Natural Concepts and Generalization Classes

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(Abstract)

The results of an experiment performed by Herrnstein, Loveland, and Cable (1976) show that pigeons possess concepts that are not based on common elements. The conclusion they draw from these results is that these concepts are largely determined by genetic factors. In the present paper it is argued that, at least for some of the concepts, the conclusion is incorrect. These concepts—called here uncommon generalization classes—were acquired by the pigeons as a consequence of certain experiences through which they went during the experiment. The discussion will also suggest the fruitfulness of replacing the vague and misleading notion of concept by the more adequate notion of generalization class.

In an article on natural concepts, Herrnstein, Loveland, and Cable (1976) describe an experiment that seems to establish the innate character of certain concepts in pigeons. In the experiment, the pecking of pigeons was reinforced when pictures showing a person, as well as parts of this person, in different settings, were projected onto a small screen within an operant chamber. The response was not reinforced when the pictures showed a different person. The experiment indicated a significant transfer of the response to other pictures showing the same person or the same parts of the person in other settings, and also to other parts of the person, in several kinds of settings. Similar results were obtained with pictures containing one or more trees or parts of a tree, and also with pictures showing water in several forms.

In the discussion of the experiment, Herrnstein *et al.* point out that these generalizations cannot be explained in terms of discriminable common elements. "Having looked at the hundreds of instances used here . . . we cannot begin to draw up a list of common elements" (p. 297/8). They then propose an explanation in terms of genetic factors: ". . . trees, bodies of water, and people have long been both important and common in the pigeon's natural environment. By now, these objects may have had enough evolutionary significance to be somehow represented in the genes" (p. 299). This does not imply, however, that pictures of

trees, water, and persons are innate categories for pigeons. The innate ingredient is less specific. "Given a finite set of varying stimuli, the pigeon activates a particular category out of the limitless number of categories more or less equally well determined by the same set. It is in this narrowing of the range of possible categories that innateness seems to be expressed" (p. 300).

Still, even this conclusion seems to be too strong. Although a basic type of the generalization classes of an organism is indeed strongly determined by innate dispositions, I will discuss evidence suggesting that at least some of the generalizations classes discussed by Herrnstein *et al.* are only indirectly determined by such predispositions.

The discussion will also clarify a number of fundamental aspects of a capacity that plays a crucial role in human life, namely, the capacity to learn to generalize according to so-called uncommon generalization classes. Finally, I will argue that a terminology based on the notion of *generalization class* has various advantages over alternative terminologies.

Normal and Uncommon Generalization Classes

The results of several experiments point to the need for distinguishing between two types of concepts, or to use a terminology which will be seen to have certain advantages, between two types of generalization

classes: classes that are normal and classes that are not normal generalization classes for a species. Consider, for example, Razran's well-known experiment on semantic generalization (1939). The experiment shows that speakers of English generalize from utterances of 'urn' to utterances of 'vase.' That is to say, they "use" the class containing sounds of 'urn' and of 'vase' as a generalization class. This class is not a normal generalization class for humans, since only certain people generalize according to this class. On the other hand, the class containing similar utterances of 'urn' is a normal generalization class for humans, or very close to such a class. Most normal people generalize from one utterance of 'urn' to other utterances of 'urn.'¹

Generalization classes that are not normal generalization classes (for a species) will be called *uncommon* generalization classes.

The transformation of a "neutral" class—i.e. of a class of entities that is not yet a generalization class for an organism—into an uncommon generalization class for the organism can usually be attributed to specific experiences which the organism has undergone with respect to the elements of the class. Thus, the transformation of the class containing utterances of 'urn' and 'vase' into a generalization class for speakers of English is a consequence of the fact that these persons have gone through certain experiences in which they heard (or read) utterances of the terms. On the other hand, the generalization class containing only utterances of 'urn' does not depend on specific experiences with this term. It is not necessary for people to have heard utterances of 'urn' before they become able

to generalize from one utterance of this term to another.²

To give another example, consider the class of similar giraffes. This class is a normal generalization class for humans, or very close to such a class. Therefore, a child, who has had no previous experiences with giraffes, can nevertheless generalize from one giraffe to another (if some behavior is reinforced in the presence of a giraffe). This explains why children can learn to apply the term 'giraffe' to the whole class just by hearing an utterance of the term while seeing a giraffe.³ On the other hand, the class containing toys—e.g. balls, dolls, and little blocks—is not a normal generalization class for humans. Therefore, a child cannot learn to apply the term 'toy' to the whole class just by hearing an utterance of the term while seeing an element of the class. The child must previously go through the experiences that transform this class into a generalization class for him.

With respect to normal generalization classes, two questions can be asked. (1) Why do (normal) organisms generalize according to the normal generalization classes of their species? (2) Do normal generalization classes possess a property that distinguishes them from other kinds of classes? I shall deal only very briefly with these questions, since I am interested here mainly in uncommon generalization classes. Regarding the first question, the answer given by Herrnstein *et al.* seems to be the most plausible. It is very likely that the disposition of an organism to generalize according to the normal

²It may be necessary that for people to generalize from one utterance of 'urn' to another, they must already be acquainted with English or with a similar language. But the important point is that they need not to have heard utterances of the particular term 'urn.' A general exposure to the language is sufficient. On the other hand, the generalization from 'urn' to 'vase' occurs only after the person has heard (or read) utterances of the specific terms.

³Of course, the class will not always be strictly identical with the class to which adults apply the term. On this topic see, e.g. Anglin (1977), Reich (1976), Stemmer (1979).

¹By speaking of *similar* utterances of 'urn,' I am using the notion of similarity in an intuitive, non-technical way. I return to this topic in section 5, where I also discuss some uses of the notion of salience. Regarding the claim that most normal people generalize from one utterance of 'urn' to other utterances of this term, see fn. 2.

generalization classes of its species derives principally from genetic factors, and that the disposition has been evolutionarily selected because of its survival value.⁴ Regarding the second question, the discussion in Quine (1973, p. 16-27) suggests that most, perhaps even all normal generalization classes have the following property. The elements of these classes have a number of (broadly defined) features that are possessed by the *original* entities, i.e. by the entities whose perception by the organism gives origin to its generalizing behavior. Moreover, these features are salient for the normal members of the corresponding species. (However, it does not seem to be necessary that all the elements of the class share the same features. It probably is sufficient that each of them possesses part of the salient features of the original entities. See, e.g. Posner (1973) and Cerella (1979) on this "clustering" effect.)

The two questions also arise in connection with uncommon generalization classes. Now, the answer to the first question is clearly different from the one given above. The disposition to generalize according to a *particular* uncommon generalization class *C* does not derive from genetic causes. Thus the generalization from the sounds of 'urn' to the sounds of 'vase' is not genetically determined, since most normal humans do not "use" the class containing these sounds as a generalization class. This suggests that the disposition to generalize according to such classes is acquired by an organism with the help of certain experiences, which brings us to the following question. What are the experiences that transform a class that is not a normal generalization class (for a species) into an uncommon generalization class (for some members of the species)? Clearly, it is not yet possible to give a complete answer to this question.

⁴The implications of the latter conclusion for the topic of induction have been investigated in Quine (1969), Quine and Ullian (1970), and Stemmer (1971a, 1978a, 1978b).

However, for certain elementary cases, Hull's analysis (1943, p. 191-194) of what he calls logical or abstract similarity enables us to give an answer. Consider the experiences that transformed the class containing utterances of 'urn' and 'vase' into a generalization class. Generally speaking, they were those that enable speakers of English to learn the meanings of these terms. More specifically, and only for elementary cases, the experiences were like the following.⁵ The child heard (at least once) an utterance of 'urn' while seeing an object *a*, and he also heard (at least once) an utterance of 'vase' while seeing an object *b*. Moreover, and this is crucial here, the class containing *a* and *b*—that is, the urn and the vase—is a normal generalization class for humans.⁶ As a consequence of these experiences, the class containing utterances of both 'urn' and 'vase' became an uncommon generalization class for the child.

In general, the union of two (or more) normal generalization classes *X* and *Y* may become an uncommon generalization class for an organism, if (but only if) the organism is exposed to at least two pairing situations. In these situations, an element of *X* is paired with an entity *a* and an element of *Y* is paired with an entity *b*, and *a* and *b* belong to a normal generalization class *Z*.⁷

This conclusion is also supported by the

⁵Here under elementary cases I refer to cases in which a person learns the meaning of a term *ostensively*—i.e. by hearing the term while observing the corresponding object—rather than *verbally*—i.e. by hearing the term in a verbal context without observing the object.

⁶Notice that its elements share a number of features that are likely to be salient for humans, in particular, the features that determine the shape of *a* and *b*.

⁷It is possible that *Z* does not have to be a normal generalization class. It may be sufficient that it be an uncommon (acquired) generalization class for the organism. But this hypothesis has to be confirmed empirically. Notice, moreover, that I have stated only that the described experiences *may* transform a neutral class into an uncommon generalization class. It is the task of the experimental psychologist to discover the conditions which will allow us to predict that the transformation will indeed take place.

following experiment described by Pavlov (1927, p. 55-56). A dog was exposed to several pairing situations in which the sound of a buzzer, the sound of a metronome, and a tactile stimulus were paired with the reception of acid. Then, one of the stimuli was inhibited and it was observed that the inhibition generalization to the other stimuli. This shows that the exposure to the pairing situations had transformed the class containing the three kinds of stimuli into an uncommon generalization class for this dog.

The conclusion also seems to account for the transformation of the class containing balls, dolls, and little blocks into a generalization class for children who have played with these objects. These children have been exposed to at least three pairing situations in which an element of the class balls, of the class dolls, and of the class blocks were paired with "playing activities." As a consequence, the union of the three classes became an uncommon generalization class for these children.⁸ Once this had taken place, the children could learn to apply the term 'toy' to the elements of *all* the classes by hearing utterances of the term while seeing elements of *some* of the classes.

Our analysis enables us to give a partial answer to the question regarding the experiences that transform a class of entities into an uncommon generalization class for an organism. One of the experiences that has this effect is exposure to the kind of pairing situations we have described here.

Some Results of the Herrnstein et al. Experiment

Let us now return to the Herrnstein *et al.* experiment. The interesting results of the experiment show that a response

which was reinforced in the presence of a picture of one part of an object transferred to pictures of other parts of the object, say, from the picture of the head of a woman to a picture of her legs. Concentrating on this example, the experiment shows that the class containing pictures of the head and of the legs of the same person had the status of a generalization class for the pigeons. This generalization is surprising because the absence of shared features that are salient for pigeons suggests that the class is not a normal generalization class for pigeons. Now, our conclusions make it possible to attribute this generalization to previous experiences undergone by the pigeons. Among the pictures that were presented to them were pictures of the complete person. That is, the pigeons had observed at least one pairing of the head with the complete person, and at least one pairing of the legs with this person. Hence, we have here a process in which elements of a normal generalization class *X* were paired with an object *a*, and elements of a normal generalization class *Y* were paired with an object *b*. Moreover, *a* and *b* belong to a normal generalization class *Z*: pictures of the complete person. As a consequence, the union of *X* and *Y* became an uncommon generalization class for the pigeons, which therefore explains their generalization from certain parts of the person to other parts.

According to this interpretation of the results of Herrnstein *et al.*'s experiment, a behavior that apparently derives from innate behavior mechanisms turns out to be learned. The behavior derives from specific experiences, just like the generalization from 'urn' to 'vase' (which clearly is not genetically determined). Since the pigeons of the experiment indeed had these experiences, the interpretation obtains a high degree of plausibility because it reduces the number of their inherited behavior mechanisms.⁹

⁸I am assuming here that "playing activities" constitutes a normal generalization class for humans. But if this is not the case, then perhaps the hypothesis of fn. 7 may account for the transformation of the union of the classes into a generalization class for the children (provided one can show that the class of playing activities is at least an uncommon generalization class for children who have engaged in such activities).

⁹Cf. Skinner (1953, p. 26): "... the doctrine of 'being born that way' has little to do with demonstrated facts. It is usually an appeal to ignorance."

The present interpretation is also directly confirmed by some other results obtained in the experiment. Herrnstein *et al.* report that three (out of four) pigeons also generalized from the pictures of the person to pictures of her child, and they mention that this child occasionally appeared with the mother in the positive stimuli. This result cannot be accounted for in their interpretation, which compels them to call it a misclassification (even though 75% of the subjects were involved). However, it can be explained easily in our interpretation. Since the child appeared together with his mother in some of the pictures, the pigeons had been exposed to the pairing of the child with the complete person, i.e. with elements of class *Z*. Therefore, the class of pictures of the child—say, the class *V*—also became a part of the uncommon generalization class that had become operative for the pigeons.

Innateness

Our analysis suggests the following conclusions regarding innateness. The disposition to generalize according to the normal generalization classes of a species is largely determined by genetic factors. Moreover, the capacity to acquire uncommon generalization classes by having experiences like those described above is also likely to be innate. However, the *particular* classes that have become uncommon generalization classes for certain members of a species have no genetic basis. They arise from the particular pairing situations to which the organisms are exposed like those that give origin to the uncommon generalization class containing utterances of 'urn' and 'vase.' Still, there is an innate factor even in uncommon generalization classes. Since these classes consist of the union of several normal generalization classes, and since the latter classes are strongly determined by genetic factors, uncommon generalization classes are partially determined by innate

predispositions. (This explains, for example, why *all* people who have learned English can generalize from utterances of 'urn' to utterances of 'vase,' in spite of the fact that the class containing these utterances is clearly not represented in their genes.)

These conclusions point to the possibility of using an alternative terminology for speaking about the two types of generalization classes. Instead of *normal* we might use the term *innate* generalization classes to stress their strong genetic basis. Instead of *uncommon* we might speak of *acquired* generalization classes in order to express the fact that the tendency to generalize in accordance with these classes is acquired as a consequence of certain experiences.

Generalization Classes Versus Concepts and Categories

Throughout this paper I have used the term *generalization class* rather than the more customary terms *concept* or *category*. I prefer this term for two reasons. Firstly, the term *generalization class* expresses in a very suggestive manner the basic data that are obtained in experiments on concept possession or concept formation. In paradigm experiments of this type, the organism is stimulated *m* times by *m* entities $a_1, \dots, a_m$ and responses are reinforced. The *m* entities can be instances of different stimuli, such as *m* pictures of different triangles, or instances of the same stimulus such as *m* utterances of 'urn.' (Since there may be minor differences between the different utterances of 'urn,' I prefer to consider them as different entities.) After the training period, it is then observed that the organism generalizes from these *m* entities to *n* entities $b_1, \dots, b_n$. For example, when being presented *n* pictures of different geometrical figures or *n* utterances of 'urn,' the organism responds without being reinforced. Hence, our basic datum is the class containing the $m + n$ entities $a_1, \dots$

. . . $a_m, b_1, \dots, b_n$. This class I then call *generalization class* because the name points to the generalization from the m reinforced to the n nonreinforced entities.

The second reason derives from the usual connotations of the term *concept* and *category*. Many psychologists conceive concepts or categories as having some kind of independent existence. Thus they speak of *the* concept "animal" or "dog" as if these concepts somehow exist in the mind of humans and perhaps of other organisms, too. Now, maybe concepts and categories indeed have such an independent existence, or, to use Quine's terminology (1970, p. 8), there exists perhaps a 'gallery of ideas.' However, with respect to experiments like those discussed here, this view is misleading, since the generalization classes—i.e. the concepts or categories—that are obtained are always *relative*, relative to original entities. Thus, the generalization class that originates in a black poodle who is sleeping will often be different from the one that originates in a white San Bernardo dog who is running, in spite of the fact that both animals fall under the concept "dog" (as well as under many other concepts, e.g. "quadruped," "mammal," "animal," "three dimensional object," etc.) Therefore, the use of terms such as *concept* and *category* (also to *classify*), which do not have relativistic connotations, may bring the psychologist to ignore the dependence of a particular generalizing behavior on the nature of the original entities. (This may be the reason why some of the treatments of so-called cognitivist psychologists are methodologically unsatisfactory.) This suggests the usefulness of adopting a terminology which clearly points to the fact that every generalizing behavior starts from original entities, and that generalization classes are relative to these entities.

Similarity and Salience

With the help of the notion of *generalization class* it is possible to clarify certain uses of our intuitive notion of

similarity. Thus, suppose that the child, who heard an utterance of 'giraffe' while paying attention to a giraffe, generalizes from this giraffe to the elements of class G . We might then say that for the child the elements of G are *similar* to the original giraffe.

This conclusion shows the circularity of my earlier statement that normal people generalize from one utterance of 'urn' to *similar* utterances of this term. It is the other way around. It is because normal people make this generalization that we conclude that the utterances are similar for them.

The notion of generalization class also stands behind one of our intuitive notions of salience. Thus, let us make the plausible assumption that most of the elements of G are (normal) giraffes; that is, animals with four legs, with a long neck, with a head, etc. We would then conclude that features such as the quadrupedness of the original giraffe, his long neck, his having a head, etc. were *salient* features for the child.

Moreover, from the fact that the generalization class was G rather than, say, the class containing pieces of dust, we obtain another conclusion about salience, namely, that when the child heard the utterance of the term 'giraffe,' the giraffe was for him a salient aspect of the stimulus situation, at least more salient than the dust of the giraffe's cage. I referred to this type of salience when saying that the child *paid attention to the giraffe*.

These conclusions point to the methodological primacy of the notion of generalization class. It is from the data about the generalization class that we conjecture hypotheses concerning the similarity and salience conditions that are operative in a particular generalization process.

Notice, finally, that by applying the distinction between normal and uncommon generalization classes to the notion of similarity we obtain two subnotions: normal similarity which is strongly deter-

mined by genetic factors and *uncommon* similarity which is only indirectly determined by such factors. I have investigated this topic in Stemmer (1971b, 1973, 1978c), where I used the terms *innate* and *acquired* similarity instead of *normal* and *uncommon* similarity. See also Quine's extensive treatment of the notion of similarity in his book (1973). With respect to the notion of salience the situation is somewhat different. The difference between the two types of generalization classes is not directly reflected in the conditions of salience. But I shall not enter into this here. The reader is referred to Quine's chapter on salience (1973, p. 24-27) in which he formulates a number of important conclusions about this topic, including some about the innate character of certain salience conditions.

Conclusions

A distinction has been made between normal and uncommon generalization classes. Whereas the former are strongly determined by genetic factors, the latter are to a great extent determined by specific experiences. A basic type of the experiences that enable organisms to acquire uncommon generalization classes—namely, exposure to certain kinds of pairing situations—was then discussed. The conclusions that were obtained suggest that at least some of the classes that are operative in the Herrnstein *et al.* experiment are uncommon generalization classes, which means that they are largely determined by specific experiences. Finally, arguments have been presented which suggest that a terminology that is based on the notion of *generalization class* has certain advantages over other terminologies.

Let me close with a word about the importance of a comprehensive investigation of the capacity to acquire uncommon generalization classes, which seems to have been neglected somewhat. I believe that such an investigation is indeed highly

important, because of the fundamental role played by such capacity in human life. Especially in language acquisition it performs a fundamental function. Not only is the learning of terms such as 'toy,' 'clothes,' or 'furniture' based on this capacity but, as I have argued in Stemmer (1971b, 1973, 1978c), it is very likely that it also underlies the creative use of language. It is this capacity which enables us to understand and to produce sentences we have never heard before.¹⁰ Hence, a systematic investigation of the capacity might enable us to give an adequate "behaviorist" account of language acquisition.

¹⁰In particular, this capacity appears to stand behind the psychological reality of syntactic categories such as the category of noun or of verb phrases. As has been shown by several scholars, such syntactic categories must be available for children in order to enable them to learn a generative grammar (see especially Chomsky, 1965). Now, in that syntactic categories are uncommon generalization classes. These classes become generalization classes for the children as a consequence of the experiences through which they go when learning the language of their community.

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