cues. When pressed to give the hypotheses they had entertained, there were 8 reports of "after some time interval," 2 of punishment for "incorrect" or faltering associations; 2 of after a given but unknown word, 1 of "when I was

too relaxed," 1 of after a given but unknown kind of word. Seven subjects were satisfied with verbalizing only that the shock came after the word "stop." There were 14 reports in which it was clear that during the experiment the subject had been checking on the accuracy of his predictions. Five reported that they had never correctly anticipated the shock; 9 that they had been sometimes right and sometimes wrong. All these unaware subjects realized that they did not really know when the shock was coming; the hypotheses they entertained were seen by them to be incorrect.

At the end of the second, or extinction, session, they were briefly interviewed again. Twenty of the 22 subjects had nothing to add. Two developed correct but uncertain identifications of the conditioned stimulus upon requestioning but maintained that only at the time of requestioning had this hypothesis developed.

Many of these unaware subjects, although unable to verbalize the connection between the conditioned and unconditioned stimuli could verbalize some of the characteristics of the word list. Typically the subject could say, when asked, "There were an awful lot of farm words," and "Some words were repeated a lot and some were not."

Discussion and Conclusions

In this preliminary investigation, Diven's technique was modified in five particulars: (i) each subject was his own control; (ii) the physiological records were so read as to study clearly only conditioned *anticipatory* effects; (iii) the technique of physiological measurement controlled for individual differences in overall reactivity and for varying base levels; (iv) both conditioning and generalization were studied as a systematic function of the number of reinforcements; and (v) the task presented to the subjects was modified in an important fashion in that only one group of words, the rural words, cohered by virtue of common meaning. The nonrural words formed a group only by exclusion from the rural class.

Although not all the statistical comparisons reached satisfactory confidence levels, it seems clear that we may conclude that, if a word-sign becomes the signal for a painful stimulus, without the subject being able to verbalize this relationship, an anticipatory autonomic response will ensue. This unconsciously formed anxiety reaction, moreover, will appear to other word-signs meaningfully related to the conditioned word.

When one considers the arbitrary choice of words, without attention to such refinements as associative strength, word frequency in our everyday language, word length, and ease of association, the evidence for conditioned anticipatory response and its generalization bespeaks a strong and pervasive phenomenon.

The difference between cow-shock subjects and paper-shock subjects is not readily interpretable. Had both groups showed significant conditioning and generalization, the interpretation would be simple. Only cow-shock subjects, however, showed significant within-group trends for generalization. This may be because (i) generalization depends upon semantic relationships previously formed in the subject's life-experiences, (ii) generalization did occur in paper-shock subjects, but it was a more difficult task for the organism, requiring first the segregation of one group of words as being excluded from the meaning held in common by a group of rural words, and then reaction to these segregated words as a group characterized by the attribute of nonrurality. An attempt to answer these questions was made using a control group, shocked alternately on rural and nonrural words. This group did not show regular trends, as did both the cow-shock and paper-shock subjects. The individuals behaved so erratically, however, that significant differences could not be demonstrated among the two experimental groups and the control group. Rather than burden an already complicated presentation with these results, we decided to test these alternatives in another set of experiments.

There is a puzzling difference between the results for conditioning and generalization. Generalization seemed stronger, and was certainly more reliable, than conditioning. Moreover, we noted no relationship between the two. Taking these results at face value, this is the first time, to our knowledge, that a conditioned response appeared to be weaker than its concomitant generalized response or, indeed, that the two did not seem to be mutually interrelated. Previous investigations have reported only transitory equality or superiority of the generalized response over the conditioned response upon the *initial* presentation of the generalization stimuli after conditioning had been established (*20*). Our result may be (i) artifactual, as a result of our differential statistical treatment of indices of conditioning and generalization, (ii) characteristic of conditioning at the unaware end of an awareness-unawareness continuum, (iii) characteristic of anxiety responses, or (iv) a result of the combination of unawareness and anxiety. These possibilities are currently being investigated.

Our use of the terms *anticipatory autonomic response* and *unawareness* requires brief comment before this report is closed. First, what produced the heart-rate changes? We make no claim that the heart rate responded, so to speak, directly to the stimulus words. The effect may have been produced indirectly via greater muscular tension or greater expended energy in key-tapping or in association; or it may have been produced via respiratory changes; or, indeed, it may have been a compensation for a directly produced drop in blood pressure. We do not know the chain of events—physiological or behavioral or both—that produced the differential cardiac accelerations. Heart rate is used here only as an indicator.

Second, what do we mean by *unaware*? Although we carefully defined this at the outset as meaning simply that the subject could not verbally identify the conditioned signal, it should be emphasized that this "unawareness" is not a unitary indivisible phenomenon. *A priori*, several levels of unawareness might be distinguishable, ranging from nonrecognition (ver-

bal) of the conditioned stimulus even when the experimenter informs the subject what the conditioned word was, to verbal recognition of the stimulus in more or less complicated forced-choice tests. Although it is perhaps unfair to anticipate future reports, it seems appropriate to mention that this *a priori* expectation is corroborated by direct experimental evidence.

References and Notes

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The Scientist in Contemporary Life*

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IN a recent letter given wide publicity in the press, Albert Einstein states:

> If I would be a young man again and had to decide how to make my living, I would not try to become a scientist or scholar or teacher. I would rather choose to be a plumber or a peddler in the hope to find the modest degree of independence still available under present circumstances.

Einstein's letter was written in reply to a request for comment on the article "U.S. science: the troubled quest," by Theodore H. White, which was published in *The Reporter* on 14 and 23 September 1954. This is only one of many incidents that highlight the reaction of many scientists to the political and social environment in which they work.

Conversely, there are many signs of uneasiness on the part of others with respect to scientists and to scientific and technologic advance. The shadow of the A-bomb and the H-bomb hanging over the world like the sword of Damocles has intensified this growing distrust. At the recent conference on *Science and Human Responsibilities* at Washington University, E. H. Harbison of Princeton observed that "we have paid a heavy price for electric lighting, nylon, standardized radio entertainment, subways and airplanes, and the price has been a loss of spiritual values." Last year at a meeting of the American Philosophical Society, Lewis Mumford condemned physical scientists for failing to prepare society for the consequences of nuclear fission. He proposed a moratorium on science until society caught up. A few weeks ago I received a letter from the Science Council of Japan calling upon all professional societies to join in working for peace and mutual understanding by abolition of the A- and H-bombs. These are only a few examples of attitudes toward science, scientists, and the products of science which are widespread today.

It is essential for the welfare of both scientist and society that these unsatisfactory attitudes be corrected by mutual understanding and cooperation. The Cosmos Club, meeting ground of scientist, scholar, and humanist, offers them many opportunities to learn to know each other. I am taking advantage of one of these opportunities to set forth, with no claim to originality, a discussion of some of the sources of misunderstanding.

The contributions of science to mankind need no

* A talk given before the Cosmos Club, Washington, D.C., 16 Nov. 1954, and published with its permission.