pations and retentions belonging to the moment of responding are different than after the reinforcement has had its effect. Before reinforcement, the retentions and anticipations of that momentary response may be indefinite or may be irrelevant to the experimenters purposes. At any rate, what is to become a reinforcer at first is not a salient anticipation or expectation belonging to the response (or the time of the response). Later, however, after the reinforcement has "taken hold", when the reinforced response is present, its horizon of retentions and anticipations is changed. Now, the retentions might be that the response just made was followed by a reinforcement. In making this response the anticipation is that the retained relation will continue; thus, the anticipation is that reinforcement will follow. None of this involves specific intentional acts of anticipation and retention; these are matters of operative intentionality (they occur because of the structure of temporality). To engage in specific acts (act intentionality), the learner would have to recall or expect something.

This temporal structure allows one to see how it is possible for a reinforcement to influence a response even though it occurs after the physical or objective presence of that response. That is, though no longer physically present, the response is retained in the momentary present of the occurring reinforcement and thus can be retroactively influenced by that reinforcement; at the same time, present anticipations become more delimited. In other words, the significance of the retentions and anticipations of the retained response is changed by the occurrence of the reinforcement in a way analogous to the manner in which words read at the beginning of a sentence change their meaning when words later in the sentence are read (and all of this delimits the anticipated meaning of the not yet but soon to be read part of the sentence). Everything being described here occurs in a momentary present. Because they are phases of the momentary present, the retentions and anticipations described are not intentional acts and are no more mentalistic than is the "now" of a momentary present.

Without going into detail, extinction is a matter of the "new" anticipations becoming unfulfilled until yet another synthesis occurs where the connection between the response and reinforcement may be retained (remembered) as "what used to be but is no longer the case". The upshot is that within the momentary

present, the retentions (recollections) and anticipations (expectations) will change so the connection between the response and the reinforcement will become ambiguous or be nullified.

As already mentioned, the Premack principle is where a more preferred behaviour is used to "reinforce" a less preferred one. Interestingly, most educational psychologists view the Premack principle as an obvious application of the principles of operant learning which, as we have seen, it is not. They find no difficulty in the fact *that the contingencies for* ("If you do X") *and the indication* of the occurrence of reinforcement ("you will be able to do Y") are explicitly provided to the learner *before* any responses have been emitted. This provides the learner beforehand with an expected future (consequence) which will be anticipated at the moment of engaging in the action defined as the contingency for that "reinforcement" to occur. The arrangement strips any doubt from the fact that expectations and anticipations are functioning full force. In other words, this arrangement assumes (requires) that the learner "will do X to obtain Y", or, at least, "will do X with the expectation that Y will follow".

An important point to stress now is that even though the Premack principle erroneously is considered by many to be an example of operant learning, it does share with operant learning, in the true sense of the concept, the same temporal structure described above.

The above analyses lead to the conclusion that, stripped to its core, operant learning is a matter of arranging a relationship between a desired (by the experimenter) response and a valued (by the learner) occurrence such that the valued occurrence becomes a salient part of the horizon of anticipations/expectations of that response. It is precisely these anticipations/expectations which are changed (learned) in operant learning. The changed frequency of responding is symptomatic of this change, but it is *not* what has been learned.

5.4 An evaluation of the "theory" of operant learning.

Even though the temporal structure essentially is the same for both, the "pure" form of operant conditioning (wait for a desired response to occur, then reinforce it) assumes that the learner merely is a responding being whereas the contingency manage-

ment approaches (e.g., token economies, the Premack principle) often recommended as applications of operant conditioning, assume, at least tacitly, that the learner is an anticipating, choosing being. This fundamental difference seems to go unnoticed by most educational psychologists.

If one accepts the first assumption, one must remain strictly within the circular definition of learning and reinforcement provided by Skinner, otherwise one is confronted with a multiplicity of questions which are unanswerable from a Skinnerian perspective (e.g., how does a reinforcer work, how can a response, no longer physically present, be reinforced so that the probability is increased that it will occur in the future?). Indeed, it is for good reason that questions such as these are not asked and seem in no need of being asked from the perspective of operant learning. That is, in accepting the circular definition as unproblematic, one does not have to worry about such questions or about "intentions", "anticipations", "meaning", etc. because, *by definition*, it is the consequences (reinforcement) of the response that "strengthen" or make the response more likely to occur. How or why this occurs is said to be of no "practical" concern (and it isn't). Therefore, all one needs to do, in a practical sense, is to find consequences that strengthen the desired responses. Those consequences (reinforcers) are the cause of the resulting change in behaviour and that is all one needs to know.

Unfortunately, logically and phenomenologically, this circularity is problematic as far as the model of operant learning being able to offer an intelligible theoretical account or understanding of the nature of operant learning in particular and of learning in general. Among other things, this circularity interferes with one obtaining a clear grasp of *what* is being learned and of whether it even is an account of learning of any kind, operant or otherwise. The issue of what is being learned already has been addressed briefly. What about the issue of learning as such? Here we can refer to psychopedagogics.

5.5 Psychopedagogics and operant learning

What does Skinner's model of learning have to say about what learning as such is? What are the modes actualized by persons when they learn? Apparently, these questions are of little or no

importance to Skinner and his followers. The model of operant conditioning leaves such questions unexamined.

When a situation of operant learning is structured (e.g., by a teacher) such that the relationship "if I do X, Y will occur" is discoverable (i.e., if a response is reinforced), the model simply assumes that sensing, attending, perceiving, remembering, etc. are occurring but that they need not be studied as such (as behaviours, they are open to a behavioural analysis which investigates the contingencies under which they *occur*, but it does not investigate what they *are*). The issue of overriding importance is the consequence of a response, whether or not perceiving, remembering, etc. are implicated. But these categories of learning, the modes of learning to be considered in Chapter 3, are precisely what psychopedagogics focuses on because it is only by actualizing these modes that any kind of learning whatever (e.g., signal, operant) can occur. Clearly, operant conditioning is not an acceptable model of learning as such. As will be emphasized below, it is an effective way of influencing learning under limited circumstances.

What does operant conditioning have to offer pedagogics, in general, and psychopedagogics, in particular, especially if it is not an accountable view of learning? It provides a paradigm or model for arranging circumstances to facilitate the *learning of* a relationship between a response and a consequence. In other words, as does Pavlov's, Skinner's model provides a method for teaching a very limited though sometimes important *content*. The operant learning approach offers a wealth of information regarding contingencies influencing learning but virtually no insight into what learning is. For example, a popular topic of research in the area of operant learning is how various schedules of reinforcement (ratio, random, etc.) influence changes in the rate of responding; this refers to conditions for *influencing some* (not all) learning.

The important point here is that the model of operant learning provides a didactic or teaching model of very limited scope. It is not an account of how someone learns, per se. It *is* an account of how learning sometimes can be influenced in certain ways.

5.6 Conclusions regarding prospective teachers

Why should a teacher be familiar with operant learning? The

answer is the same as was given for signal learning. Operant conditioning provides a model by which certain behavioural consequences can be learned, and of variables influencing this learning. It does *not* provide a fundamental model of what learning as such is.

In applying the model of operant learning to educational situations for pedagogic purposes, one must be extremely cautious. This model (any model) must be evaluated in terms of pedagogic criteria. Although this topic cannot be pursued here, it should be noted that the application of the Premack principle illustrated earlier is an example completely devoid of any pedagogic considerations. The overriding, if not exclusive, question in that example is "what can be done to restore order to the class?" Of course, there is nothing wrong with this question itself. The problem is that there is no consideration of how the use of the Premack principle contributes to the child's becoming an adult, to the clear and consistent exemplification of norms and values, etc.

The model of operant conditioning should be familiar to teachers for what it essentially is. It should not be presented under the pretense or promise that it provides a fundamental insight into the nature of learning. For example, in planning a lesson, the modes of learning (e.g., perceiving, thinking) must be taken into account but, in this context, the model of operant learning seldom if ever will be relevant.

6. INFORMATION PROCESSING

The model of how learning occurs

This model begins with "the assumption that the human mind and the computer *function* similarly" (Rosser and Nicholson, 1984). The aim of this model is to account for how content to be learned (information) enters the information processing system and how that input is transformed (processed) into a form storable in and retrievable from long-term memory. The model makes use of the following key terms regarding information storage, viewed as structures analogous to the hardware of a computer: *a sensory register, short-term memory,* and *long-term memory.* These types of storage differ in terms of the nature and extent of processing of the information that has taken place. Processing refers to activities such as attending, rehearsing, elaborating, organising, integrating, analysing and the like. Such processes are seen as analogous to computer software, the "programs used to manage the information" (Rosser and Nicholson, 1984). This model of learning essentially is a model of human memory. It is a model of learning in the sense that learning occurs by means of the processing of information such that it becomes stored in and retrievable from long-term memory.

Stimuli from the environment activate our *sensory apparatus* or *receptors.* According to Gagné (1985), this activation transforms the stimuli into neural information. This neural information enters the *sensory register* where it persists in more or less complete form, usually for less than a second. Not only is decay of the information rapid, but the capacity of the sensory store is extremely limited. Only what is *attended* to in the sensory store persists longer, the remainder dies away and has no further effect on the nervous system.

Again, according to Gagné (1985), by means of selective perception, the information recorded in the sensory register is transformed into patterns of stimulation. "Selective perception depends upon the learner's ability to attend to certain features of the contents of the sensory register while ignoring others." The selective perception of features (e.g., invariances such as edges, textures, slants, and three-dimensional objects) "forms a new kind of input to the short-term memory."

Attending is the first process to occur and it moves the information to *short-term memory.* Some authors (e.g., Lindgren and Suter, 1985) recognise two types of attending. The first type is called an *orienting response* and is said to occur when some information in the sensory register catches one's attention. A sudden, loud noise, an unexpected or novel stimulus can initiate this response. If this information (stimulus) is considered to be relevant (by one's *executive control),* a second type of attending will be initiated in that the information will be attended to in the sense of examined. This attending enters the information into short-term memory. The process of learning begins at this point.

Before continuing, it should be mentioned that one's executive control is "the decision-making center that supervises the entire information-processing operation" (Lindgren and Suter, 1985). The survival of information stored briefly in the sensory register

"depends on whether executive control can give it meaning and consider it worthy of further attention. The meaning of a bit of information is determined by its relationship to our past experiences with it or similar stimuli and other stimuli with which it occurs" (Lindgren and Suter, 1985). And, with respect to executive control, Klausmeier (1985) describes two aspects which parallel the function of a computer program and its external source of electrical energy. As he says, "the executive control of the human being necessarily includes the activating process as well as the control process. Accordingly, there are two aspects of the internal, or executive, control of our own learning. One is the control of motivation, and the other is the control of the information flow and the related mental operations."

Continuing with the flow of information, now that the information has moved into short-term memory, it is stored in two forms: "(1) an acoustic form in which the information is internally heard by the learners, and (2) an articulatory form, in which the learners 'hear themselves saying' the information" (Gagné, 1985). Visual images also may be a way in which information is stored in short-term memory. Although information which enters short-term memory may be stored there for a longer period of time than in the sensory register without any processing, it can be held there even longer if it is rehearsed.

Two forms of rehearsal have been identified. Maintenance rehearsal is rote repetition of the content with the aim of maintaining the information intact. The second form is elaborative rehearsal or encoding, such as relating the series of numbers 1-6-5-2 to the year (1652) Van Riebeeck landed at Table Bay. Elaboration not only helps maintain the information in short-term memory, it facilitates entering that information into long-term memory (and later retrieving it from there). This is because elaboration requires that the present information be related to information already in long-term storage.

Elaboration also can increase the limited capacity (5 to 9 items) of short-term memory. In the above example of the series of numbers, if one simply tries to retain the four units as given (e.g., by maintenance rehearsal), one quickly approaches the limits of this store; however, if these four numbers are "chunked" or coded into one year, there is "room" in the store for four to eight additional units ("chunks") as well.

After attention has played its role of selectively attending to some of the information in the sensory register, all conscious processing occurs when short-term memory functions as *working memory*. Working memory is where one rehearses, elaborates, organises, and integrates what is received in short-term memory from the sensory register and what is retrieved from long-term memory.

Klausmeier (1985) states that "we *rehearse* the last items we have read. We *organise* by connecting two or more items of the new material before relating them to what is already known. We *elaborate* by relating new information to what we already know." And further on he says, "We *integrate* by combining items into a more complete knowledge structure." Klausmeier goes on to say that "from a strictly information-processing point of view, these are the only processes necessary for explaining initial learning". This processing in working memory is referred to as encoding, and this encoded material initially learned is stored in long-term memory. In basic agreement with Klausmeier, Lefrancois (1985) says "processing refers to activities such as organizing, analysing, synthesizing, rehearsing, and so on." Lindgren and Suter (1985) add that long-term memory "is the repository for information that has been filtered through the attention mechanism, the sensory apparatus, the sensory register, and short-term memory".

Long-term memory differs from short-term memory both in the duration and the capacity of storage. Whether the storage of information in long-term memory is permanent or not, in a practical sense, duration of storage is not a problem. What is more, its capacity appears to be unlimited. As far as the learner is concerned, the basic problem with long-term memory is the search for and retrieval of (called accessing) the information stored there. A metaphor commonly used for long-term memory is a large library were the storage of books is not a problem. The problem is retrieving a book when needed. The book may be there (as may the information in long-term memory) but if not accessible, retrievable, it cannot be made available for use. Strategies of learning (teaching) that facilitate the retrieval or accessing of stored information will be considered in the next section.

When information is retrieved from long-term memory, it is available for use. As Rosser and Nicholson (1984) say, "retrieval