# THE PSYCHOLOGY OF SKILL ACQUISITION

R. H. SHARP, B.Sc., M.A., D.L.C.

*Department of Physical Education, University of Leeds*

*The title of this paper includes such a large body of knowledge that an attempt to describe every detail in a single paper would be both a pretentious and fruitless exercise. Instead, I shall describe briefly how the psychology of skill acquisition is viewed in terms of a general conceptual framework and secondly, how such a model can be of use in considering some aspects of the learning process.*

The study of psychology in general is a multi-dimensional discipline and has been defined as 'the science of animal and human behaviour'. In this respect, psychology is more concerned with functions of the body as they affect the behaviour of the *whole* person rather than as separate from the total behaviour. The psychology of skill acquisition then is the field of knowledge concerned with the scientific study of skilled performance and learning of the whole individual. Such behaviour need not necessarily take place in the gymnasium or on the field of sport but in any situation where man meets the environment with skill and precision, e.g., in industry or outer space. The assumption is that the same principles or 'laws' underlie skilled performance regardless of the setting in which the individual performs.

This brings us to the definition of skill. The psychological definition is not quite the same as that used, for example, in industry, where the skilled – unskilled continuum is generally fixed by the amount of time necessary to learn a job. A more stringent definition than this is adopted, e.g.:

> . . a complex, intentional action involving a whole chain of sensory, central and motor mechanisms which through the process of learning have come to be organised and co-ordinated in such a way as to achieve predetermined objectives with maximum certainty.
>
> (Morris & Whiting, 1971).

Skill is thus, (a) intentional, i.e. goal directed, (b) learned, (c) organised and co-ordinated, and (d) not just the simple connection of responses to stimuli, but involving central integration. This latter point is reflected in the term which is now frequently used to define most skills whether previously termed 'motor', 'physical' or 'mental' skills, etc., and that is the term *perceptual-motor skill* – which emphasises the important relation that exists between the stimulus and subsequent response.

One of these criteria which bears importance not only to the way we study skilled performance but also the way we would go about structuring teaching or coaching situations is that it is organised and co-ordinated. Skills have both *hierarchical* and *sequential* organisation. By hierarchical we mean that several small components of a skill can be grouped under a larger component part, and in turn several larger components may be grouped under yet a larger one still – until the whole skill is described. For example, several major components of the rugby pass might be the fall-away, hand position, backswing, forward swing, etc., each of which could be broken down into several smaller units such as grasping, twisting, pushing, etc. By sequential organisation we mean the way in which component parts fit together in time. Usually it is necessary that component parts be completed in some relatively restricted course for efficient performance, e.g., the backswing precedes the forward swing which precedes the release. In this way the execution of skills has been likened to the running of a computer programme, in which the programme is the whole skill and the sub-routines which make up the programme, the component parts of the skill.

This somewhat artificial, but heuristic way of viewing human behaviour is similar to the model I now wish to describe. This approach has its foundations in the war-time period when there developed a vast array of new man-machine systems for military purposes. It became evident that when such systems broke down the fault lay mainly in the human operator. There thus developed a need to understand the many facets of human capacity and performance in situations where man interacted with his environment. Since that time a conceptual framework has grown within which man is viewed as a processor of information with limited capacity. In this way he has been likened to a communication system – rather like the G.P.O. telephone system, for example, in which information is received, transmitted and finally emitted. Figure 1 illustrates the physical components of this model.

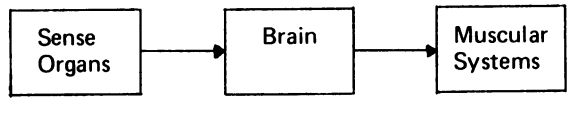
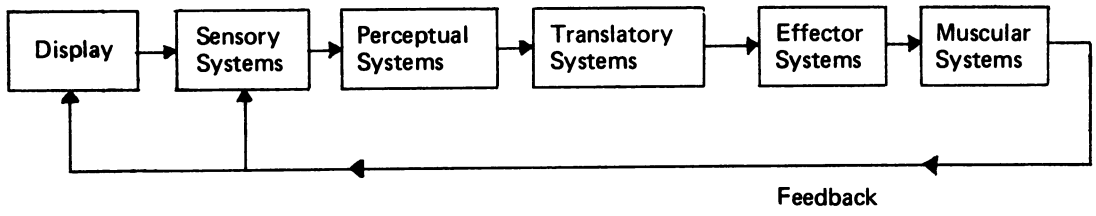



*Fig. 1.*

This diagram illustrates the link between the sense organs which give rise to the reception or input of information, the brain which transmits and acts upon or makes decisions about that information and the muscular system which emits information, or effects actions on the basis of those decisions. This simple model can be elaborated one stage further so that at a functional level we have Fig. 2.




In this model, information from the display (the external environment) e.g., visual and auditory information, and/or information from the internal environment (proprioceptors in the muscles, tendons and joints) is transduced by the sensory systems and a neural message sent to the perceptual systems. Here, the information is compared with stored memories of past experience leading to an interpretation or description of the display. On the basis of this 'perception' the translation systems decide upon an appropriate course of action. If a response is to be made then a sequence of commands are sent to the effector systems which organises the response pattern and an executive command sent to the muscular systems to effect that response. The carrying out of an effector action then gives rise to feedback information about the adequacy of the response, which together with new information in the display can be monitored by the sensory systems to control further behaviour (this model is elaborated by Whiting, 1969).

This brief outline provides a very simplified view of skilled performance but has several points to commend it. Firstly, by abstracting the common procedures from among the multitudinous acts of behaviour it allows one to view such a complex system as the human body in an organised and systematic way. Secondly, not only does it allow focusing on the major underlying systems involved in skilled performance such as perception, decision making etc., but also possible causes for its breakdown. For example, let us consider a skill which in order to be performed successfully requires using information from the display. In the first case, performance may be below standard because the learner or performer fails to take out the correct information from the display. This may arise because he does not know what information to use or because he has not the sensory acuity to deal with the correct information. Secondly, the performer may focus his attention on the right kinds of information but put a wrong interpretation on it, e.g., when being 'sold' a dummy. This might be a problem of relating new situations to past ones — possibly through inexperience, or insufficient time to recognise the situation. Thirdly, the performer may select the right information and interpret it correctly but fail to translate his perception into the appropriate response. Once again this could be due to inexperience or insufficient decision time. Fourthly, the correct plan of action might have been chosen but incorrectly organised by the effector systems. Thus, for example, the player might have timed his catch late or kicked with the wrong amount of effort. Lastly, the whole course of information processing might have been adequate but the muscular system unable to effect the intended response pattern because it was fatigued or injured or below fitness.

These situations might not of course always appear in a clear cut way, and any failure may be due to several inadequacies. However, an analysis in these terms may lead the teacher or coach or player to ask further questions in attempting to find reasons for performance breakdown.

In attempting to understand skill learning in terms of the model described above it is important to appreciate that there is a maximum limit to the amount of information a person can process in a given time. We say that man has a *limited channel capacity,* which is reached when increasing the amount of information input does not lead to further increases in the amount transmitted. This is reflected for example in the well known inverted — 'U' relation between stress and performance. In the early stages of learning the individual's processing capacity is constantly being put to the test. In a ball game situation for example, the learner has to contend with information in the form of ball flight, on-rushing opponents, possible moves after ball acquisition crowd noise and possibly even a plane passing overhead. Most of this information will be irrelevant whilst some of it will be important and so one of his tasks will be to somehow discard the irrelevant information and concentrate only on the important cues. One way he can do this is to *selectively attend* to the important information. This is learned ability and is possible because of a 'filter' mechanism somewhere in

the central nervous system which can block unattended information. The situation is similar to a crowded room where above all other conversations only one has to be concentrated on.

In order to minimise the amount of information processed then, which is especially critical in time-stressed situations, the learner must acquire an ability to selectively attend to the right sorts of information. At the same time of course he must learn to ignore the irrelevant information. This is where the teacher or coach can play a fundamental role; by informing the learner what is, and what is not important information in the display. It presupposes that he knows what are the important perceptual cues and this knowledge is probably gained only by being thoroughly conversant with the skill. It is also important to realise that different cues may be important depending on the stage of skill acquisition. One generalisation from the literature is that in many skills, as learning progresses there is a decreased reliance on visual cues in favour of internal, kinesthetic cues. This is observed in basketball for example where in the early stages visual attention is directed mainly to the ball. Whilst this kind of attentional behaviour is obviously wrong in terms of efficient performance it may be a necessary stage of learning. If it is, then the instructor should take care in extrapolating from what the expert is known to do, to what the beginner ought to do.

Another limitation of early learning will be an inability to perform not only correct movement patterns but correct movement patterns in response to particular environmental situations. This is because there is so much uncertainty about the appropriate response. Early learning is consequently a period when there is much *stimulus uncertainty* and *response uncertainty,* and it is not surprising therefore that with such a high processing load many gross errors are made.

As practice continues the learner's knowledge of important cues increases as does his ability to sequence component parts of the skill correctly. The amount of unnecessary information processed thus diminishes and selected responses are more appropriate to the stimulus situation. The learner can thus apportion more processing capacity to dealing with stimuli and responses in the future, i.e., adopt anticipatory behaviour. Such behaviour is highly beneficial but is only possible because of the *regularity* within the environment. Many aspects of the environment convey little information which will be useful in controlling skilled behaviour because they tell the performer something he already knows. Examples of such regularities or *constants* are, ball-flight, shape of pitch, team organisation etc. Thus, for example, the individual who through exposure to many similar situations has learned the predictable nature of ball-flight does not have to monitor continually the flight of a ball about to be caught because once the initial characteristics of the ball's flight have been recognised, the remaining flight is redundant. He does not therefore need to react to every bit of information, he only has to 'abstract the constants' and on this basis predict future states. Prediction is thus an important feature of skilled performance. In fact it is a necessary prerequisite for otherwise if the performer only acted upon immediate information, because of reaction time limitations his behaviour would be very erratic and inefficient. Thus if the ball catcher decided to close his hand upon ball contact, his grasp would always be one reaction time too late. Anticipatory behaviour also allows the performer to deal with immediate uncertainty in the display during the prediction interval. For example, the full-back awaiting a descending ball might make a rough estimate of its velocity, then effect a brief appraisal of the on-rushing opposition before directing his vision back to the ball. It is this kind of behaviour which leads to the smoothness and timing which is so characteristic of highly skilled performance.

Prediction then, can greatly reduce the amount of information which has to be processed, and, as a result, the more predictable a given situation then the easier it is for the performer to meet the demands of that situation. It is in the interests of the opposition then to make that situation as unpredictable as possible. This could be done by developing within the game many strategies, adopting unfamiliar tactics or making particular plays very similar to others with the object of 'fooling' the opposition. Feinting and dummying are instances where uncertainty is created in apparently predictable situations. Such moves, where the opposition is 'caught on the wrong foot' has further disadvantages than just creating uncertainty. This is because having made an incorrect movement it takes longer than a simple reaction time to correct that movement. This follows because it takes the translatory systems time to 'clear' before they can deal with another stimulus. We say that the individual is caught in a *refractory* state.

As the performer acquires competency in the skill his ability to predict future moves by the opposition will have increased and he will be able to anticipate not only immediate plays but whole patterns of plays and their possible outcomes. This ability coupled with his ability to selectively attend to only the important cues in the display ensures that the display is now one in which there is very little uncertainty. The player thus appears to be operating at an almost automatic level, and, as the saying goes, has 'all the time in the world'.

In summary then, I have briefly described how the human being can be viewed as a processor of information and how skill acquisition can be thought of as the gradual reduction of uncertainty. Whilst I have

dwelt on certain topics more than others, e.g., selective attention, anticipatory behaviour, this does not reflect their importance over and above others such as motivation, stress etc. It was necessary however in order to keep the paper down to manageable proportions.

Although this approach does not present any new information it might allow the teacher or coach to view skill acquisition in a slightly different perspective, and possible to consider problems of skill acquisition in a way which was not available before.

## REFERENCE

1. MORRIS, P. and WHITING, H. T. A. (1971) *Motor Impairment and Compensatory Education.* London: Bell.

2. WHITING, H. T. A. (1969) *Acquiring Ball Skill*. London: Bell.