Evidence for the Role of Operant Reinforcement in the Acquisition and Maintenance of Linguistic Competence

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Abstract: *Linguistic competence is defined, following Chomsky, as the ability both to construct and construe novel combinations of familiar words and phrases which serve to depict situations the like of which neither speaker nor listener need have encountered in their own case. The view that linguistic competence in this sense is acquired and maintained according to the principle of selective operant reinforcement is defended, partly on grounds of evolutionary probability and the special nature of human environmental adaptation, and partly on the basis of two strands of empirical evidence: experimental evidence from studies of "verbal conditioning" and observational evidence of naturally-occurring verbal interactions in the work of discourse and conversation analysts. Although this form of selective operant reinforcement differs in a number of respects from that typically observed in the Skinner box, taken individually, there are precedents in animal learning for all the distinctive features of this form of learning. But if linguistic competence is acquired according to the same principles of selective operant reinforcement as apply in the case of animal learning, that principle by itself cannot explain why only humans have developed language and why apes can, at best, attain to the linguistic competence of a human two-year-old.*

Language is learned

Contrary to the opinion of Chomsky (1965), language, both the speaker's utterance and the listener's response, is learned behaviour. Linguistic competence, defined following Chomsky (1957 etc.) as the ability to construe and construct indefinitely many novel well-formed sentences in a particular natural language, is acquired and maintained by the same principle as that which applies in the case of animal learning and much of the learning in connectionist networks, the principle formulated by Thorndike (1911) as the "Law of Effect", by Skinner (1981/1984) as the principle of "Selection by Consequences" and by the connectionists (Rosenblatt 1959; Widrow & Hoff 1960; McClelland & Rumelhart 1988) as the "error-correcting or `delta' learning rule."

Why language must be learned

That language *must* be learned is evident from the following considerations:

(a) The pre-linguistic forms of communication analyzed by the ethologists (Tinbergen 1951) vary little within species, are demonstrably innate and permit learning only within narrow constraints, as illustrated by the phenomenon of `imprinting' (Lorenz 1935/1957).

(b) Whereas our nearest primate relatives, the anthropoid apes, are confined to a narrow ecological niche within the tropical rain forest, *homo sapiens*, and to a lesser but nevertheless significant extent, earlier hominid species have succeeded in colonising a variety of different habitats, not by developing physical characteristics adapted to those environments, but by devising and learning a new technology appropriate to that currently occupied. Moreover, if the Tower of Babel legend is to be believed, it is by learning to modify their language so as to talk about the new environment and the technology used to adapt to it that different natural languages have evolved from a single parent stock.

Why language must obey the law of effect

The following considerations show that if language is learned, it must be learned in accordance with the principles described by Thorndike, Skinner and the connectionists:

(i) The Law of Effect is an application of Darwin's principle of variation and natural selection to the process of learning. The only differences are that in this case the development is ontogenetic rather than phylogenetic, and that the units that survive or are eliminated are patterns of behaviour rather than individuals with certain inherited characteristics.

(ii) The Law of Effect is the only learning principle at the molar level of analysis that can effectively promote the survival and reproduction of the social group.

(iii) The introduction of a new set of learning principles to cope with the learning of language would be a biological extravagance, if there already exists, as there clearly does, a set of such principles tried and tested over millions of years of evolutionary history

Experimental evidence for the role of reinforcement in verbal behaviour

The proposition that linguistic competence is acquired and maintained by the Law of Effect is supported by two kinds of evidence: experimental evidence and evidence from the observation of naturally-occurring conversations and business transactions. The *experimental evidence* consists of a series of studies of what was then called "verbal conditioning" (Krasner 1958), published between 1954 and 1962 of which three stand out as both representative and evidentially persuasive.

The first and best known study is that of Greenspoon (1954; 1955). Greenspoon asked his subjects to say all the words that came into his or her head without repeating and without using sentences or phrases. He then selected a particular category of word, either plural nouns or non-plural nouns, for either reinforcement or disinforcement.[(1)] In two groups of subjects every time the subject produced a plural noun in one group or a non-plural noun in the other group the response was reinforced by the sound *Mmhmm*. In another two groups the same responses were disinforced by means of the sound *Uhuh*. In both cases there was a significant increase in the number of plural nouns or non-plural nouns in the groups in which these responses had been reinforced and a corresponding decrease in those categories of response in the groups in which the responses had been disinforced. Although it appeared from questioning after the completion of the experiment that 10 of the 75 subjects were able to verbalize the relation between the category of response and its reinforcing and disinforcing consequences as the case the case may be, the remaining 65 subjects were apparently unaware of this relationship and its effect on their behaviour.

Greenspoon's experiment can be criticised (Cf. Spielberger & Levin 1962) on the grounds that its artificiality is liable to prevent the consequences applied from having the effect that they do in the course of normal conversation, in particular, making the consequences much more salient than they are in normal conversation. This objection cannot be raised against Verplanck's (1955) experiment in which he persuaded a group of his students to engage an unsuspecting fellow student in one-to-one conversation for half an hour. After an initial "baseline" period of 10 minutes during which the number of opinions given by the subject was recorded, supposedly without any reinforcement being given, the experimenter was instructed during a further 10 minute period to make a point of agreeing with every opinion expressed by the subject. In a final 10 minute period, the experimenter was instructed to withdraw this reinforcement either by failing to respond to opinions expressed or, in some cases, by actively disagreeing with the opinion. In an alternative version of the same experiment some experimenters were asked to agree with the opinions expressed during the first ten minute period, withdraw reinforcement during the second ten minute phase and restore it during the final phase. In both cases there was a significant increase in the number of opinions expressed by the subject while the experimenter was agreeing with him; whereas during the non-reinforced phases, particularly after a preceding period of reinforcement, not only did the number of opinions expressed decline, but

"some *S*s got angry at *E* and commented on his disagreeableness, or noted his `lack of interest.'"

Apart from this,

"No *S* ever gave evidence that he was `aware' that his behavior was being deliberately manipulated and recorded, or that there was anything peculiar about the conversation." (Verplanck, 1955, p. 671).

The third piece of experimental evidence comes from a paper by Azrin, Holz, Ulrich & Goldiamond (1961) which records a series of attempts to repeat the Verplanck experiment. Of these I shall mention only the last in which the experimenters were trained animal behaviour researchers rather than undergraduate students, as in Verplanck's original study. With these experimenters

"Out of 12 attempts, not one of the four *E*'s could complete his experiment. It may be recalled that the procedure requires that the *E* restrict himself to agreement (or disagreement) of opinions, and stipulates no questions, statements, nods, smiles, or other types of interaction. The reason for forbidding such behavior proved to be obvious: *E*'s reaction, however subtle, could often be seen to exert profound but

uncontrolled effects upon the conversation of the subject. In the absence of any reaction by the four *E*s, however, all of the twelve *S*s terminated the conversation within 10 minutes by leaving the room where the conversation was taking place." (Azrin *et al.* 1961, p. 29)

This result is taken by the authors as casting doubt on the reliability and validity of the original Verplanck experiment. In fact what it shows is that you cannot maintain a conversation unless the speaker's verbal behaviour is reinforced in some way by the listener. It is clear from this that the student experimenters in the original Verplanck experiment and in the two earlier repetitions of it reported by Azrin *et al.* "instinctively knew this", i.e., they followed their deeply ingrained linguistic habit of invariably supplying such reinforcement in the form of head nods or what they took to be non-committal utterances, such as "I see", for the most part without being aware of so doing.

Observational evidence of reinforcement in naturally -occurring verbal interactions

The observational evidence for the role of reinforcement in verbal behaviour is to be found in the massive corpus of tape-recorded conversations that has been collected over the past 25 years both by social psychologists and linguists working in the field known as "discourse analysis" and by sociologists in the field known as "conversation analysis". What this corpus shows is that verbal reinforcement of the kind investigated in the three experimental studies I have described are to be found in every naturally-occurring verbal interaction between two people whether on the telephone or face-to-face. But, because of the disrepute into which behaviourism and its technical terminology have fallen over that period, they are not referred to as verbal reinforcers. Discourse analysts call them "back-channels". Conversation analysts call them "response tokens".

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Penny: it's just this bus'ness of (.) th' party [for the first y:e:ars. . . .01
. . . . . .^[ . . . . . ^
Rose: . . . . . [ye:(s) . . . . . yes= . 02
Penny: =I won't (.) be i:n tomorrow mo:rning. . . . . .03
. . . . . ^
Rose: . . . . . no= . . . . . .04
Penny: =I've left a notice on the board. . . . . 05
. . . . . .^
Rose: . . . . . .yeah.= . . . . . .06
Penny: =and there's a note for them °of the money. . . . . 07
. . . . . .^
Rose: . . . . . .who wants to pick it up?= . 08
. . . . . ^
Penny: =we:ll (.) the:'re on that li:[st. . . . . .09
. . . . . .[ .^
Rose: . . . . . .[oh the're °all on that list.= . . . . .10
. . . . . .^
Rose: = (.) and any-any of these people [can have i, (.) can they.= . . . . .11
. . . . . [ . . . . . ^ . . . . .^
Penny: . . . . . .[yes:: (.) . . . . . 12
Penny: =I do:: know John's girl friend knows about it.= . . . . . .13
. . . . . .^
Penny: =bu(t) she's not free at the same time as them tomorrow.= . . . . . 14
. . . . . ^
Penny: =so:th't lots of people know about it,= . . . . . 15
. . . . . ^
Rose: =anan the:'re goin(g) to get the shoppin(g) ou[t of it. (.) I see= . . 16
. . . . . .^ .[ . . . ^ . . . . .^
Penny: . . . . . .[yes (.) . . . . . 17
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Table 1 The Party 10/85

Table 1 (Place 1991; 1992; 1997a) is typical of this evidence. The upward pointing arrows show the points where a sentence is completed by the speaker. You will see that in almost every case, each sentence triggers a response from the listener. Most of these are reinforcers. `Yes' where the speaker's sentence is affirmative `No' where it is negative. On two occasions, on lines 8 and 11, the listener's response is a disinforcer in the form of a question requiring the previous speaker to either confirm the listener's interpretation or restate what has just been said.

Do verbal reinforcers reinforce?

Verbal reinforcers are of two kinds (Place 1997a) "*continuers*" whose function is to reassure the speaker that the sentence has been understood and accepted and thus allow her to move on to the next sentence and "*terminators*" whose surface effect is to close a speaker's turn and allow the listener to take over as speaker.[(2)] The implication of describing such events as `reinforcers' is that they have two kinds of effect. On the one hand a reinforcer may have an *intra-episodic* effect whereby the current on-going flow of the speaker's behaviour is maintained. In the reinforcement of verbal behaviour only continuers have this intra-episodic function; and the fact that they have it is clearly demonstrated both by the experimental and by the observational evidence I have cited. Much less easy to demonstrate is the *extra-episodic* effect of both continuers and terminaters, their effect in maintaining and enhancing the speaker's linguistic competence, her propensity to construct and utter sentences in the future which are relevantly similar to those that have been successful in the past, while avoiding constructions and usages that have proved unsuccessful. For the behaviourist the existence of such effects is an article of faith which is seldom questioned. For others, given the virtual impossibility of conducting a controlled experiment on the effect of systematically reinforcing incorrect usage and disinforcing correct usage, the evidence is at best circumstantial. The least circumstantial evidence relates to the initial acquisition of linguistic competence by the child rather than to its subsequent maintenance in the adult. It comes from Ernst Moerk's (1983) re-examination of Roger Brown's (1973) recordings of mother-child interaction in the early stages of language development on which Brown based his claim that children acquire the ability to construct grammatically well-formed sentences despite the fact that the mother never corrects grammatical mistakes. What Moerk's analysis shows is that although it is true that the mother in Brown's data more often supplies positive reinforcement in response to the child's utterances, there is a clear difference in her response between the cases where the utterance is grammatically correct and those where it is grammatically deviant. Not only is the positive reinforcement noticeably more enthusiastic in the former case; it is followed in the deviant cases by the mother's modelling of a corrected version of the child's utterance.

For what it is worth, my own hunch is that the child's verbal interactions with its peers are equally, if not more important than parent-child interactions in the acquisition and maintenance of the child's ability to construct intelligible sentences. The reason for thinking this is the observation that parents, particularly the kind of doting middle class mothers like the one whose behaviour is recorded by Brown, tend to be rather lenient in what they require of a child by way of grammatical structure before supplying reinforcement. Peers, though unconcerned with the niceties of correct literary speech, are much less tolerant than parents of syntactic and semantic deviations which, in the absence of the parent's intimate knowledge of her own child, render an utterance unintelligible to them. One wonders how far the prestige of Chomsky's (1965) nativist theory of the acquisition of linguistic competence may not be due to the delusion on the part of such parents that *they* are the sole source of their child's verbal education. Given this delusion, when a child produces a sentence structure which they know they have never taught the child to produce, it is hardly surprising that this is seen as evidence of the unfolding of an innate syntactic ability.

For the extra-episodic effect of reinforcement and error-correction on the maintenance of the linguistic competence of adults there is circumstantial evidence in the shape of the existence within every verbal community of social conventions backed up by speaker's anger and a serious threat of social ostracism, if they are not observed, whose function is to ensure that every intelligible utterance by the speaker is suitably reinforced, and that where a disinforcing interjection is required, its effect in provoking the speaker's anger is minimised, as in the phenomenon known to conversation analysts as `preference organisation'. If these conventions applied only to the delivery of the continuers that maintain on-going verbal interactions, it would be possible to argue that their function was confined to maintaining verbal interactions for as long as it is in the interests of both parties that they should do so. But that would not explain why the conventions are equally insistent on the supply of terminating reinforcers at the end of a speaker's turn. That only makes sense as an encouragement to the speaker to repeat similar utterances on relevantly similar occasions in the future.

Another convention which only makes sense on the assumption that appropriate reinforcement is essential to the maintenance of linguistic communication within the verbal community is the curious practice which Harry Stopes-Rowe (personal communication) has described as "mutual verbal grooming" in which slight acquaintances greet one another by exchanging remarks about the weather which go no further than what is already patently obvious to both. This practice, I submit, makes sense only on the assumption that its function is to reassure both parties that their ability to construct and construe mutually intelligible sentences describing the current situation is intact and is thus available, should it be needed, for

some more serious purpose later. Were that ability guaranteed by an innate language faculty, such reassurance would not be necessary.

The peculiarities of verbal reinforcement

But while there is good evidence that the acquisition and maintenance of linguistic competence obeys the Law of Effect, the learning situation involved is very different from that encountered in the Skinner box. Four differences stand out:

(i) In the Skinner box the behavioural unit that secures the reinforcement, the key-peck or bar-press, is the same unit that is subsequently repeated. In verbal behaviour the unit that secures reinforcement is the utterance of a complete sentence. But sentences, as Chomsky has often reminded us, are seldom repeated word for word. They are typically constructed anew on each occasion of utterance. The units that *are* repeated, the words, phrases and sentence frames, secure reinforcement only as part of an uttered sentence.

(ii) Whereas the Skinner box provides a *win-stay/fail-shift* contingency, at the level of sentence construction, verbal behaviour is on a *win-shift/fail-stay* contingency (Place 1997a; 1997b). When your sentence succeeds as evidenced by the listener's response, you do not repeat yourself; you go on to the next sentence. You repeat yourself only when the first attempt fails, usually saying the same thing in slightly different words.

(iv) The delivery of food which reinforces responding in the Skinner box strengthens the organism's propensity to emit *any* behaviour which regularly precedes it. Verbal reinforcers are specific to a particular class of behaviours and act as reinforcers only with respect to behaviour of that kind. Thus opinion-stating is reinforced by an expression of agreement, instruction-giving by an expression of comprehension, news-telling by an expression of interest or surprise, troubles-talk (Jefferson 1988) by an expression of sympathy, and joke-telling by laughter.

(iii) Whereas the delivery of a food pellet is an extremely salient stimulus event which cannot fail to occupy the focus of the organism's attention, the speaker is almost totally oblivious of the delivery of the reinforcers supplied by the listener, as is the listener of supplying them. As Verplanck remarks, they attract attention only when they are omitted on an occasion when their delivery is to be expected.

The peculiarities of verbal reinforcement are not unique

Despite these differences there is nothing in the way verbal behaviour is reinforced which does not have its parallels in the operant or instrumental reinforcement of animal behaviour. The dissociation between the response that secures reinforcement and the behaviour that is strengthened as a result has its counterpart in the reinforcement of any non-stereotyped skilled performance. Win-shift/fail-stay contingencies have their counterparts in the foraging behaviour of animals from which the concept derives. The restriction of the reinforcement of particular varieties of verbal behaviour to a particular reinforcer has its counterpart in the secondary reinforcers whose appearance allows the animal to move on to the next component in a behavioural chain (Gollub 1977). The analogy with the reinforcement of verbal behaviour is particularly close in the case of a chain in which two organisms are required to respond in alternation in order to obtain the primary reinforcer at the end of the chain. Note also that secondary reinforcement within a behavioural chain is another case of a win-shift/fail-stay contingency. Finally the reinforcement of behaviour in the absence of awareness of the reinforcer almost certainly has a counterpart in the reinforcement of behaviour by electrical stimulation of the hypothalamus (Olds & Milner 1954), a form of stimulation which we can be tolerably certain from what we know about the effect of stimulating other sub-cortical structures, produces no awareness of the stimulus in human subjects. One may surmise that such stimulation will be accompanied by a vague glow of satisfaction. But so, in my experience, is a well reinforced conversational turn, even though the reinforcers themselves are barely noticed. While it is difficult to be sure that what humans are and are not conscious of corresponds to what animals are and are not conscious of, the recent work of Cowey and Stoerig (1995) showing that monkeys with unilateral lesions of the striate cortex can learn to reach for objects they cannot "see", in exactly the same way that human blindsighted patients can, makes such inferences much more plausible than they used to be.

Operant learning cannot explain the evolution of language

But if the learning process involved in language acquisition is in principle no different from that which we observe in animal learning, it follows that we cannot appeal to the principles of learning in order to explain why it is that only human beings have developed language and why, although apes, can be trained to communicate by means of linguistic symbols, even the most intelligent and symbolically sophisticated cannot progress beyond the linguistic competence of a two-year-old human child. Nor, by itself, is the mutation or set of mutations which have changed the conformation of the human mouth and larynx so as to permit vocal speech sufficient to explain the phenomenon. For the congenitally deaf can learn to communicate in a distinctively linguistic way, even without being taught an official sign-language (Goldin-Meadow & Mylander 1984; 1990). Something has happened to the human brain associated with the development of such structures as the angular gyrus, Wernicke's and Broca's area in the dominant hemisphere of the cerebral cortex which have made it very much easier for human beings to learn the kind of associations and generalisations involved in language than it is for any animal species.

Conclusion: towards a plausible theory of language evolution

Chomsky (1965) asks us to believe that language evolved fully grown with all its syntactic complexity in a single gigantic mutation. Like many others, I find this view frankly incredible. The ability to learn those special associations that are peculiar to language must have evolved along with the development of the human vocal apparatus in a sequence of steps or stages. At each stage a mutation must have occurred which was passed on to the descendants of those in whom it occurred by virtue of its utility in securing the survival and reproduction of the social group and groups constituted by those descendants. But, conceding a role for mutations and the innate learning capacities with which they endow the organism should not be seen as in any way diminishing the importance of learning in the acquisition and maintenance of linguistic competence. On the contrary, what has been acquired in the course of the evolution of our species is the ability to learn the skills of constructing and construing intelligible sentences in whatever natural language or technical code currently prevails within the verbal community of which by virtue of possessing those skills the individual is a member.

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Notes

1. For the use of this term see Harzem & Miles 1978.

2. As a boy, my father, so he used to tell me, had the curious nickname `Ayemanayebygo'. This was a reflection of his invariable practice in those days (c. 1885) of responding to information supplied by another boy with the two continuers *Aye man!* and *Aye!* followed by the terminator *By Go!* (a euphemistic curtailment of *By God!* used as an expression of surprise).