The Problem of Response Class in Verbal Behavior

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Some years ago, when I reviewed the area of operant conditioning of verbal behavior (Salzinger, 1959), the concept of response class seemed to me to be critical both for the understanding and for the further fruitful investigation of language. A response class defined in the most general terms is a group of responses which have in common the fact that any one of them can be substituted for any other, according to some criterion. Many different criteria have been used for response class identification and these will constitute the major part of this paper. Before describing these, however, it will be useful to make some more general comments.

It was Skinner (1938) who presented the first explicit analysis of the "generic nature of response" in animal behavior and insisted that an analysis of behavior must be functional, i.e., must consist of discovering what variables control and maintain what classes of behavior, whether the behavior under discussion be verbal (Skinner, 1957) or nonverbal (Skinner, 1938). The point is that learning theory psychologists have for many years been talking of classes of responses and that attacks on learning theory because of its alleged atomistic approach are at least 30 years out of date, if appropriate for any learning psychologists but Guthrie before that. Furthermore, the concept of response class is as essential for the study of nonverbal as it is for verbal behavior. The fact that there is variation among the members of a response class (e.g., the rat may press a bar sometimes by jumping on it, sometimes by using its snout, sometimes its right and sometimes its left front paw) demonstrates that all of these can be members of a single response class as long as they share some property, in this case, a force sufficient to activate some recording device. To put it another way, the fact that there is generalization from the reinforced response to responses related to the one reinforced, has been used to shape new response classes by initially reinforcing response members which are at the periphery of a currently existing class but overlap with the desired new response class.

The concept of response class can thus be shown to be relevant to the problem of acquisition of language and to the related problem of explaining what linguists deem an important property of human communication, namely, productivity (Hockett, 1960). Some psychologists (e.g., Miller, 1962) accused learning theory of being inadequate for the task of explaining the acquisition of language in young children because of the fantastically large number of combinations of words a child would have to learn if each different response had to be reinforced at least once. Furthermore, they maintain that productivity, as shown in the new responses which all speakers emit, defies explanation by learning theory. It should be clear by now, however, that both of these criticisms are based on a view of learning theory which excludes the concept of response class.
Acquisition of language, like the acquisition of any behavior, consists of the acquisition of classes of response, thus making it unnecessary for all response members to be reinforced for all of them to be acquired. Furthermore, animals also are "productive" and new responses in the repertory of any organism require an explanation. A rat required to press a number of bars in succession will vary in the manner in which it executes these responses from time to time. At any given moment the animal can in fact emit responses which have never in the past been reinforced but which occur because, by the process of response generalization, they are members of a response class other members of which have been reinforced. In other words, responses are not completely new; they are related to old responses and quite predictable according to the law of response generalization.

Still another aspect of language has been said to be beyond the pale for learning theory, and that is grammar. Chomsky's transformation grammar (1957) probably represents the most formidable exposition and has no doubt stimulated most of the recent psychological research in this area (e.g., Miller, 1962). If we grant that Chomsky has, in fact, discovered different sentence types, and that the kernel sentence is the basic, simplest sentence, then there is no need to assume in addition that a speaker emitting or remembering a passive negative query has had to code first a kernel and then to perform a series of transformations to arrive at the more "complex" sentence. We can assume instead that sentence types as laid out by Chomsky are response classes. Barik and Lambert (1960) and Salzinger, Feldman, Cowan, and Salzinger (1965) showed that sentence structure response classes could be conditioned. These classes are related to each other in terms of such characteristics as the number of words or word sequences they share, reinforcement-eliciting potential, acoustic similarity, etc. Furthermore, Chomsky's claim that the kernel sentence is basic holds only in so far as it occurs more frequently and earlier in the acquisition of speech (at least in English), since parents are more likely to talk to young children in kernel sentences. In light of the foregoing discussion such experiments as Miller's (1962) can be explained as follows: (1) Since the kernel sentence is reinforced earliest, response generalization takes place from it to the other sentence types; and (2) Since the other sentence types receive fewer reinforcements and occur less frequently in the typical speaker's verbal repertoire, subjects find it more difficult to process such sentences than the kernel sentences. A recent experiment in our laboratory (Salzinger & Eckerman, 1965) provides empirical evidence in support of such an explanation.

Although stimulus generalization has not been mentioned, it should be obvious that this learning theory concept can also be fruitfully employed in the study of language. To give but one example of stimulus generalization, Harlow (1949) was able to show transfer to learning in discrimination reversal training such that the animal learned how to behave in a new discrimination situation on the basis of behavior which was reinforced in other stimulus situations.

Another general point to be made about the nature of response classes is that the individual response members can vary in length. As Skinner (1957) pointed out, when the analysis of verbal behavior is functional, then "Please may I have a drink of water" can be considered to be a member of the same mand response class as "water," both being under the control of the thirst drive.
Thus, I would like to suggest that the notion of response class and the related concepts of stimulus and response generalization be used as explanatory concepts for the acquisition and maintenance of verbal behavior. Of course I have not presented a complete explication of the problems involved, but I have tried to suggest the direction which a thorough examination could take. Some theoretical and experimental work has already begun along these lines (Braine, 1963a, 1963b; Jenkins & Palermo, 1964). Like Skinner (1957) and Osgood (1963), I am certain that learning theory can provide us with adequate tools for the analysis of verbal behavior.

Before describing the various ways in which response classes can be and have been specified, it might be well to point out the similarity between this concept and such concepts as response in Verplanck's glossary (1957), category in Roger Brown's book (1958), and of course, as already mentioned, Skinner's notion of the generic nature of response.

**Common Effect**

One way in which a response class can be specified is in terms of its effect or consequence. Skinner (1938) mentions the orderliness of the dynamic changes in the responses as a criterion for discovering a response class. At first glance it appears then that the entire specification can be accomplished by the experimenter. But Skinner himself noted that we must take "account of the natural lines of fracture along which behavior and environment break" (Skinner, 1938, p. 33) in order to define stimulus and response. Furthermore, Skinner (1948) also noted that not all reinforcement contingencies are, in fact, under the experimenter's control. Thus, pigeons given reinforcement ostensibly independent of any particular response over a period of time, may acquire some definite response class. This kind of behavior is called superstitious and is typical of many experiments in the operant conditioning of verbal behavior. It can more properly be ascribed to a discrepancy between subject and experimenter "defined" response classes.

In a recent discussion of the concept of response class, Staats (1961) raised an objection to specifying a response class in terms of its reinforcement because most verbal responses are in fact followed by the same general reinforcements. The key concept here, however, is reinforcement contingency, not just reinforcement. In other words, the audience, the questions asked, the general environment, and other discriminative stimuli (SD's) determine which particular response classes will be reinforced at a given time or place. Thus, if you (an American) are at a restaurant within earshot of a waiter or waitress (who you know understands English), you would be likely to emit a member of the response class "May I have a menu?" Your verbal behavior would very likely be quite different if instead you were at a shoe store, if the restaurant were deserted, if the waiter or waitress understood no English at all, or if you had wagered you could get a menu without asking for it. Furthermore, the vocabulary you employed to describe an experiment to your six year old would be very different from the vocabulary you use for a colleague, although in both cases the reinforcement would be general in nature only.

Compared to the total number of studies in operant conditioning of verbal behavior (Krasner, 1958; Salzinger, 1959; Greenspoon, 1962; Williams, 1964), little work has been done on the analysis of the problem of response class. However, some interesting experiments do shed light on this problem.
A recent paper (Lindsley, 1963) made somewhat unconventional use of reinforcement contingency; it defined vocal hallucinatory behavior as a response class in terms of the fact that it could not be modified by direct reinforcement.

Two experiments (Rheingold, Gewirtz, & Ross, 1959; Weisberg, 1963) dealing with the conditioning of early vocalizations (in children 3 months old) demonstrated that infant vocalization can be operantly conditioned, but that even here one must be sensitive to the problem of response class. In both experiments, so-called emotional (e.g., crying) and reflexive (e.g., coughs) responses were never reinforced on the assumption that these do in fact constitute separate response classes. It would be most interesting to note what would happen if those responses were reinforced. With older children the problem of response class increases in complexity. In an experiment where we reinforced a response class consisting of statements including the pronouns I, we, me, and us (Salzinger, Salzinger, Portnoy, Eckman, Bacon, Deutsch, & Zubin, 1962), we found it impossible to disentangle this response class from a more general response class of amount of speech, since both showed the conditioning effect. The ambiguity is probably a function of the fact that the syntactical structure forced a correlation between the two response classes, since structures including these self-referred pronouns occur so often in children's speech. That this need not occur in all studies of continuous speech was shown in our other studies with adults (e.g., Salzinger, Portnoy, & Feldman, 1964a). In the study with children, however, we have an instance where it is impossible to tell whether the response class definition of experimenter and subject coincide.

In another experiment (Salzinger, Pisoni, & Reisel, 1959) we showed that the reinforced responses (specific digits), belonging to what we had originally conceived of as response classes of even or odd numbers, conditioned separately rather than as classes. Furthermore, in an experiment where we compared the relative conditionability of verbal and nonverbal response classes (Salzinger, Feldman, & Portnoy, 1964), the five nonverbal members conditioned as a single response class but the five verbal members tended to condition separately. The verbal responses, incidentally, conditioned at a faster rate than the nonverbal ones. It is interesting to note than Vulany and O'Connell (1963), in an experiment on the effect of verbal rules on nonverbal behavior, found that the verbal rules were, like our verbal responses, more rapidly acquired than the nonverbal behavior.

In 1963, we reported an experiment on the conditioning of plural nouns (Salzinger, Portnoy, Zlotogura, & Keisner, 1963). That study was prompted by two considerations: the conflicting results of experiments dealing with the response class of plurals, and our belief that the appropriate and accurate definition of this class required syntactic context. By reinforcing plural nouns in continuous speech, we were able to show the conditioning effect originally found by Greenspoon (1955), but we found, in addition, another discrepancy between experimenter and subject response class definitions. When dividing the response class of plural nouns into subclasses defined by the concluding sound, it became clear that only those plural nouns ending in a /z/ sound, as in "dogs," conditioned significantly. This particular result suggests the conditioning process which may go on in the child who is learning phonemic response classes.

A final set of our experiments to which I would like to refer consists of studies on the conditioning of self-referred affect statements (see, for example, Salzinger, Portnoy, & Feldman, 1964a). This is a complex response class and we therefore checked on its integrity. We were lucky in our choice of definition, since neither general self references nor speech in general were influenced by the reinforcement of self-referred affect statements. Furthermore, our latest
study (Salzinger, Portnoy, & Feldman, 1964a), dealing with a longer period of acquisition, showed that the response class of self-referred affect proceeds from the more general to the more specific; that is, reinforcement of the specific class appears to increase speech rate first, then self references, and finally the self-referred affect statements.

We decided to study this response class from another point of view, namely that of subclasses (Portnoy & Salzinger, 1964). We asked two questions: Is it reasonable to include in one response class both positive and negative affect? and, Can we use the semantic differential (Osgood, Suci, & Tannenbaum, 1957) to define a response which would have integrity during operant conditioning as was suggested some years ago (Salzinger, 1959)? The study showed that you could indeed classify words by the above procedure such that they could be conditioned operantly, and that there is response generalization between positive and negative affect statements. The study thus supports the notion that the self-referred affect response class used in the aforementioned studies does, in fact, constitute an integral response class. In addition, positive affect statements, which had the highest operant level, showed an increase in that level, indicating that positive affect statements yield response-produced positive reinforcement whenever they are emitted. In other words, another property of response classes that needs to be examined in detail is the conditioned reinforcement resulting simply from the act of their emission. Response classes usually associated with positive reinforcement are likely to be high on positive evaluation according to Osgood's semantic differential and likely to reinforce positively their own emission because of their reinforcement history. An analysis of the change in degree of pleasantness, obviously highly related to Osgood's evaluation factor, of reinforced emotional words (Ulman, Krasner, and Gelfand, 1963) showed another interesting phenomenon: those emotional words emitted during conditioning were more pleasant than those emitted during operant level. This finding led these investigators to a conclusion similar to our own concerning the importance of the subject's response-produced reinforcement. This line of research may well supplement the work of Kanfer and Marston (1963a, 1963b; Marston, 1964a, 1964b), which utilized a separate self-reinforcing response class. Another independent source of evidence for response-produced reinforcement comes from a study by Finley (1964), who found words differing in evaluative meaning to differ predictably with respect to their positive or negative reinforcing value. Finally, Staats, Staats, and Finley (1961a) successfully conditioned a response class defined to contain positive evaluative meaning; Staats, Staats, Mirke, and Finley (1961) conditioned a response class defined in terms of negative evaluative meaning; Steinberg and Oakes (1964) conditioned words selected on Osgood's evaluative and potency factors but not on the activity factor; and Durlav (1962) was able to affect an increase in "activity" words only when subjects were told what the correct response class was.

A type of experiment thoroughly investigated by the Staats (Staats & Staats, 1963) consists essentially of having subjects emit a series of different words subvocally (the series is a response class having in common the same connotative meaning) while viewing a given nonsense syllable. The nonsense syllable, after a number of trials, then acquires a semantic differential rating in the direction of the response class of words emitted in its presence. While Staats and Staats have consistently interpreted this as an experiment in classical conditioning, it seems to me that an argument can be made for it as an example of operant conditioning. Although the reinforcement is not explicit, aspects of the procedure do in fact provide at least the rudiments of an operant conditioning experiment:
for example, the subjects saying the words in chorus and their complying with the instructions of the experimenter (a very important reinforcement contingency in many experiments, namely, avoiding the negative reinforcement from failing to follow instructions). Since different nonsense syllables are paired with response classes differing in connotative meaning, the subjects learn to make discriminative responses; thus, one nonsense syllable becomes the SD for words belonging to the positive evaluative response class and another nonsense syllable becomes the SD for words of the negative evaluative response class. These words, which were selected because they are SDs for certain semantic differential values, are then evoked when the nonsense syllable is rated after the conditioning part of the experiment, thus giving rise to a change in connotative meaning. According to this interpretation, then, a response class not only can function to strengthen response members belonging to it which have not been directly reinforced, but also, in becoming conditioned in the presence of an SD, can itself serve as an SD for a further response such as a particular semantic differential rating.

Although conceived as an experiment in concept learning rather than operant conditioning, Underwood and Richardson's (1956a) experiment successfully makes use of a definition of response class similar to the experiments employing the semantic differential. The last experiment to be cited along these lines (McBrearty, Kanfer, Marston, and Evander, 1963) showed that conditioning varies not only as a function of the definition of the reinforced response class but also as a function of how distinctive its delineation is from the other response classes which are to be avoided rather than omitted.

Some response classes to be conditioned are based on judgments made for use in specific experiments, as with that of hostile verbs (Buss & Durkee, 1958; Simkins, 1961) or with "symptomatic" verbal responses (Ayllon & Haughton, 1964). Other reinforced response classes are based on tabulated word association data. Maltzman (Maltzman, 1960; Maltzman, Simon, & Licht, 1962; Peterson, 1956) defined a response class of common and uncommon word associations; Staats, Staats, and Minne (1961) defined a response class in terms of the fact that its members were all associates of one stimulus word; Staats, Staats, and Finley (1961b) created a response class by building in different degrees of serial associations between chains of verbal responses; Rotberg (1959) defined a class of antonyms (which, according to a recent experiment by Carroll, Kjeldergaard, and Carton (1962), are often the common associates); and Thorndike and Rock (1934) used the interesting classification of responses into syntagmatic (yours — "truly") and paradigmatic (up — "down") responses. Response classes have also been defined by test traits (Nuthmann, 1957; Oakes & Droge, 1960; Staats, Staats, Heard, & Finley, 1962), providing still another empirical basis for response class definition.

I will not try to list all the response class definitions used, since most of them are described in reviews, but I would like to mention the following for their special interest value: private events consisting of covert responses as possible SDs for a response class (Hefferline, 1962); categories established to describe face to face interaction in groups (Oakes, 1962); the interesting set of studies which have defined verbal response classes in terms of the class of nonverbal responses they would influence — viz., the effect of food responses on eating (Lovaas, 1964), of aggressive words on aggressive behavior (Lovaas, 1961), and of building-related words on number of building-pictures drawn (Timmons, 1962). Lane (1960, 1964) and Lane and Shinkman (1963) used the very simple vocal response "lul" and studied its physical properties, shaping response classes exclusively in terms of these properties. Goldiamond (1965) has shown
that a response defined as being fluent or nonfluent (more familiarly known as a stuttered response) can also be modified by operant conditioning.

Finally, I would like to make a few comments on the phenomenon of awareness in operant conditioning. When I reviewed the area of verbal operant conditioning, I defined awareness of a reinforcement contingency as a "verbal response (usually subvocal) to the response-reinforcement contingency so that subsequently this verbal response becomes a discriminative stimulus (an occasion) for the emission of the response utilized in the experiment" (Salzinger, 1959, p. 84). Verplanck (1962) has used such response class definitions of awareness and has shown them to behave like other operant response classes in their reaction to reinforcement, Dular and O'Connell (1963), with an experimental design similar to Verplanck's, also found that statements of rules about the reinforcement contingency are conditionable. Nevertheless, they still believe that statements of rules about sorting are quite different from the actual sorting response and base their belief on the differential rate of conditionability of the two response classes. As already noted above, this result is quite similar to a finding in one of our experiments (Salzinger, Feldman, & Portnoy, 1964) which showed that verbal responses (cf. statements of rule) are more easily conditionable than nonverbal responses (cf. sorting behavior). In any case, I would like to reiterate that it is possible to conceive of awareness as a response class which under certain conditions may act as an SD (perhaps after it has been conditioned as the main controlling stimulus) for the emission of the main experimental response class. The general conditions under which such SD's function will be summarized by Leonard Krasner at this conference, but I would like to call your attention to an aspect specifically related to response class. Other factors being equal, the smaller the number of different members in a response class, the greater the likelihood of the response-reinforcement contingency acting as an SD for statements of rule. I will not try to document this except to point out that both Dular (1962) and Spielberger (1962) presented what they considered to be airtight arguments against conditioning-without-awareness by relying in large part on experiments based on response classes restricted to one or two pronouns.

Thus, a great many response classes can be defined in terms of their effect, or, perhaps more accurately, can be discovered by observing what other responses increase when reinforcing only some of the members of a class. This might be a way of finding out, for example, what verbal concepts children have at different ages or whether schizophrenic patients or brain-damaged patients do in fact have only "concrete" response classes.

Linguists use a modification of an operant conditioning procedure as one method for arriving at the phonemic and syntactic rules of a new language. They emit responses in various orders and contexts and receive positive reinforcement from their informants only when their responses match responses in the informants' language.

The remaining ways of defining response classes impinge upon areas which will be covered in detail by other speakers at this conference, and so I will discuss these in general terms only.

Common Stimulus

A response class can be defined by specifying the stimulus which controls the emission of a group of responses. This section could have included the
operant conditioning experiments since they demonstrate the control exerted by the same reinforcing stimulus, but we will restrict it to $S^D$'s and unconditioned stimuli only.

Most obviously relevant here are the word association experiments which have given rise to the distinction between syntagmatic and paradigmatic associates (Osgood & Sebeok, 1965), where the latter makes reference to the relationship among words which are mutually substitutable in the same position of a given sentence frame, and the former refers to the relationship among words which follow one another in sentence frames. These two types of associates were compared in a task requiring subjects to complete mutilated strings of such words (Salzinger, S., 1964). Results showed that paradigmatic strings are structured like response classes so that any word serves as an $S^D$ for any other word in the string, while the syntagmatic strings showed sequential effects of words. The sequential influence of successive words also relates to what constitutes a reasonable response unit (Salzinger, 1962). In an interesting analysis of the proportion of syntagmatic responses obtained from words differing in grammatical class, Deese (1962) made the discovery that nouns evoke mostly paradigmatic associates, verbs and adjectives produce them about half the time, and adverbs evoke mostly syntagmatic associates. This suggests that certain parts of speech are more complete units than others, as Glanzer (1962) found when he compared function words to lexical words embedded between two nonsense syllables. Since the function words (incomplete units) were learned more easily than the lexical words (complete units) when joined with nonsense syllables (incomplete units), it follows that the state of completion of responses may well be an important prerequisite for the formation and learning of these response classes.

Some years ago Ervin (1961) and Brown and Berko (1960) pointed out that the older a child gets the more likely he is to emit paradigmatic associates rather than the syntagmatic associates which he emits at an earlier age. This finding was recently corroborated on larger samples by Entwisle, Forsyth, and Mussen (1964). McNeill (1963) studied the development of paradigmatic associates experimentally and concluded that they originate from using these words in the same context of speech. Thus, I would like to suggest that grammatical response classes are formed in speech on the basis of substitutability in the same position of sentences or that a sentence position acts as an $S^D$ for a class of verbal responses. A recent experiment (Baker & Sonderegger, 1964) showed that such sentence frames can also account for the acquisition of meaning response classes, as was suggested earlier by Werner and Kaplan (1950).

With the availability of extensive norms for word association data, a great many experiments have been performed on what Cofer (1965) called the organizational characteristics of free recall when he reviewed that literature. One type of organization was called "category clustering" where words were generally recalled in clusters when categorized groups of words were presented to subjects in random order. The other was called "associative clustering" where associates were recalled in clusters after subjects had been presented with a group of stimuli from the Kent-Rosanoff Word Association Test randomized together with their high associates. Both types of organization depend essentially on the extent to which an $S^D$ (category name in the first and a stimulus word in the second) controlled a class of verbal responses. It can also be shown that associative connections influence visual duration thresholds (House & Verinis, 1962) and that sentence, association, category, and letter context all relate to intelligibility of verbal stimuli (Rubenstein & Pollack, 1963). The psychophysical literature is quite large and these are of course experiments in an area which Irwin Pollack will
cover in much more detail. Some light was shed by Judson and Cofer (1956) on 
the way in which word stimuli give rise to response classes. They showed that 
a response to a given word influences the availability of response classes to 
subsequent words.

The literature on word association can obviously not be fully related to 
the concept of response class in a couple of paragraphs, but one of its findings 
seems appropriate to explain a recently reported clinical phenomenon. Laffal, 
Lenkoski, and Ameen (1956) found a man who consistently substituted "yes" and 
"no" and other opposites for each other and explained this phenomenon by 
suggesting that it "served primarily as a means of coping with hostile impulses." 
Staats (1957), in a comment on the article, pointed out that opposite speech 
might be functioning essentially as an escape or avoidance response from the 
aversive stimulation coming from speaking appropriately. I would like to add 
here only that opposites or contrast responses have great strength in word 
association tests (Carroll, Kjeldergaard, & Carton, 1962), demonstrating that the 
patient's verbal behavior was quite different from the word salad syndrome 
sometimes reported, since his "incorrect" verbal responses not only remained 
within the confines of the appropriate response class but in fact most likely 
consisted of the highest associate to the appropriate response. It would certainly 
be worthwhile to investigate the extent to which tangential responses in schizophrinic 
speech are members of the same or related response classes as the 
appropriate response. That schizophrenic patients do make responses inappropriate 
to the context surrounding them was demonstrated recently by results obtained by 
applying the cloze procedure and other context-sensitive measures to schizophrenic 
speech samples (Salzinger, Portnoy, & Feldman, 1964b, in press). It might also be 
pointed out that analyses along these lines will no doubt prove to be useful for 
gaining an understanding of aphasic disorders. Lyle Jones and Davis Howes will 
no doubt have some interesting comments on this topic.

In an interesting series of experiments Carroll (1955) showed how response 
classes consisting of sentence types vary as a function of the stimulus situation. 
So-called polite requests, to give but one example, occurred most frequently when 
the stimulus situation was set up so that the subject believed he was doing 
something for his own benefit, while the imperative, without polite words such as 
"please," was employed when the subject believed he was doing something for the 
other person's benefit. This particular finding has an interesting corollary 
in a study of the letters exchanged between disturbed children and their parents 
and friends outside the institution (Salzinger, 1958). The institutionalized 
children made a larger number of polite requests in their letters than their 
correspondents in the outside community, but the number of imperative statements 
was the same for both groups, suggesting that the members of the community did 
not feel that they were expressing wishes for their own good but for the good of 
the disturbed children. Thus, here is an example of the use to which a response 
class can be put once its controlling variable has been identified.

Some psychologists have suggested that the study of animal communication bears 
no relationship to human verbal behavior, but it is my belief that this is pre-
judging the issue. Some years ago, after Skinner (1957) suggested that animal 
vocalizations were not conditionable by operant techniques, Marcus Waller and I 
(Salzinger & Waller, 1962) did an experiment the results of which contradicted 
this statement. We found it relatively easy to condition barking in dogs by 
operant techniques; moreover, it was possible to establish rather exact stimulus 
control over their vocalization.
The general area of animal communication is undergoing much study at this time (e.g., Sebeok, 1965; Lanyon & Tavolga, 1960). Most of these studies reflect an interest in classifying the response classes of vocalization in terms of stimulus situations which "release" them, but evidence for modification of vocal responses in reaction to the environment is increasing. We are fortunate at this conference in having two presentations on this subject (by J. C. Lilly and by J. H. Grosslight and W. C. Zaynor).

The phonetic aspects of speech constitute another important stimulus variable controlling certain response classes. The literature on phonetic symbolism, contradictory though some parts are, has suggested that there is an intrinsic relationship between certain sounds and certain responses (meanings assigned to them). In a recent review, Taylor (1963) concluded that the meaning-sound associations are not inherent in the sound per se but related to the specific verbal habits of each language.

Common Response

Another method used to define verbal response classes is by way of a common response which is evoked by a group of verbal stimuli. It is assumed that relationships found among words acting as stimuli will correspond to their relationships when they act as responses.

The classical conditioning literature is quite important here, of course. The general paradigm consists of using a specific word as a conditioned stimulus, and, after it elicits a specific response (salivation, GSR, etc.), observing the extent to which other verbal stimuli, related to the conditioned stimulus in a variety of ways, also elicit the conditioned response. An optimistic review of work in this area was undertaken by Razran (1961), and some later evidence was adduced by Kurcz (1964) for semantic and phonetographic generalization with an operant response. A recent review of semantic generalization (Feather, 1965) has been less enthusiastic, pointing out a number of methodological difficulties in the experiments and suggesting that the important variable in semantic generalization consists of the subject's categorization of the stimuli. In a rather interesting study, not included in Feather's review, Whitmarsh and Bousfield (1961) correlated a generalization index computed on the basis of their word association data with the results on semantic generalization obtained by Razran (1949) using a salivary response. The correlation between the two indices was +.70 (p < .001) indicating, contrary to Feather's (1965) contention, that mediation by common responses does occur and that these responses can be used to predict what words will constitute a class. The kind of response classes formed varies as a function of age (Razran, 1961; Riess, 1946; Luria, 1961), going from phonetographic response classes early to semantic classes later; it also varies as a function of drug intake, going from phonetographic (drug) to semantic (nondrug) generalization. Of some relevance to this is an experiment by Sumby (1963), who found that words of low frequency tended to cluster in terms of phonetic characteristics while words of high frequency tended to cluster in terms of semantic properties. One is tempted to draw an analogy here between the phonetic generalization in young children and the semantic generalization in older children. I would like to suggest that the classical conditioning results with young children can be simply ascribable to the low frequency of occurrence of the stimulus words, that is, the words are grouped together by sound because their meaning is unfamiliar to the children.

So far, then, I have pointed out that the common response can be a respondent
(that is, an autonomic response) or an operant, in terms of the overlap in the free associates of two words. It can also be the operant response evoked in a controlled association situation. Of these, the semantic differential (Osgood, Suci, & Tannenbaum, 1957) has received a great deal of attention. We have, in fact, already mentioned its usefulness for defining response classes which can subsequently be reinforced in operant conditioning experiments. We might add the variation of this measure as a function of age. Maltz (1963) found that there is less consistency in the meanings assigned at an early age, giving evidence for the gradual development of meaning response classes. The semantic differential is focused on obtaining measures of connotative meaning, i.e., evaluative meaning, potency, and activity, and gives rise to response classes along these dimensions. Another set of restrictive associations has been obtained by having subjects respond with their sense impressions only, in terms such as "round," "soft," "clear," to a series of concrete nouns (Underwood & Richardson, 1956b). A measure of "response dominance" obtained on the basis of these data was found to relate to acquisition of concepts (Underwood & Richardson, 1956a) as well as to degree of clustering in free recall (Bousfield & Puff, 1964). A third restricted association procedure, recently utilized, consisted of rating a number of verbs on the "impression" they would make when employed in a sentence (Dixon & Dixon, 1964). The values were found to relate to the degree of conditionability of the verbs. There are of course many other procedures used for scaling verbal material, such as association value (Glaze, 1928) and meaningfulness (Noble, 1952). All of these are potential methods for specifying response classes.

I have already mentioned the studies by Staats & Staats (1963) on the acquisition of meaning. Their work should be cited here again because their experimental method consists essentially of establishing response classes by systematically pairing common responses, i.e., words of the same connotative meaning, with nonsense syllables. One would predict that if different subgroups of nonsense syllables were systematically paired with words belonging to different groups of similar connotative meaning, that the nonsense syllables in a free recall task would cluster in accordance with the variation of their acquired connotative meaning.

**Topography of Response**

Construction of a response class in terms of the topography of the response is probably the most tempting to students of language, and for certain purposes it is quite adequate. Linguists have, for instance, talked of certain markers to indicate grammatical class. An example of such a marker would be the suffix "ly," which often indicates an adverb. Response classes based on the length of words have proved useful for distinguishing between the writings of different authors. Mendenhall (1887, 1901) found that Shakespeare used a relatively larger number of four-letter words (literally not figuratively), while Bacon used a larger number of three-letter words. Although the latest, and far more mathematically sophisticated, study of disputed authorship did not find this particular method useful, Mosteller and Wallace (1964) were able to identify response classes simply in terms of words having identical orthography. They tried to make use of function words as a response class, the classification of which depends at least in part on context (Fries, 1952) and which would therefore appear to be a response class functionally rather than topographically defined, but they were unsuccessful. Since they simply worked from a list, independent of context, the resulting response class definition depended entirely upon the orthographic description of the words. The use of specific words, or, for that matter, groups of words, has
of course also played an important role in studies of content analysis (Pool, 1959). In the content analysis studies, as in the word count studies, the final decision as to the usefulness of a category depends on how well it varies as a function of the variables of interest to the investigator.

There are, of course, other ways of describing the topography of verbal responses, for example, fluency or nonfluency (stuttering). This response class, Goldiamond (1965) has maintained, can also be controlled by external reinforcement and is traceable in etiology by the effect (reinforcement) it evokes from other people. Animal communication has also been described, and with recent improvement in instrumentation, its physical properties have been used for purposes of designating response classes (Lanyon & Tavolga, 1960). In our own study of barking in the dog (Salzinger & Waller, 1962), the topography of the response could be observed to undergo changes with changes in experimental procedure. The beagles at first barked in their usual fashion by lifting head and forefeet off the ground and producing a howl. Since extended sound production only activated our relay once, while a number of shorter discrete barks activated the relay a number of times and therefore resulted in more reinforcements, the dogs learned eventually to emit the latter type of sounds. Another observation which we made on the dogs was that the discrete barks would revert to howls when we instituted a relatively large increase in the requirement of the number of responses per reinforcement. These subsequently changed back to discrete barks as the animals adjusted to the new schedules. This kind of observation suggested that the difference in response topography corresponded, at least roughly, to an emotional (respondent?) response class on the one hand and a pragmatic (operant) response class on the other.

Perhaps the most interesting research on the acoustic aspects of speech has been done at the Haskins Laboratories; here they have managed to investigate the relationship of a topographically defined response class (the sound spectrogram) to a functional response class by using a simplified sound spectrogram as a stimulus in a perception experiment. These investigators (Cooper, Liberman, & Borst, 1951; Cooper, Liberman, Harris, & Grubb, 1958; Liberman, Harris, Hoffman, & Griffith, 1957) realized that simply giving a complete physical description of a response class might include parts of a response not involved in the process of communication. For example, they found that subjects discriminate the same acoustic differences better when the sounds lie on opposite sides of a phoneme boundary than when they lie within the same phoneme. In other words, the phonemes established by linguists do in fact act like response classes even in a simple discrimination experiment. These investigators also found correspondence between their classification of sounds in accordance with acoustic patterns and the phonetic classification by place and manner of articulation. However, further investigation showed that in some cases, "large and abrupt change in acoustic pattern contrasts with the comparatively small and continuous shifts in articulation... The identity of the perceived consonant remains the same throughout, and thus parallels the invariance of the articulation," (Cooper, Liberman, Harris, & Grubb, 1958, p. 937). This finding has given rise to a motor theory of speech perception (Liberman, Cooper, Harris, & MacNeilage, 1962) in which the neuromotor commands are said to control the perception of phonemes and where there appears to be a close correspondence between phoneme and articulation (the topographical description of the response). We will hear much more about this in Harlan Lane's discussion.
Correlation to a Known Response Class

Another method of arriving at a response class is to examine what verbal responses co-occur with known response classes.

I have already talked about some examples of verbal-verbal correlations, e.g., the clustering in recall of words which had been initially exposed to the subject in random order. I have also mentioned some experiments on operant conditioning of those verbal response classes sometimes called awareness or hypotheses or intentions which influence subsequent verbal responses. Correlations between response classes in content analysis studies, where they are usually called categories, are of course critical in many cases. Laffal (1965) has made extensive use of such analyses, which he calls analyses of "contextual associates."

Finally, we have mentioned studies on the relation of sequential verbal responses to each other. The cloze procedure (Taylor, 1953) is a technique constructed to study contextual effects and is sensitive both to grammatical and to content factors (e.g., Salzinger, Portnoy, & Feldman, 1962; Fillenbaum, Jones, & Rapoport, 1963). It allows one also to talk about the response classes and their homogeneity as a function of such factors as statistical approximation to English (Salzinger, Portnoy, & Feldman, 1962), aphasic speech disability (Fillenbaum & Jones, 1962), or schizophrenic speech (Honigfeld, 1963; Salzinger, Portnoy, & Feldman, 1964b, in press).

The analysis of syntax provides examples of response class correlations. An obvious example is the agreement in number between a subject and its verb. Very interesting studies on the acquisition of language (Braine, 1963b; Miller & Ervin, 1964; Brown & Fraser, 1964) have come up with the general finding that at least early in the speaking history of a child there are two general response classes: a class of pivot words and a class of X-words. We have observed, in an experimental study (Salzinger, Feldman, Cowan & Salzinger, 1965), the extensive use to which such pivot words are put from their first acquisition; the speech-deficient child whom we provided with the pivot word "give-me________" put almost every X-word in his limited repertory into that frame before proceeding to the next pivot word and similarly inserting X-words into it.

Paula Menyuk (1963, 1964), who will be talking about this at length, has done some interesting studies of what I consider to be sentence length response classes and how these classes vary as a function of age. In order to describe these sentence response classes she must examine the correlations of the constituents in these sentences.

Finally, I would like to mention briefly some interesting covariation of certain verbal and physiological response classes (Davis & Malm, 1951; Malm, Shagass, & Davis, 1950). In both cases these verbal and physiological measures were taken on disturbed individuals; the study of such relations in normal subjects is quite rare (Hefferline, 1962).

State of the Organism as Determinants of Response Class

Clinicians are interested in the relationship between a patient's state and what he will say, but their response classes are often ad hoc, if not post hoc. In making interpretations, the clinicians actually address themselves to the more general problem of response classes under the control of private events. To what
extent are response classes ostensibly under the control of pain really under the control of certain external stimulation, and to what extent, then, are such verbal responses as "I have a toothache" under the control of the mentioned referent, and to what extent do such responses belong to other response classes? The entire area of private events raises a question which could well be studied by means of operant conditioning techniques; is it easier to condition a response class to an external stimulus or to a private stimulus? Experiments done with such private events as the autokinetic phenomenon (Sherif, 1935), as opposed to such obvious external stimuli as differences in length of lines much above threshold (Asch, 1952), indicate that subjects can be influenced to change their responses to a greater extent with the first than with the second.

The effect of drive operations has been suggested by Skinner (1957) to control a response class which he has called "mands." An example would be a request for water when the individual has been deprived of it for a long time. Two experiments (Sanford, 1936, 1937) in reference to this both showed that subjects' food responses vary in frequency with the strength of the food drive (number of hours without food).

Drugs, like other drive operations, afford the opportunity to modify or induce certain states and therefore provide more information on these states. The effect of various drugs on verbal behavior has been assessed by too few investigators, but we will have a number of presentations as well as a review of the area at this conference. Suffice it to say that a response class approach might well reveal some interesting data about the effect of various drugs; for example, is it easier to condition a subject under the influence of LSD to "see" beautiful colors than a subject under the effect of a placebo? Are response classes which are normally controlled by positive reinforcement changed less than response classes normally controlled by aversive stimulation? Are response classes under the control of a reinforcement contingency influenced to the same extent by a drug as response classes not under such control? A study in our laboratory (Salzinger, Pisoni, Feldman, & Bacon, 1961) has suggested that chlorpromazine influences primarily those response classes which are under the control of a reinforcement contingency, leaving other response classes relatively invariant.

Miscellaneous Response Class Definitions

Investigators have used other criteria for response class. Chomsky (1957) has spoken of so-called grammatical and ungrammatical response classes (though he did not refer to them as classes). Empirical tests, however, did not confirm such a division of sentences (Hill, 1961; MacKay & Sleator, 1960), since subjects did not consistently place various sentences dubbed "grammatical" or "nongrammatical" in the same categories as Chomsky.

Another response class definition has come from frequency of occurrence data. Words originally thought to be aversive to subjects were shown by Howes and Solomon (1951) to have higher visual duration thresholds simply because of their membership in the response class described as having low frequency of occurrence in the English language. Other such definitions have been used with reference to word association responses, and so-called common or popular responses have already been mentioned as being conditionable response classes.

Perhaps the final kind of response class to mention is what I have called the legislated response class, wherein a group of responses is simply assigned a
name and thereby considered established. A good example of this is the name "fantasy," which has been applied to the verbal behavior evoked in the presence of TAT cards.

Implications

I have reviewed a large number of studies and their concomitant response class definitions. I have, in fact, described response classes in studies where the authors saw none. But as one reviews the literature with the concept of response class in mind, one begins to see them everywhere, a kind of perceptual offense effect.

The implications of this review are that response class is an indispensable concept for the examination of verbal behavior, that its explicit definition in many cases would reveal similarities and differences among response classes which might not otherwise be observed, and that it may well offer critical guidelines for gaining an understanding of the biological foundations of verbal behavior. Among the most challenging phenomena the neurophysiologist must explain are: the apparent change from sound similarities to meaning similarities which occurs in response class definition as a function of experience or age; the manner in which the brain groups verbal responses which have no physical similarity, implying some categorizing function within the brain itself which corresponds to the behavioral categories; the way in which a key word or words, like a category name or a specific sentence context, evokes a response class of words from a subject; and the brain structure or function which apparently controls grammatical and content response classes separately.

Penfield and Roberts (1959) have suggested that there are two different but basic brain mechanisms: "the experiential record," which holds past experience in its unique pattern but holds no generalizations, and the "conceptual record," which stores the concepts which are based on the specifics of the experiential record. The authors go so far as to speak of the "ganglionic equivalent of a word" and the "ganglionic equivalent of a concept" (Penfield & Roberts, 1959, p. 230). In the book by Osgood and Miron (1963) there are discussions of possible relationships between such aphasic disorders as difficulties of name finding and agrammatism and the processes of paradigmatic and syntagmatic association found in normal speech. Finally, Sir Brain's recent article (1961) on the neurology of speech suggests a concept of schema which acts, not as a pattern or mold to which other responses are matched, but as a kind of receptor organ which does not require a one-to-one correspondence. Essentially, this receptor is sensitive to the probability that a given stimulus belongs to a certain class.

Some neurophysiologists are, in other words, already giving some thought to the problem of response class. I hope that this paper will give them more grist for their mill and increase their interest in understanding the neurophysiological counterpart of response class.
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