

DRAFT ONE OF PAPER TWO (Completed to this stage 12.6.87)

PAPER TWO

LEARNING, REINFORCEMENT, MOTIVATION AND CONTROL

in the Generation of New Experience in Child Development
and some of their consequences for the adult

by

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A Personal Note

My attempt to describe the essential constituents of early human learning and development, as a dynamic and inevitable pattern of growth, began in about 1960 as a resolve to learn something about the development of young children by direct observation.

Although I was aware of the existence of a literature on this topic, and had read a little of it, I decided to make my own observations first, then reflect on them and only much later to read what other people had said.*

After several years of casual but careful looking at children in public and private places, on buses and trains, in parks and waiting rooms, nursery and infant schools and the houses of friends, I was able to work with two hundred or so backward and 'brain damaged' children in whom variations on the more usual patterns of development could be studied during my everyday work as a doctor.

In this way, by observing normal and anomalous behaviour, and by speculating on possible learning and behavioural growth mechanisms, I inevitably began to build and test hypotheses.

It is, of course, more usual to approach a subject by first critically studying the work of others; however, there are advantages to be gained, especially when one's concern is with the origins of understanding, in collecting and collating first-hand information.

In due course I hope that my ideas will be compared and contrasted, by myself or others, with those of workers such as Gesell and Piaget.

These ideas have been developed in association with the practical teaching of normally and abnormally developing children. The initial ideas immediately suggested how the growth of understanding might be actively encouraged and the early experiments soon gave rise to an approach to teaching differing considerably from current practices.

Almost inevitably, or so it seems, the focus of my professional interest moved from the neurological problems of children to the educational needs of such children, and then further to those of *all* children and young people.

* My rationale for this course of action, which remains reflected in my assessments of children's abilities and difficulties of adaptation, will be discussed in the fifth essay 'General Understanding and Conventional Language', as will my views on terminology. (Unfortunately, Dr Waldon completed only the first three of these essays: *1. The Processes of Sorting and Matching* *2. Learning Reinforcement, Motivation and Control (Draft)* *3. Movement and Sensibility: Tolerance and Constraint (Draft)* MC, TB)

For twenty years the ideas have been developed in association with my daily work with children with all kinds of learning difficulties. This has provided a living laboratory for observation and experimentation. However, I now feel the time has come for me to set them down as a scientific theory, stating my definitions and axioms, and formulating testable hypotheses.

In the first instance, I intend to do this in the form of five essays each of which, whilst being in some sense complete of itself, is meant to be read in conjunction with the others.

Years ago, following many attempts to explain my ideas to others, I became convinced that I had a personal communication problem which I should concentrate on meliorating; however, I subsequently realised that, whilst not denying my inadequacies in setting out novel notions simply and clearly, the very ideas I was attempting to communicate were to do with the developing understanding. That is to say, the hypothesis is REFLEXIVE.

Since, as will be seen, the hypothesis claims that although the transmitter of information (the writer for example) can offer material, albeit more or less satisfactorily, the onus is entirely on the learner (the reader) who must *actively* set out to understand, even though she can not yet appreciate what that understanding will consist in, and effortfully follow through with the process indefinitely.

Emphasis will be laid on the CREATION OF EXPERIENCE and on the essentially much more active role of the receiver, the learner and the questioner, than that of the sender, teacher or 'answerer'.

The job of the writer is to facilitate the effortful strivings of the enquirer, much as a midwife eases the travails of childbirth.

I shall try to be clear; the difficulty of the subject matter is a function of the reader's interest.

Geoffrey Waldon
1985

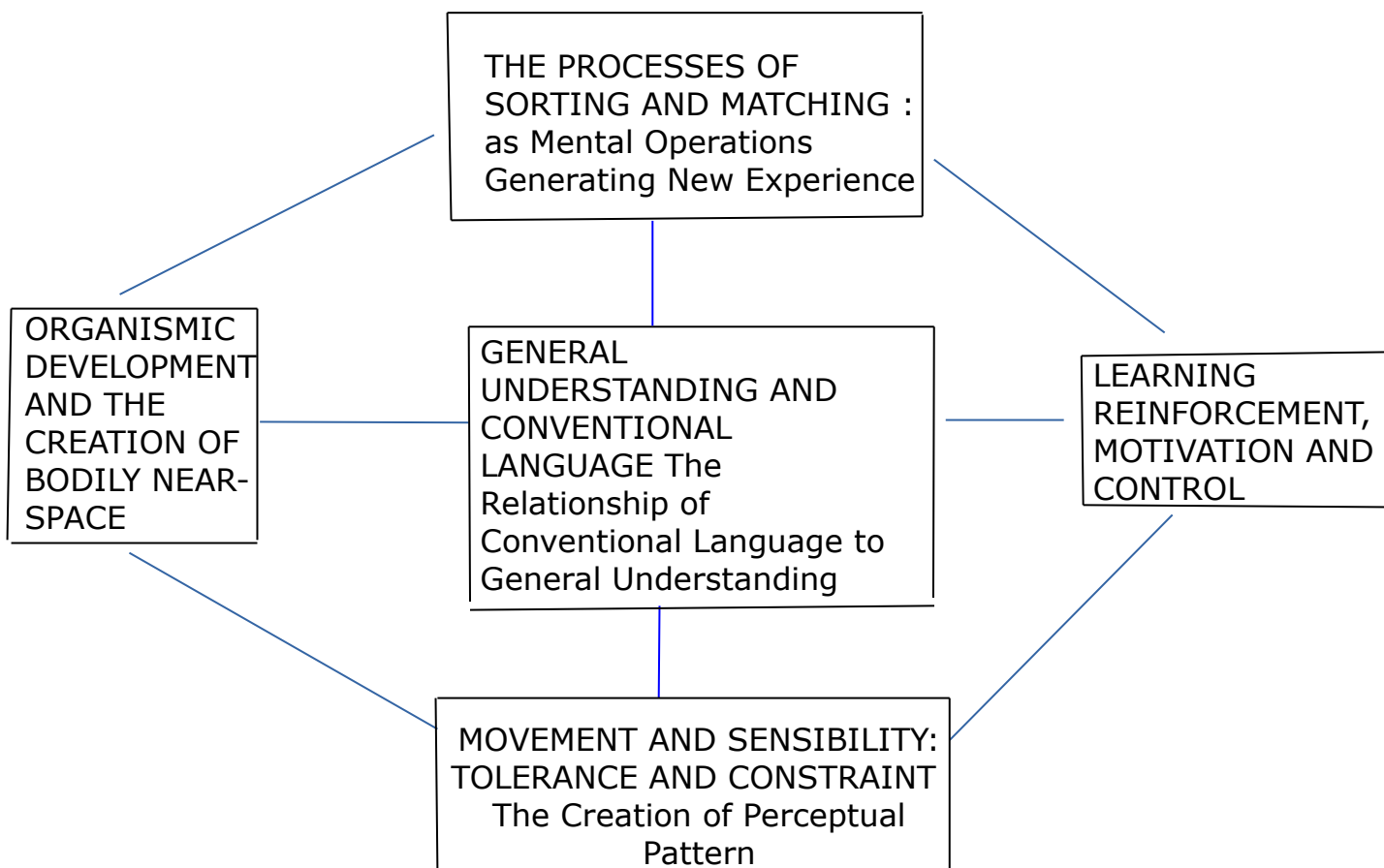
ABSTRACT

This paper represents part of an ongoing study to prepare an interpretative description of the learning and development of general understanding in the child.

The ideas concern (i) the source of the sensory receptor activity patterns from which experience is ultimately created; (ii) the reinforcement and drive, caution and control, which powers and regulates the creation of experience; (iii) the essential role of movement, its ranges of tolerance and constraint, in this process; (iv) the self-creation, for each individual, of a functional bodily unit and an increasingly interesting and structured space within which to act and generate experience; (v) the form of the subsequent development of general understanding, including the need for a learned mechanism for creating and organising experience with increasing acceleration; and (vi) the relationships of this understanding to conventional language, etc.

The basic ideas, all of which first crystallised nearly twenty five years ago after a gestation of several years, have found their daily application in work with retarded and emotionally disturbed, as well as with normally adjusted, people. Now, having had such a prolonged period in which to mature, I intend that they should be set down in outline within five intimately integrated essays, having the provisional titles:

- A) THE PROCESSES OF SORTING AND MATCHING as Mental Operations
Generating New Experience in Child Development
- B) LEARNING, REINFORCEMENT, MOTIVATION AND CONTROL of the
Generation of New Experience in Child Development and some of
their Consequences for the Adult
- C) MOVEMENT AND SENSIBILITY: TOLERANCE AND CONSTRAINT –
The Creation of Perceptual Pattern
- D) ORGANISMIC DEVELOPMENT AND
THE CREATION OF BODILY NEAR-SPACE
- E) GENERAL UNDERSTANDING AND CONVENTIONAL LANGUAGE
Relationship of Conventional Language to General Understanding.
Pathology of Learning and Development in 'Retardation' and
'Handicap'.



There is, of course, no suggestion that the system being described is quinque-partite; however, a seemingly chance convenience allows the description to be dealt with in four parts, plus one which is concerned primarily with the product of the system as a whole and its reflection in everyday spoken and written language. This convenience more than compensates for the artificiality of the division.

Although the implications of the ideas for education and for the treatment of emotional disturbance will be obvious, discussion of the applications has already been dealt with in detail in ‘Understanding UNDERSTANDING’ Volumes 1 – 13 (unpublished).

I would like to heed the excellent advice of the King of Hearts: ‘Begin at the beginning, and go on till you come to the end: then stop’; however our subject matter has no evident beginning and, even more certainly, no end, so that as with the chicken and egg problem, apart from moving so far as is possible from the simpler to the more complex and from origins to derivatives, our start must be more-or-less arbitrary.

I choose first to lay down a number of notions so that they can be taken up in discussion later when more definitive mechanisms are dealt with, much as a bowls player places woods beyond the jack to be available when the game moves further down the green. That was one of the aims of the paper on Sorting and Matching.

In this, the second paper, we shall examine: 'Learning, Reinforcement, Motivation and Control'.

The aims here are:

(a) to list the basic requirements of an experience-creating system

(b) to outline the manner in which patterns within the activity of the sensory receptors which are selected as significant, or worthy of repetition, are marked for future reference or *reinforced*, so changing the behaviour-generating state of the system, that is to say, 'the understanding'

(c) to suggest a source of the driving force which powers or energises learning and the creation of experience - *Motivation*

(d) to suggest a mechanism by means of which the power and direction of the application of this force in learning is regulated or controlled.

Following this outline it is hoped to draw attention to its relationship to some commonly met with behavioural needs.

(e) to hint as to how this mechanism might underlie the 'creative impulse' and continuing drive to create, in both art and science

(f) to suggest how it, in interaction with the environment, determines the form of the adult personality and the ways in which we react to strain

(g) to suggest how this mechanism gives rise to or furnishes what are referred to as the 'emotions'

(h) to suggest how it governs the 'flexibility' of our thinking

(i) to suggest how it influences the reliability of our witnessing and testifying to events

(j) etc.

LEARNING, REINFORCEMENT, MOTIVATION AND CONTROL

IN THE CREATION OF EXPERIENCE

Introduction

In this essay I hope to outline that part of the description which deals with what motivates an individual to act on the world, that is to say to observe; what determines the significance of patterns and how they are marked for future use once they have been selected for incorporation within the understanding; and what controls the rate and direction of the observational processes which lead to the creation of experience.

Following a mention of some of the features of behaviour and development which should be 'explained' by the description, I intend to describe the mechanism of learning, reinforcement, motivation and control, much as I originally conceived it about twenty five years ago, before attempting any sort of detail.

The core section of this essay is on learning, reinforcement, motivation and control (Section 4) which is deliberately made up of three parts. The first is introductory (4.1), briefly outlining what is to be 'explained' and the explanation itself. This is given in a loose conversational style before being given a little more formally in the second part which I nowadays call the 'naive theory' of learning (4.2). This presents it in more-or-less the form in which I first wrote it down during the early sixties and before some of the main principles of the developmental theory, now essential to the combined theory and discussed in Papers 3, 4 and 5, had occurred to me as being important.

The naive theory is still the active working theory which I attempt to communicate to teachers and whose principles are exploited in the general practice of teaching I advise - the Waldon Approach to Education.

In the third part I attempt to present the principles once again but this time as an ordered series of rather more rigorously formulated definitions, statements, postulates and conjectures (4.3).

It is quite possible to read sections 4.2 and 4.3 independently of the remainder of the paper. A number of notes annotate the essay, the longer ones being assigned to an appendix in which the relationship between the well-known processes of 'Operant Conditioning' and my learning theory is suggested, and certain regularly experienced feelings and behaviours, especially those associated with drive and interest and curiosity etc., and those with insecurity, uncertainty and anxiety, are discussed briefly in the light of the theory.

Beginning this essay, once again, with the topic of survival is partly to emphasise that this notion is the natural starting point in any discussion of learning and the development of understanding, and partly to allow its consideration to lead inevitably to the process of individual adaptation, or the capacity to improve the chances of survival by means of 'benefitting from experience', that is to say, employing the processes and strategies of learning, guided by the accumulated experience (or understanding) to increase the life expectancy and perhaps the degree of relative emotional security or 'comfort'.

Furthermore that strange ineffable tendency for certain organisations - the plants and the animals - to persist in a dynamic and constantly self-regenerating state, against the otherwise overwhelming inclination of the surrounding system to reduce or run down to a condition of low-energy and comparative disorder - that struggle for survival that drives all living things, seems to be manifest(ed) in the 'drive to do', to be active, which in humans I term *motivation*. It will be seen later that my notion of motivation may well not coincide completely with the common notion of 'motivation' which tends to, or so it seems to me, be confused with incentive (incentivation), an entirely different process or force.

The 'life force' must *create* in order to meet adequately the great diversity of conditions, to take advantage of any and every opportunity. It must insinuate and pervade, change the character, enliven . . .

1. SURVIVAL - Active Persistence

'The force that through the green fuse drives the flower...'

It is not my purpose to speculate on the nature of life or death; however a consideration of some of the characteristics of survival in general does throw a light on the basic processes of human adaptation.

1.1 Homeostasis - passive survival, struggle - active survival

The survival of a 'living' element involves the persistence of a limited and circumscribed region of patterned space whose very existence seems extremely improbable when compared with the nature and state of the greater space surrounding and containing it and which discontinues in this persistence (ceases to survive) under those same sorts of conditions as soon as some living-element-centred active process (the 'survival force') ceases to operate.

Despite the improbability of its very existence, its own macro behaviours within the region of its immediate existence, although relatively complex, are singularly predictable. That is to say, the survival behaviours of such a living-element, its existence once given, are susceptible to study.

1) In order that a creature should persist in time, maintain some sort of identity distinct from the surroundings, there would seem to be a need for a mechanism which:

- i) resists change of state, and
- ii) opposes the environmental forces which tend to bring about such changes, and
- iii) restores to rights any disequilibrium when it does occur

- in short, a need for a mechanism for preserving sameness, an homeostatic mechanism.

Homeostasis

Such an homeostatic mechanism would seemingly have had to evolve over a long period of time and to be part of the genetic endowment of the organism, operating effectively within the limits of its 'programme' but not susceptible itself of adaptive change in function.

Such a mechanism, therefore, tends to maintain the organism in the 'pre-selected' state. The creature is a placid, 'stay at home', 'reclusive', contentment-seeking sort of beast, and is suitable only for a simple monotonous existence within a relatively unchanging environment, for short-term survival as an individual; as one of innumerable creatures whose individual life-span need not be long, in vertebrate terms; just long enough to stand

some chance of replicating and, in company with innumerable other similar creatures, of producing a sufficient number of mutations to cope with the more enduring changes within the environment.

A different survival strategy is to enhance the chances of the survival of *smaller numbers* of creatures for longer periods of time - to increase the individual life-span. Under this system each creature needs to be better able to resist or ride-out a wider range of variations in the environmental conditions; however each must be capable of adapting *during its own lifetime* to new or unforeseen changes when they occur. It must have not only a high tolerance to environmental changes but also itself a capacity for change.

Such a creature must begin to dominate its environment to some extent so as to be capable of surviving under conditions less favourable than those for which it was specifically 'designed' genetically. It must be able to 'learn from experience' within its own life-time. Its capacity for persisting must be more actively seeking to ensure survival, more '*actively preparing*' its defence against change; more offensive even, as well as being capable of 'storing' its capacity for increasing flexibility within the modifications to its range of behaviour-designs (observation-designs).

For an individual to be at least potentially able to adapt to conditions wholly unexpected, and therefore not specifically planned for, it must be capable of learning to 'understand' and to exploit its own capabilities, to 'map' its surroundings to some extent and to predict outcomes of its interactions with the surroundings.

This implies an 'exploratory' and 'experimental' inclination. Floating about adjusting passively within certain predetermined limits to environmental change is not enough; such passivity just will not do.

There must be not only active escape from noxious stimuli but also avoidance, and a seeking out of more satisfactory situations and conditions before they become, or seem to be, absolutely necessary. There must be *active preparation for survival*. Hence in addition to resistance to change etc., there must be:

- i) PATTERNED ACTIVE MOVEMENT of some sort;
- ii) A show of preference for the more satisfactory over the less satisfactory;
and, necessarily:
- iii) A means of 'recognising' degrees of satisfactoriness;
- iv) Selection, a selective process distinguishing between alternatives;
- v) A means of increasing the likelihood of more satisfactory conditions being met with;
- vi) '*Learning*', a capacity for effecting enduring change as a result of (the outcome of) previous behaviours, for creating experience;
- vii) '*Understanding*', or some degree of organisation of and capacity for exploiting this experience, however primitive.

Enduring changes in behaviour result in and reflect changes in the understanding which selects and designs the unit behaviours (or observations). The changes in understanding arise from the difference between observation-design and the realisation of that design and the discrepancies noted when the predicted (or intended) outcome of the action is compared with the actual outcome.

Understanding is comprised of such experience and is continually sustained, modified, enlarged or enlivened by newly created experience.

1.2 HUMAN SURVIVAL. Parallel between passive and active survival in animals, and dependence and independence in humans

'... Drives my green age' Dylan Thomas

If the human is by far the most successful of the survivors which operate in this way and its success is the direct outcome of its structural and functional simplicity and of its extreme lack of specialisation... its manner of creating appropriate experience and incorporating it into the organisation, giving rise to the experience-creating behaviours, or observations, is of particular interest.

Such study is the subject matter of this paper.

It may be of interest here to draw attention in passing to the survival relationship which seems to exist between human children and adults.

For animals existing within fairly homogeneous surroundings there is less overt need for active exploratory behaviour and it is possible and not entirely unexpected that a creature equipped to cope actively with changing conditions should, for want of necessity or practice, revert or relapse to the more passive condition.

There seems to me to be a parallel here with human life, a parallel therefore relevant to our enquiry.

It seems to me that these survival characteristics of the simplest creatures are ultimately the same as those of the human being when balanced between the actively 'alert' searching behaviour of the more adaptive creature, and the 'ultrastability' or the simple immediate resistance to change of the otherwise relatively passive being.

This seems to me strongly reflected in the passive versus active adjustment to conditions in the human being, particularly between child and adult; in the contentment seeking, emotional peace-seeking, 'need-to-close-up-and-complete-everything' attitude of most of us much of the time, and the open-minded flexibility of some of us some of the time.

A newly born baby, although quite unspecialised, is a relatively passive and helpless creature, very responsive to and dependent on environmental comforts and strongly resistant to change and unusual interference.

Very soon however, such a baby increases its level of activity and normally maintains the rate of this increase beyond that necessary to compensate for the changes in bodily size and form*.

* Note See 'Motivation' section 4.2

During this time the active child becomes progressively more flexible to change, and adaptive to prevailing conditions and situations, without increasing its state of bodily and functional specialisation.

It utilises many times more effort, space and time than is necessary to its continuing existence but stores up drive and adaptive potential for its future career.*

If however, conditions are bland and only mildly 'threatening/demanding', the child diminishes its activity to the necessary minimum and subsides into an environmentally dependent organism, as it approaches full growth.

Whatever the necessity and virtues of 'division of labour' (division of responsibility) one of its liabilities is its tendency to encourage dependence (on others and/or society).

The human adult is typically the antithesis of the child; namely *parsimonious of effort, space and time*, mean about resources.

* Note See 'Motivation' section 4.2

SURVIVAL STRATEGIES

	A	B
State	Static equilibrium	Dynamic equilibrium
Attitude	'Content' 'Self-satisfied' 'Retiring'	'Restless' 'Expectant' Enquiring
Behaviour	Passive Reactive	Active Interactive
Responsiveness to Environment	Rigid Resistant to change Reactionary	Flexible Adaptive to change Revolutionary
Structural and Functional complexity	Relatively simple Programmed for expected eventualities	Complex Programmed to benefit from inter-action with environment; to learn from experience
Specialisation	Specialised	Unspecialised
Survival duration Life-span	Long enough to replicate	Long enough to produce increased numbers of mutations Combinative reproduction

3. UNDERSTANDING - ORIGINS OF EXPERIENCE IN THE SENSES AND MOVEMENT

The origins of 'meaning' in the changing patterns of activity within the sensory receptors which reflect the learner's bodily movements is the subject of the third essay 'Movement and Sensibility...' which might well be subtitled 'Meaning from Movement'. Nevertheless some mention needs to be made here in order to give background to the processes of learning which bring about the creation of experience.

3.1. UNDERSTANDING

Understanding is that capacity which determines and governs the occurrence, form, quality and appropriateness of those observations on the environment which constitute the process of active existence or survival and which are usually referred to as 'adaptive behaviours'.

General understanding is that simplification by which most basic components of stored experience are abstracted towards their application in observation, whether this leads to novel gain or simply to restatement of established experience.*

The more frequently repeated observations tend to be stored as ready-made behaviours continually available for use (in much the same way as common phrases and sentences are used in everyday speech).

These ever ready-for-use pre-packed skills which facilitate everyday living make up what we may call particular or *personal particular* understanding.

Of the total stored experience at any time, which we might term the fundamental understanding, that which has been digested and assimilated to some degree into the basic structure or core of the organisation, forms the *general understanding*.

All the actively acquired experience is the result of the action of general understanding but any of this experience can become the raw material for the production of a kind of casual or 'extrinsic' (non-observational) gain of 'experience' which makes use of excesses of redundant reinforcant and results in the acquisition of simple behaviours brought about by external factors - often or usually the deliberate actions of other members of the culture to which the learning organism belongs.

* Note that engaging in tasks, recognising, interpreting and setting out to solve problems etc. are all subsumed under the heading 'General Understanding'.

These super-added behaviours constitute a 'cultural understanding' or, since they superficially resemble the particular skills realised by the exercise of general understanding in response to cultural needs, *cultural particular understanding*.

It will be noticed that the theory of understanding consists primarily of theories of the fundamental learning¹ and *form of growth of general understanding*².

Note

1. Little time and space is given to the secondary form of 'learning' (reward training) since it is so well described elsewhere. Nevertheless its relationship to fundamental learning and the origins of the reinforcing agent involved is outlined. (See also Appendix A).
2. For a simple account of the overall form of development of early general understanding and the learning paradigm for general experience-gain see the essay 'Understanding UNDERSTANDING'. <http://www.waldonassociation.org.uk/pdfs/library-index/waldon-associates-understanding-understanding.pdf>

3.2 ORIGIN OF EXPERIENCE

A child grows and develops from an embryo bringing with it, as genetic endowment, only certain physical apparatus and a small number of in-built tendencies from which to construct an adaptive understanding.

Somewhen during this physical growth and the appearance of the innate movement tendencies, the necessary component experience begins to be created. But from what?

There is a physical apparatus consisting of several parts connected together so as to allow a small measure of independent movement between the parts. There is a motive power and a tendency for some movements to occur especially in reactive response to prior changes of posture.

The ranges of movements possible - the tolerances - are limited and constrained in various ways and to varying degrees by the physical structures and by the innate response-movement tendencies - the '*postural reflexes*'.

Now, unless the tissues are directly and lastingly changed by the mechanical effects of the movements themselves, as the bed of a stream is created by the action of running water and waterborne debris¹, the only elements within the body directly responsive to environmental² forces are those cells or cellular arrangements which selectively convert (transduce) various kinds of energy - mechanical, photic, thermal, etc, into nerve impulses which thereafter travel towards the CNS in specific nerve-fibres and nerve-fibre pathways.

The *sensory receptors* are the only points of contact between the learner-survivor, or its component organs, and the environment. It is these energy-change-sensitive organelles which must detect the postural changes which ultimately give rise to experience.

The sensory receptor organs represent the sensuous interface between organism and environment; however it should not be assumed that this interface coincides wholly, as the tactile sensors more-or-less do, with the physical outer limits, rind or skin, for not only do some organs such as those of hearing or vision, lie well beneath the skin and receive/detect energies from a distance, but among the most important receptors are those which signal energy changes from within and throughout the organism - in particular, from the point of view of adaptive learning, the receptors within the muscles, tendons and joints which mediate potential information about muscle tone, movement and posture.

Footnote

1. Many parts of the (growing) body, of course, do require movement or exercise during growth for their proper formation (e.g. hip joint).
2. Both 'internal' and 'external' environments.

Nevertheless an awareness of the skin boundary does play an important part in the formation of a bodily image, and the capacity for defining and localising various sensations more precisely¹.

All experience stems from the activity of the sensory receptors - not immediately from the nature of the receptors themselves but from the patterns of activity produced by the switching on and off of individual receptors. Which particular 'sensations' are 'experienced', or otherwise made use of adaptively (whether 'vision', 'hearing', 'touch', etc), depends solely on the internal connections.

All understanding of the world, or more accurately the world itself, is created from consistencies in the patterns of activity within the sensory receptors or their arrays, as 'recognised' in the patterns of nerve impulses reaching the CNS.

The human animal should be recognised as being totally enclosed within an inert and largely opaque shell which however allows some incident energy to filter through to appropriate energy-sensitive organelles - sensory receptors - situated just deep to the skin. The majority of sensory receptors within the body are however distributed in the muscles, tendons and joints and are sensitive principally to changes in the spatial relationships between the bodily parts - that is to say, to movements gross, as in the shortening of muscle, or minute, as in the changes of pressure between tendon fibres.

Each individual is therefore insulated from and able to make contact with the environment, including other individuals, only through the medium of these sensory receptors and their activity².

In investigating the development of understanding in the human being, therefore, it is the nature, distribution, manner of stimulation, and ways of imposing pattern on, the sensory receptors which must occupy the focus of our attention¹.

Footnote

1 See Paper Three 'Movement and Sensibility....'

2 'Every man is an island' (Waldon)

3.3 IS THERE AN INNATELY ENDOWED UNDERSTANDING OR KNOWLEDGE?

If understanding is the product of the creation of experience, and experience is lasting change within the repertoire of available behaviours, then for the origination and advancement of an understanding there must be an initial repertoire of behaviours susceptible to undergoing change in its components with which the child is already endowed before birth.

Understanding or knowledge is the behaviour-generating state which is itself the product of experience created in the discrepancy revealed when an actual event is compared with the design which initiated its appearance. It follows therefore that there must be a pre-existent repertoire of non-learned or 'given' behaviours each of which is susceptible of undergoing change.

Movements are to be seen in the embryo before the eighth week of gestation and even a very premature baby exhibits a well-established system of 'postural reflexes'.

Hence even when assuming that there is definite scope for learning and that the foetus is actively learning during the later weeks of gestation it is clear that the primary capacity for producing the clearly-defined behaviours which give rise to progressive learning is the outcome of genetic endowment.

Understanding or knowledge consists of, or can only be inferred from, examples of behaviour. We must judge the presence of understanding or knowledge from the appearance of behaviours, and to be consistent therefore we must assume the appearance of behaviours to indicate the existence of a state of understanding or knowledge which has given rise to these behaviours.

In this sense the earliest spontaneous behaviours of the foetus are the evidence for an inborn or given state of understanding or knowledge.

The notion of conscious awareness is irrelevant to our definition since throughout life awareness supervenes only gradually as new experience becomes more firmly established, and until the child has attained to the status of an organism* it is difficult to see how we can even conceive of its having an awareness of its bodily parts.

Observations or organised behaviours which create new experience in the child or other animal, thereby producing enduring changes in the frequency, amount and form of its subsequent observational behaviours, must be considered to represent its current state of understanding and knowledge.

* See endnotes 14/15 'Understanding Understanding' Waldon Association website

If these earliest observational behaviours, as for example the 'postural reflex' responses, were in-born, then we must accept that, in this sense, some knowledge or understanding is innately endowed¹.

Observations which occur 'spontaneously', what Skinner might refer to as operants², may themselves be much changed by learning processes; however the earliest ones, from which all later understanding originates and which give rise to variants, extensions and recombinations, are not themselves learned.

These inborn tendencies to produce activity and to impose distinct forms upon that activity may be 'released' or 'triggered' by a prior active or a passively imposed change of posture or change of position of the body relative to the gravitational field. For example a postural state itself, or the changes of posture leading to the adoption of that posture, may be sufficient to bring about a further and different posture, as for example in the tonic neck reflexes. The activity of some muscles, under certain sets of conditions, evokes a tendency for the child to assume fairly clearly defined physical attitudes, which tendency will be influenced in its realisation by other forces and 'tendencies' (including other 'postural reflexes', responses, structural constraints, gravitational forces etc.) so that the actual product will always be a resultant of several forces including the 'effort', and a number of constraining factors¹.

The posture or movement which gives rise to a clear response may itself be the result of some other 'stimulus' such as an earlier 'postural reflex', or of intestinal discomfort or visual fixation on a source of direct or reflected light, or to a sudden sound.

There are innumerable ways in which activity is induced directly in a newborn child quite apart from those 'spontaneous' movements resulting from the learning which takes place during the later weeks of gestation and more obviously from birth. Within a few hours one would normally expect that learned interactions between the child and its mother will already be well under way.

A mother's holding her new-born baby will inadvertently impose postures, cause movements, induce 'fixations' and thereby bring about differential movements in the bodily parts, and otherwise excite the sensory receptors of the child through touch, pressure, scent, taste and sound.

Footnote

1. See Paper Three 'Movement and Sensibility....'

2. A behaviour recognised to be emitted but without reference to any possible or 'probable' stimulus'.

The child's responses will themselves be responded to, more or less definitely, and in a selective manner, so that in addition to the child's defining, consolidating and expanding its general understanding, its behaviours are also being 'shaped' by adult influences, and are themselves 'shaping' the responses of the adult (Skinner, B.F.).

Soon it will be found that some maternal behaviours elicit specific responses which appear to be apposite, sometimes seemingly complementing and sometimes resembling the trigger behaviour.

Naive observers commonly infer quite ludicrous and unnecessary states of awareness as accompanying such 'social' interchanges, which imply the child's 'knowing' what its mother is intending and that the child is 'imitating' its mother's behaviours. Such behaviours do however derive from and represent the foundation and origins of the future understanding, and these interchange behaviours are the basis for subsequent 'conscious' social behaviours.

3.4 WHAT ARE THE BASIC FUNCTIONAL COMPONENTS OF AN EXPERIENCE-CREATING SYSTEM?

What basic equipment must a new-born child be already equipped with in order to begin to construct a reality for 'itself'? Presumably it will need some sort of 'building blocks' from which to construct its world. It will need to create units of experience but in or from what?

What is the ultimate something of which or within which similarities and differences can be recognised? Wherein lies identity? In form? In relation? Pattern subsumes both, for in some sense all things and all relations and all behaviours may be considered in terms of patterns. But patterns in or of what?

We have already recognised that the sensory receptors represent the sensible interface between child or animal and the environment and that consistencies in the bodily movements will be reflected in the patterns of receptor activity occasioned by these movements. The sensory receptor activity pattern is then the obvious candidate for the source of the unit of experience or atom of understanding.

To get spatial patterns of sensory receptor activity we need a consistent spatial relationship between the receptors; they must be ordered or arranged in some way, and this implies a matrix of some kind. Are there any essential features about the matrix, other than its being able to maintain consistent arrangements?

Well, to answer this we need to ask what will be the most important 'cause' of receptor activity - what will be the source of stimulation? Receptors can only change from 'not responding' to being 'active' and back again to the resting state. Hence unless the stimulating energies are themselves switching on and off, *movement* is required in the creation of pattern.

Movement of what? Environmental forces moving relative to the receptors? The child moving passively relative to the environmental forces? The baby itself moving actively?

All these are probable sources of significant receptor activity patterns but the baby's own active movements are the only ones over which it has, retains and increases control and these are likely to give rise to by far the greatest amount of consistent pattern.

For the baby to be the main agent of pattern formation it must be able to move any one part of its body relative to another as well as being able to move any or all parts relative to fixed points within the environment.

Therefore the matrix on which the receptors are arranged must consist of a number of connected parts with a degree of looseness in the linkages, and there must be a means of moving those parts actively, continuously and smoothly. If some movements are to be

repeated 'deliberately' at some stage there needs to be some means of 'steering' the movements, of having the parts move in predictable patterns.

If these receptor activity patterns (RAPs) are to be the 'building blocks' of experience and understanding they must somehow be recorded or 'remembered' so that they may be recognised when met with again. But which to record? All of them? Is there a priority? What could constitute significance? Could it be frequency of occurrence?

Could it be that the earliest occurring and therefore the most frequently performed movements, each creating its own peculiar range of sensory receptor activity patterns, are also the most significant since they give rise to all subsequent behaviours?

Provided movements are not too rigidly constrained, repetition is also the main source of variation and variety.

WHAT ARE THE MINIMAL REQUIREMENTS OF AN EXPERIENCE-CREATING MECHANISM?

The fewest basic physiological components for an efficient 'environment-sampling' or experience-generating system would seem of necessity to include the following:

1. RECEPTORS; Suitable sensory receptors tuned to particular ranges and thresholds of electro-magnetic and mechanical energy (light, heat, vibration, stretch, torsion, etc.); capable of signalling *change* in frequency of occurrence, intensity, duration and quantity.
2. A CHASSIS: A fairly rigid framework about which the receptors are regularly and permanently distributed; but divided into a number of loosely connected segments which move relative to one another.
3. A MOTOR SYSTEM: Some means of (i) moving and (ii) steering the receptor-arrays relative to the environment (the potentially incident energy changes), and to one another.
4. TOLERANCE: A sufficient range or 'space' within which the relative movements can take place. 'Freedom of movement' or tolerance.
5. CONSTRAINTS: a) Physical form and characteristics
(b) inherited reactive movements patterns, the 'postural reflexes'
- which together impose some limitation on the number or range of RAPs produced.
6. A SIGNIFICANCE DECIDING MECHANISM: A simple means of deciding which RAPs are significant and worth repeating.

7. AREINFORCING SYSTEM: A means of marking some receptor-activity patterns (RAPs) as 'significant'.
8. MOTIVATION: A source of motive power to set and keep the whole system in active motion.
9. A MEMORY: A means for storage and recovery of the significant patterns in such a way as to continually modify the steering and sensitivity components.

4. A THEORY OF LEARNING - REINFORCEMENT, MOTIVATION AND CONTROL

4.1 INTRODUCTION LEARNING: The Problem

Children¹ appear to learn in two different but related ways which are perhaps most readily distinguished in practice by a consideration of the conditions under which the two forms of learning take place.

One form of learning is exemplified by the popular notion of a 'child' *learning under instruction*, which I prefer to term reward training. A child is expected by an adult to be able to spell certain words, to bisect an angle, to know the date of the Great Fire of London, to tie his shoe laces, to become familiar with the form and use of a mathematical formula or the rules of a game, etc. A very high proportion of the learning expected of a child by its parents or by teachers is of this form. It is generally assumed that the skill, task or information is familiar to the tutor who, after preparing the child, presents it to him, requires in due course evidence of learning's having taken place, and rewards, corrects or punishes the outcome. There is a clear cut item to be learned and satisfactory learning is selectively reinforced in some way.

It is taken for granted that the tutor decides what is to be learned and in what form, when and how it is to be learned and under what conditions. The learning takes place with the aid of models to be emulated, in comparison with which the student's efforts can be measured as satisfactory or unsatisfactory, as right or wrong, as signalling progress or attainment, etc. The tutor's role in supplying the reinforcement when considered appropriate (by the tutor) is deemed a necessary one. Desirable behaviours are strengthened whilst less desirable behaviours are allowed to wane or are explicitly discouraged.

Sometimes no human tutor is present but a skill involving attainment or achievement may be reinforced by gaining a 'prize' or release from confinement or a reduction in a state of need, etc. The behaviour is reinforced by its effect on the environment; it is affected by "what happened after the organism had behaved" (B.F. Skinner).

In each of these situations it seems clear that *reinforcement* takes place *after* the event it reinforces. Behaviour, which may be complete in itself or a component fragment of some greater whole, is an accomplished fact *before* reinforcement takes place. This form of learning is in keeping with Thorndyke's 'Law of Effect'² and with 'Operant Conditioning' in which a behaviour is said to be reinforced by its consequences.

Footnote 1. The arguments centre largely about children since the intention is to present a description of learning and development in understanding; however, all the arguments are (must be) applicable to any age group as well as to the 'higher animals'.

2. 'Right' movements tend to be 'stamped in' by the satisfaction of 'success', whilst 'wrong' movements are 'stamped out' by the dissatisfaction of 'failure'.

In the other learning situation the child who may be quite alone is playing spontaneously. Although certain patterns of behaviour stand out he appears to be engaged in a complex fabric of activity that seems continuous so that any interruption must occur at places which are not 'natural breaks' for some of the strands of learning activity.

Nevertheless observation shows that novel variants occur from time to time, and sometimes quite new behaviours arise.

Since the behaviours rarely seem to culminate in clear-cut successes, attainments etc., or in opportunities for 'consequences' to reinforce behavioural fragments it would appear that reinforcement in this case must also be continuous, taking place simultaneously with each of the strands of activity.

Watching children in spontaneous play suggests that this latter form of continuous learning, devoid of clear-cut culminations and largely free of adult intervention, is by far the more common type of creating understanding. Throughout the waking state the child seems perpetually engaged in spontaneously learning a variety of 'skills' at differing levels and at differing rates, but all simultaneously.

Some of the characteristic features of the non-specifically reinforced learning involved in the acquisition of cultural particular skills, and of the 'specifically-reinforced' fundamental learning which gives rise to general understanding are summarised in the following table of comparisons.

Table: LEARNING FOR UNDERSTANDING (GW 1976)

	Fundamental Learning for : GENERAL UNDERSTANDING	Associative Learning for : - CULTURALLY DIRECTED (SOCIAL) PARTICULAR UNDERSTANDING
SOCIAL STATUS	Functionally alone	With another
SELECTION OF TASK OR ACTIVITY	Self selected	By another
STATE OF PREPAREDNESS	Inevitably appropriate	Dependent on interpretation of 'teacher'
SOURCE OF TASK etc.	Previous experience of learner	Previous experience of 'teacher'
DESIGN & CONTROL OF TASK	Self	Other
REINFORCEMENT	Simultaneous: and all activity reinforced. Related in kind (qualitatively related) to the activity Amount directly proportional (quantitatively related) to effort expenditure	After: only selected acts reinforced. Not related in kind to the activity Not related in quantity to the effort expended (often nearer to inverse proportion)
MOTIVATION	Tendency to produce effortful activity seeking outlet - motive power	Incentive - reward from another for achievement, 'success', co-operation etc.
FORM	Exponential growth towards generality All new understanding grows out of earlier and contains the essence of the earlier Invariable genetic sequence	'Shaping' down or building up brick by brick Segments of learning not necessarily related to each other
SPECIFICITY OF 'GOAL' ACTIVITY SKILL, MOTION, ETC.	General - at most definite a 'bundle of possibles'	Specific, Precise
TOLERANCE	High	Low
MANNER OF LEARNING	-	-
ROUTE TO GOAL	Tortuous and varied	Direct and simple
VARIATIONS ON BEHAVIOUR	Encouraged	Selectively discouraged
MEANS TO END	Means constitute the 'end'	End is independent of the means
TIME TAKEN IN LEARNING TASK ETC.	Deliberately prolonged	Reduced to a minimum
EFFORT INVOLVED	Deliberately excessive	Minimal
VALUE OF 'GOAL' (ACTIVITY, SKILL, NOTION, DATA)	Interest - source of further understanding	Usefulness or 'appearance'
EDUCATIONAL PURPOSE	'Scientific' Enlarging understanding (appropriate application assumed) Enlarging reason, scepticism, radicalism	'Technological' Applying understanding Controlling behaviour Facilitating accepting and 'fitting-in' behaviours Acceptance - conservation - reaction Conformity

Note: Gain of particular understanding ideally derives directly from the use of the general understanding. It remains a non-social activity being selected and initiated by the learning organism and shaped and reinforced in direct response to the perceived effects of such activity upon the environment; however our contrast here is between gain of general understanding and gain of particular understanding as imposed by other members of the society. GW 1976

LEARNING AND EXPERIENCE

If from some moment the behaviour or range of behaviours of a creature is modified as a result of an encounter*, chance or otherwise, we might say that *learning* has occurred, and that this persisting change constitutes the *creation* (or generation, or acquisition) of *experience*. An enduring change in the behaviour-generating state of the creature implies that experience has been created, that learning has taken place.

I suggest that once a behaviour has been registered by the learning or experience-creating mechanism (the animal, child or adult, etc.) as worthy of repetition or reconsideration it may be treated or marked in some manner so as to render the possibility of its rehearsal more likely. This 'marking as significant' constitutes the reinforcing, or relationship strengthening, component of the learning process.

Consider and compare the two apparently differing and commonly encountered sets of conditions in which such learning regularly takes place - for example, a parent's deliberate encouraging of a skill or the acquisition of information in a child, with the same child's 'spontaneous' learning when playing by itself. We notice that the adult selects the task or activity; chooses when and where it is to take place; shows approval or non-approval for the 'rightness' or 'wrongness' of the child's efforts; and uses reinforcers (rewards) whose effects are not qualitatively related to the skill or association being reinforced. The reinforcement is given *following* the total or a discrete component of the behaviour being taught, and the quantity or intensity of this reinforcement is not noticeably related to the child's 'success' in achievement or more particularly, to the amount of effort expended. (See previous table of comparisons 'Learning for Understanding').

On the other hand, the child playing by itself tends to play continuously, often moving from one activity to another, in fact often leaving an activity, from an adult's point of view, unfinished, or repeats an activity or series of activities many times. It thus shows but little sign of interest in the 'completion' of the 'task' or in doing something 'right' etc. And yet a little observation reveals that its behaviours are continuously showing progressive changes; that it is in fact learning.

It would seem then that the factors eliciting reinforcement for this kind of learning originate 'inside' - are 'intrinsic', and apparently happen without the need for any sort of end point or culmination or 'success' etc. In this play the child selects the task type as well as the level and manner of playing for itself.

Footnote

* In practice even a readily noted 'encounter' can only be presumed to bear a causal relationship to the change of state or creation of experience, and almost always the encounter itself or its equivalent can only be a supposition; however such 'encounters' do not have any necessary part in the definitions of either the process of learning or the change of state I refer to as 'experience'. (See 4.3, Postulates 7 & 8)

REINFORCEMENT AND SIGNIFICANCE

1. The argument, being centred about human beings – babies - and our being of the same species, tends to suggest 'pleasure' as the likely reinforcing agent. 'Unfortunately', since I insist that we can only observe a baby's learning by inference from witnessing the enduring changes in its behaviours which signal the creation of experience, and cannot directly share its sensations (even though being so similar we can identify with it and empathise, so relating its supposed feelings to the way we feel when behaving similarly), we are forced to abandon the notion of 'pleasure' as the essential reinforcing agent. So basically we are in the same position as the 'behaviourists' and 'ethologists' and can understand their frustration with those who blithely invoke introspections and feelings in argument. (See note on use of the terms 'Pleasure' and 'Unpleasure' in the 'naive theory', Appendix C).

I suggest that we might extricate ourselves from this seeming stalemate by re-examining our definition of reinforcement: *experience* is recognised by an observer as an enduring change in the behaviours of the observed; and the fact that behaviours observed rarely, if at all, before such and such a time or event, appear significantly more often or even with increasing frequency following that time or event, indicates that *learning* has occurred. The change of state associated with the change of probability as to the appearance of the behaviour seems to require the 'addition of' some feature which marks out this particular behaviour for special treatment in regard to its future likelihood.

If we are building a machine we should probably incorporate a marking (or 'ear marking') device to be applied to those significant behaviours whose frequencies of occurrence are to be changed. So let us simply say that *reinforcement consists in the addition of some factor which, when occurring in association with a particular behaviour modifies that behaviour's subsequent probability of recurrence*. You will notice that this does not rule out 'pleasure' as a reinforcing agent. It simply implies that we need make no reference to the 'feelings' of the creature or machine, whilst not actually ruling out the possibility of an awareness of these sensations by the creature or machine.

2. Before taking the matter of reinforcement further let us broach the subject of significance. What decides whether a behaviour should be reinforced or not? What decides whether the likelihood of recurrence of a behaviour should be modified in the first place?

Having a preference for 'simple' explanations I ask why should frequency itself not imply significance in the first instance? Since from before birth the baby has a tendency to move, quite clearly the forms of these movements are influenced by some constraining factors (such as physical characteristics and 'postural reflexes' etc.); clearly certain basic behaviour patterns (and their accompanying sensory receptor activity patterns) will recur much more often than others, quite independently of any learning process; therefore it might be reasonable to postulate that any extreme of frequency (necessarily) constitutes the primary principle of 'significance' capable of eliciting the process of 'marking' or reinforcement.

The more often a behaviour has recurred then the more positive reinforcing agent that behaviour then engenders, and the even more likely it is to occur in the future.

Note: I suggest that in training the use of reinforcement which is induced after the event (the *consequences* of an act reinforcing the antecedent behaviour) actually encourages the *interruption* of continuity of learning - in fact rewards the *cessation* of learning, and that the usual manner of using training procedures necessarily elicits anxiety and/or 'defensive' behaviours designed, so to speak, to avoid or escape from such emotional discomfort. Consider also the *control* of learning and the matter of *motivation*.

3. (a) Since this would seem to imply that those patterns which would be reinforced more than others because of their initial frequency would tend to be progressively selected for activation, with a tendency to the creature's (machine's, child's) becoming entrapped in a few relatively stereotyped behaviours, and
(b) since frequency preferred significance,

it might be expected that the frequency of recurrence of the selected behaviours and the total activity would increase exponentially.

Two major problems with our hypothesis. Must we abandon it?

4. Before abandoning the hypothesis we might examine the questions: Are there likely mechanisms, (i) which could curb the tendency to stereotypy of behaviour and, (ii) which could *control the runaway tendencies of our model* that its present form seems to predict?

We need not spend too much time on (i) for the inbuilt high tolerance or ranges of natural 'clumsiness' ('freedom') tend to ensure that with the usual handlings of a baby, its being put down in various postures or on a variety of surfaces, and being pulled about during bathing and dressing, that a very wide range of possibilities must constantly occur; furthermore *interaction between the postural reflexes* will induce a wide range of resultant postures and movements (change of posture). With our machine model though we must remember that such mechanisms would need to be built-in.

When it comes to (ii) however, why is it that the positive feedback mechanism we have hypothesised does not lead to *oscillation*, the baby or machine simply running out of control, finally to exhaust or destroy itself ('self destruct')?

One immediately obvious factor is *fatigue* itself which as an opposing influence will up to a point limit the activity; and, *what is much more important*, the increasing total size and mass, the redistribution of mass (baby's change of shape) and the increasing limb lengths (implying larger turning moments), impose increasingly large loads on the baby's movements.

On the whole however, these controlling factors are not influenced by an 'error-actuated negative feedback' system; they tend to just be there rather than to vary according to the immediate requirements. Therefore such controlling factors do not deal with the matter of a need for caution in dangerous situations, etc.

Here we need a mechanism which counterbalances the *positive* reinforcing influences we have already postulated; and a *negative* reinforcing system is suggested to fulfil this purpose.

Having postulated a *positive reinforcing factor* whose presence, induced in association with the afferent or inflow of sensory nervous impulses, increases the probability of the reinforced behaviour's being repeated, we now postulate an opposing *negative reinforcing factor* which diminishes the likelihood of repetition.

Since I suggest frequency of occurrence of a sensory receptor activity pattern as the criterion conferring primary significance we might say that it is the quantity of potentially significant pattern within a perception that determines the total amount of reinforcing agent, whilst the proportion of the pattern present which is recognised as *familiar* decides the balance between positive and negative influences.

MOTIVATION AND INCENTIVATION

This topic causes much confusion largely because two very different forces are spoken of as interchangeable or even as being identical, but also because convention has encouraged the notion that motivation is more related to what is being learned than to the process of learning and the state of understanding. Consideration of motivation commonly invokes ideas such as 'interest', 'reward', 'intrinsic drive', 'instinct', etc.

By motivation I mean the source of energy that powers the learning process. Our enquiry is into the origins of the effort necessary to the creation of experience.

MOTIVATION

- 1) Certain actions occurring within the behaviours of the baby clearly occur with increasing frequency, vigour and variation. Within this build-up of spontaneous activity new behaviours arise. Thus there are increasingly to be expected changes in both the rates and the forms of the child's activity - experience is created, learning is taking place, somehow seemingly generating its own power source: its motivation.
- 2) We have hypothesised that a sensory receptor activity pattern (RAP) somehow induces the transitory mobilisation of *positive reinforcant* whose presence somehow increases the probability of recurrence of that RAP (and therefore *the movement that incurred it*) according to its familiarity (the degree of previous frequency and recency of occurrence).

- 3) This means that, in the absence of any controlling mechanism, every action incurring a RAP is thereafter more likely to recur. Those which happen to occur more frequently in the early stages (due to bodily constraints and postural reflexes) will be selectively reinforced, *but the total amount of activity will increase exponentially.*
- 4) This increasing amount of activity moving increasingly more massive and lengthy bodily limbs represents *an increasing power source.* This is ***motivation***, power to move, motive power.
- 5) Motivation (in the Waldon sense at least) is not directly related to the nature of the activity or to its outcome. It is thus very different from incentivitation in which a promissory reward for success or attainment engenders a *specific need* the satisfaction of which (the success) is always in some measure of doubt; hence incentivitation always entails the anticipation of 'failure' (in my view actually creates the notion of 'failure') and the engendering of anxiety (or the 'anticipation of unpleasure' (Waldon)). Motivation on the other hand is blind and has no intrinsic direction. It does not involve other than the present (or *immediate* future) and its availability to induction (unlike the incentive reward which hangs on attainment, 'success' etc.) need never be in doubt.

Now let us examine these ideas in a slightly more formal manner.

4.2 INTRODUCTION AND OUTLINE TO THE NAIVE HYPOTHESIS OF LEARNING – Reinforcement, Motivation and Control.

Introduction to the 'Naive' Hypothesis

So far as our requirements are concerned, the most obvious difference between the reinforcement activity in the two kinds of learning referred to in the previous section is that in one case the reinforcement (reward) is supplied *after* the activity to be reinforced - that is to say, following the recognition of the activity's having come to a satisfactory conclusion. By contrast, in the other case the reinforcement must be assumed to be taking place *during* the activity, for this may well have no conclusion and commonly has no available model against which to judge its 'correctness' or identity. Furthermore several strands of potential experience-creating activity are in progress simultaneously.¹

Observation of children at all ages leads to a recognition that most learning does not need '**extrinsic**' rewards. It further shows that such learning does not require specific end-points or culminations. From this we can deduce that the hidden or '**intrinsic**' reinforcement occurs *during* the activity as opposed to overt or 'extrinsic reinforcement' (or more accurately the use of 'reinforcers') which happens or is given after or at the culmination of the activity.²

Whether reinforcement is intrinsic or extrinsic, whether it occurs during or following activity, it involves a reinforcing agent or reinforcant (which may be potentially capable of being experienced as a sensation³), which evokes a tendency to prolong or to repeat the associated activity, or is somehow capable of cementing an association or connection between events.

Footnote

1. The creation of experience and understanding necessitates simultaneous parallel, branching and interlacing activities in which various skills and notions are developing at different rates. The cessation of the most evident activity must necessarily interrupt various other threads of experience-creation quite haphazardly.
2. All reinforcement is, of course, ultimately intrinsic. The terms 'extrinsic' and 'intrinsic' in this respect can refer only to the *origin of the immediate inducer* of the reinforcing action as being outside the learner's body, as a reinforcer in the Skinnerian sense, or 'inside', as the spontaneous and active movements of the learner itself.
3. By 'sensation' here is intended something of which one is aware, a 'feeling'.

OUTLINE OF THE 'NAIVE' HYPOTHESIS¹

This overall picture of the motivating (generalised reinforcement), reinforcing and controlling mechanism of experience-creation will be followed by a little more examination and a more systematic description of the various features.

PROPOSITION 1

Let us postulate a reinforcing agent or *reinforcant* which can come into being so influencing the conditions as to maximise the probability of some patterns' being rehearsed or re-created.

PROPOSITION 2

Let us further suppose that *all* sensations² associated with sensory-receptor activity are also always accompanied by a greater or lesser quantity of positive reinforcant. Any pattern of sensory receptor activity which, during its transmission as nerve-impulses through the higher reaches of the CNS, is registered as distinguishable from the background activity, is associated with or may be said to induce a measure of reinforcant.

PROPOSITION 3

And that those sensory receptor patterns which are somehow judged to be more worthy of being repeated - the more significant patterns - engender relatively more reinforcing factor (reinforcant) than other less significant patterns, which include the background 'noise'.

We thus suppose that significant patterns are marked for recording by a positive reinforcant - which I sometimes choose to call 'pleasure'³ - a factor or force modifying behaviour in a positive way, and capable, *when sufficiently great* (in amount and/or 'level'), of being apprehended as a positive feeling or emotion.

Footnote

1 This is the form of the hypothesis of reinforcement, motivation and control formulated in 1964.

2 By 'sensation' in this context is intended the patterns of nervous activity within the nervous system which originate in the activity of the sensory receptors and which travel *towards* the brain.

3 See 'Note on the use of the Terms Pleasure and Unpleasure'. (Appendix C)

We can infer such a positive reinforcement from a child's play behaviours and also from his or her response to what we usually call 'rewarding'. Our own introspections, when empathising with the child actively enjoying play or being rewarded in some way, allow us to recognise the sensation which is referred to in conventional speech as 'pleasure'. Since we introspectively recognise our experience of various levels of conscious 'pleasure', from extreme ('ecstasy') through various degrees of 'delight' to mild 'contentment', we can extrapolate to levels of 'pleasure' which are *subliminal*. Subliminal sensations - although the phrase sounds paradoxical - can be thought of as sensations reduced just below consciously perceptible levels which nevertheless are potent enough to influence behaviours and to flavour moods.

That the positive reinforcant is the pleasurable sensation is most unlikely and it is not necessary or even likely that the learner is usually consciously aware of variations in 'pleasure' levels; however it is probable that the anticipation of such sensations plays a role in incentivation and in the extrinsic reinforcement of operant conditioning, (perhaps sometimes as the relief from a strainful 'need' as in partial or temporary satisfaction of an appetite).

It will be seen that the notions of 'pleasure' and 'unpleasure' as conscious sensations do not figure in the primary propositions.

Propositions 4-6 will be examined later.

SIGNIFICANCE

PROPOSITION 7

Let us now suppose that one of the criteria of 'significance' is 'frequency of occurrence' and that the more often a *sensory pattern*¹ is encountered the more readily it is reinforced and its trace added to the store of experience²; that is to say, the more 'familiar' the pattern, the greater the amount of accompanying positive reinforcement and the greater the likelihood of its future occurrence or subsequent familiarity³ within the repertoire of patterns.

Footnote

1 By sensory patterns or sensory receptor activity patterns (RAPs) is meant the pattern of activity within the receptors themselves or the consequent patterns of nervous activity (nerve impulses) within the flow pathways of the CNS.

2 Experience, to be defined later (see Section 4.3, Postulates 7 and 8), implies the capacity for re-activating the behaviour which engenders such patterns.

3 Familiarity will be defined later (see Section 4.2, PROPOSITIONS 5 and 6).

REINFORCEMENT

Reinforcement: Proposition 2 implies that every receptor-activity pattern immediately awakens this reinforcing influence, together with its potentially positive sensation. This reinforcant may perform its function or duty immediately, that is to say, during the activity; or an excess of it may be utilised to adventitiously cement an otherwise unrelated association, or to 'seal' a complete action or behaviour. For example: actively effortful play is self-reinforcing, (positive) reinforcant being continually mobilised throughout. Under these conditions a particular sequence of movements occurring only once or the simultaneous 'recognition' of some entirely fortuitous association may be reinforced adventitiously by the momentary excess or overflow of the (positive) reinforcant engendered by the activity.

The relationship between the pattern being reinforced and the reinforcant induced by that pattern of sensory activity is clearly different from the relationship between the pattern and a reinforcant of unrelated origin. The former reinforcant being engendered by the very activity it is strengthening may be termed *specific*; that utilised fortuitously or induced by a 'reinforcer'¹ to effect or strengthen an unrelated association or action may then be termed *non specific*.

MOTIVATION

Motivation: From Propositions 1, 2, 3 and 7 it will be seen that the more receptor-activity patterns generated per unit time the greater the concentration of reinforcant and, since this implies a greater likelihood of any particular pattern's occurring more frequently, the more reinforcant per sensory pattern. Any bodily activity will stimulate receptor activity to produce positive reinforcant. The greater the amount of activity engaged in, and the greater the vigour of the activity involved, the greater the amount of *positive* reinforcant: *effortful activity therefore encourages effortful activity*. That is to say, the *learned* striving to generate positive reinforcant by means of effortful activity results in a powerful tendency or inclination *to be active and to make movement*.

This tendency represents the motive power for observing² or producing active behaviours, for actively seeking to repeat patterns of experience - it is *motivation*.

Motivation is self-replenishing motive power but it is more than this, more than power lying dormant waiting to be used; it is urgent pent-up power temporarily restrained or suppressed but continually seeking controlled release into purposeful action.

Footnote

1 An object or behaviour used to reinforce a behaviour, commonly referred to as a 'reward'.

2 Observation (see Section 4.3, Postulates 11 and 12).

Interest is a function of understanding and understanding is related to the frequency of occurrence and familiarity (and perhaps other criteria of significance) of receptor activity patterns, etc.; however it will be seen that, although motivation is thus related to levels of interest in general it is not 'directional' in that it is not the interest in an activity, etc. which motivates.

Motivation is thus both *learned* and *blind*.

The antithesis of motivation is incentive or *incentivation* which, bearing the same relation to post-activity reinforcement as motivation does to simultaneous reinforcement, tends to induce completion or 'closure'¹.

Our model now seems to have (i) a power supply and a means of continually charging-up this source of power; and (ii) a means of selecting out and enhancing the likelihood of recurrence of the most significant patterns of sensory receptor activity for use as the raw materials in the creation of experience.

The model suggests that the experience-creating system (child, animal, adaptive machine) should through actively effortful movement become progressively 'charged-up' or motivated to engage in movements which further excite sensory-receptor activity, and be thus increasingly drawn towards repeating every movement and action.

Under the conditions outlined each action (definer ²) and direction of action or that aspect of the environment towards which the definer is directed (director ³), that is to say each 'observation', would be expected to increase the attractiveness of that observation and to enhance the urge to re-create or re-engage with it.

Footnote

1 Closure or the abrupt culmination of an act which tends to be accompanied or followed by a fall in 'tension', a relief from uncertainty.

2 A definer is a classifiable action or bundle of closely related actions such as 'giving', 'putting', 'picking-up' etc. It will be noticed that its linguistic equivalent or verbal-definer corresponds approximately to the 'verb'.

3 A director is whatever marks the location towards which a definer is directed. This is usually an object. Hence a verbal-director corresponds to a 'noun'.

This ostensibly desirable tendency does however suggest at least two weaknesses or flaws which would need adjustment, correction or modification before our model be accepted. Namely an apparently uncontrolled exponential build-up of movement-activity whose extent, limits and vigour are unclear, and the lack of clarity as to whether the forms or kinds of activity encouraged by such a mechanism would be likely to veer towards variety or cling to stereotypy.

For example, would the activity build up to some maximum limited only by the exhaustion of the available fuel or the accumulation of metabolites in the 'motor' tissues referred to as fatigue?

Would the activity become increasingly random and chaotic or would it be narrowly restricted to whatever activity happened to be the first to be initiated? What factors would determine the choice between variation and monotony? What mechanism(s) ensures that the range of variation is sufficient so preventing the activity's being limited to precisely repeated chains of identical actions or stereotypes, and allows for abrupt changes of behaviour, and for choice between behaviours? What mechanism(s) prevents the experience-creating system from going into oscillation¹ or 'burning itself out'? What mechanism(s) prevents the experience-creating system's engaging freely with and thus falling foul of destructive situations with which it has had no prior encounter?

If a child learns in this way how does it come to recognise dangerous or inappropriate situations? Perhaps even more important to learning, how does it learn to vary the *rate* of its meeting with learning situations? That is to say, how does it *control* its learning?

Why is it that ordinarily the child becomes neither a fireball of curiosity, neglecting food and sleep in its pursuit of pleasure, nor an accident-prone victim tending to represent a danger to itself when it begins to move bodily about?

Of course an occasional child does become an exceptionally energetic prodigy and some toddlers do have accidents² but a lot less than one would predict from the model as it now stands.

Footnote

1 A condition of activity in which each action amplifies its own output. 'Positive feedback'.

2 The commonest serious accidents among toddlers occur under conditions where the danger is hidden from the child as for example a saucepan of boiling water on a cooker as opposed to a bowl of hot water on the floor.

The model, as developed so far, does supply a source of power for activity but seems only to deal with learning in terms of greater or lesser degrees of unrestrained attraction, of greater or lesser probabilities of recurrence. It does not account for continuously variable regulation of the amount, urgency or vigour of behaviours.

Selection of patterns to be marked for future rehearsal or re-examination, that is to say for reinforcement, is made on the basis of how significantly more worthwhile one is than another. There is no provision in our model for negative significance, for the active rejection of a pattern of activity. There is no provision for a repulsive force to oppose the attractive one in governing the application or outlets for the forces of motivation.

The model lacks a mechanism for autonomously regulating the rate and tendencies of early learning.

CONTROL OR REGULATION OF LEARNING

Control

There are of course, physical controls which limit the total amount of activity. For example, the activity entails the movement of mass - the more massive the parts moved, the larger the movements, the greater the amplitudes of the movements, the bigger the turning moments of the various levers involved, the greater the frequencies of individual movements, and the longer the duration of an activity, as well as the greater the impedance against which each movement must act, the more effort is required.

A tendency to fatigue as a result, for example, of the constant need to oppose gravitational forces is itself a controlling factor in the child's meeting with change.

All these factors increase the 'load' on the motive power and, to some extent, variously limit the total amount, or specifically some of the components, of the total activity. As a child grows its total mass, its height and length of limbs increases, and its overall shape changes, all of which 'absorb' and offset the exponential gain of motive-power during the same period of time.

Thus the inevitable increase in bodily size and changes in bodily form both impose a rapidly increasing load on the power resources and tend to limit the possibility of unbridled intensification of unopposed activity.

These physical forces exercise a general controlling influence on the overall activity of the child and probably represent the most important government of activity during the first six months of human postnatal development; however they do not vary from moment to moment, do not adjust to the dangers as conditions and circumstances change and they little influence choices involving similar actions on different occasions.

For such moment to moment control there needs to be a continuously variable mechanism locked into the observation or experience-generating process itself. A reciprocal negative force is required to counterbalance the positive one. In view of our coupling the postulated (positive) reinforcant with the sensation of 'pleasure' could the necessary antagonist be 'pain'?

In common parlance pleasure is opposed to pain; however pain as an aversive influence does not seem to answer our need, for children are not constantly hurting themselves. In any event, pain usually results from something's already having gone wrong - the child's having fallen off the table or burnt itself. For our model we need something which operates continually *during* the learning, something which controls or regulates the conditions - an 'error actuated negative feedback' mechanism.

We need another factor whose accompanying sensation is the opposite of and tends to counter pleasure - an unpleasure. Combinations of varying proportions of pleasure and unpleasure, or rather the reinforcants which are capable of giving rise to such sensations, independently of the actual amounts or concentrations of the antagonistic components, would seem to provide for a wide range of states embodying both attractive and repellent forces and varying between the two unadulterated potential extremes.

Let us then augment our first, second and third propositions so as to suppose that all receptor-activity is associated with a greater or lesser quantity of two, mutually opposed or conflicting reinforcants, one of which is the *positive* reinforcant we have already postulated, the other being a *negative* reinforcant (associated, when sufficiently 'strong' in level or quantity, with sensations of emotional discomfort or 'unpleasure'). Thus:

PROPOSITION 1 (emended)

Let us postulate two mutually antagonistic reinforcing agents or reinforcants which can come into being as a result of sensory receptor activity so influencing the prevailing conditions as to vary the probability of some patterns being rehearsed or re-created by the potential learner.

PROPOSITION 2 (emended).

Let us further suppose that *all* sensations* associated with sensory-receptor activity are also always accompanied by greater or lesser quantities of *positive reinforcant* (or *posiforcant*) and *negative reinforcant* (or *negiforcant*). Any pattern of sensory receptor activities which, during its transmission as nerve impulses through the higher reaches of the CNS, is registered as distinguishable from the background activity, is associated with or may be said to induce measures of both positive and negative reinforcants.

* See note on 'sensation' in Section 4.2, original Proposition 2.

PROPOSITION 3 (emended)

Those patterns which are somehow judged to be more worthy of being repeated - the more positively significant - engender relatively more positive reinforcant (posiforcant) than other less significant patterns or '*background noise*'. Those patterns which are somehow judged to be less desirable or more worthy of being suppressed or opposed - the more negatively significant - engender relatively more negative reinforcant than other less significant patterns, including background noise.

We can now interpolate fourth, fifth and sixth propositions into conveniently 'overlooked' gaps in our numbering system.

PROPOSITION 4

The generation of positive reinforcant and that of negative reinforcant are largely independent, as are their individual actions. Furthermore, the quantities produced and the levels reached of each kind of reinforcant, are related to the ratio of the quantity of familiar pattern to the whole quantity of awareness in any perceptions; thus:

PROPOSITION 5

The quantity and level of positive reinforcant is **directly proportional** to the familiarity content that is to say, to the proportion of the whole of any particular perception which consists of patterns which have been encountered frequently before.

PROPOSITION 6

The quantity and level of negative reinforcant is **inversely proportional** to the familiarity fraction of any particular perception.

From these propositions we would expect that a child meeting with, that is to say becoming aware of, a less than very familiar situation would feel attracted to it according to the content of patterns it has met with before but also feel repelled by an awareness of what is not yet understood. Its 'approach' would be one of interest tinged with caution, but with each repeated experience interest and enjoyment increase, whilst emotional 'insecurity' diminishes.

Origin of Cautiousness and Cautionary Behaviour

From a consideration of the first year in a child's growth we might expect that caution and control would be especially necessary from the time the child begins to move spontaneously from place to place. And indeed such is the case. Observation reveals that children do become more cautious during the second half of the first year and, during this time, begin to show actual signs of 'fear' and 'anxiety' for the first time. Before this stage emotional distress tends to be associated with pain or other physical discomfort or with startle, but now, by three-quarters way through the first year, a normal child may show 'fear' or 'anxiety' at the appearance of an unfamiliar face and, by early in the second year, at suddenly recalling or realising that her mother is not near at hand. Are these emotional changes in the developing child related?

PROPOSITION 8

Reinforcant, although related in amount and duration of production to, and indeed being induced by, the 'perceptual' (deriving from the sensory receptor activity) pattern being experienced and reinforced, is not necessarily restricted in amount to the actual reinforcement needs of the pattern responsible for its production.

Since the familiarity content of perception determines the amount of (both) posiforcant (and negiforcant) very familiar patterns will normally engender an excess of posiforcant which then becomes available to reinforce the recurrence of patterns unrelated to those occasioning the production of reinforcant, or to cement associations between patterns unrelated except by contiguity in time and space, or some other linking mechanism.

This then is the source of the posiforcant utilised in the 'extrinsic' non-specific reinforcement of Operant Conditioning in Behaviour Modification or 'reward training'. Simple associative 'learning' and the training of social conduct etc., most commonly employs such non-specific reinforcement.

PROPOSITION 9

Similarly (analogously to proposition 8) accesses of negiforcant, due to (enforced or unexpected) perceptions with very low familiarity content, are commonly well in excess of what is required to ensure the necessary control or regulation of the observing behaviour (or 'observation').

The excess of negiforcant is thus available for 'aversive' or punitive training, or to induce entirely adventitious negative associations and, when sufficient, to engender phobias.

Does the negative mechanism in reinforcement come into effect only during the later months of the first year, as casual observation would suggest? After all, one does not

witness a continuously variable controlling force during the first six months except under the conditions of pain etc., as already mentioned.

I have suggested elsewhere that until a child is an organism* with an, at least partially, unified body-image it can not experience a unified *realm of awareness* to provide the discrepancy between the familiar fragment and the perceptual whole, although the mechanism does operate in respect of an individual 'limb' thus controlling the manner and rate of experience creation by that bodily part. Hence, although the two-reinforcant mechanism operates from the foetal stage, the generation of unpleasure in response to uncertainty would be unlikely to appear in the general demeanour as overt 'anxiety' before the middle of the first year from which time momentary episodes of evident anxiety are likely to be seen with increasing frequency over the period six to fifteen months. Which is what we observe in normally growing children.

CONTROL IN THE GENERATION OF EXPERIENCE

The first main controlling force, which is not continuously variable, is growth in size and change of bodily form. These progressive changes impose an exponential increase in the necessary motive power to compensate for the increasing bulk and the increasing 'turning moments' of lengthening limbs. The other, a continuously variable, controlling force outlined in the propositions, operates on the basis of the quantity of familiar pattern which gives rise to positive reinforcant, and the proportion of awareness during a perception whose component patterns are 'less familiar' (less well understood).

Footnote

* That is, a child has to learn to become an organism, or unified whole, a 'self', before which time (towards the end of the first six months of post-natal life) it consists of a number of loosely connected, more or less autonomously learning 'limbs'.

4.3 THE THEORY OF LEARNING - Reinforcement, Motivation and Control
- given as a series of statements, postulates, definitions and conjectures

MOVEMENT AND BEHAVIOUR

1. A *behaviour* is a potentially reversible change of state or change in the disposition of the elements of a pattern.
2. For the purposes of this essay a behaviour is an *active* bodily movement.
3. A *movement* is a temporary change in the spatial disposition of the bodily parts.
4. For the purposes of this essay all behaviours referred to *are or have their origins in* movements.
5. 'Mental' behaviours have their origins in movements and some mental behaviours are direct abstractions of bodily movement patterns.

LEARNING

6. Learning is the transient and temporary process by means of which/through whose action experience is created/engendered.*

Learning is the act or process of the changing state within the system of which experience is the direct product. Learning might be said to begin with the selection of an 'observation' and to terminate with the assimilation of the created experience. From this it will be seen that learning is more-or-less coterminous with the observation.

EXPERIENCE

7. Experience is that which accretes as a result of an observation when the feedback 'image' of an event (and the effects of an event) are compared with the *design for the event* (and the *expectation for the effects of the event*). This discrepancy between the design and event, if 'available' to the CNS is potential novel experience, which (if) once 'recognised' and

Footnote

* Since the understanding is being constructed from the differences between the designed and the eventual observations it would seem that *creation of* experience and understanding is the most apposite notion.

assimilated into the current understanding, becomes novel experience and enriches or expands the state of understanding.*

Since that *state of understanding* consists of a complex of observation-designs any newly created experience alters the state of understanding in terms of *observation-designs* which are actualised or exteriorised through or as behaviours.

8. Experience, then, is a lasting change in the current repertoire or range of behaviours of an animal, human or adaptive machine, which continues thereafter for a finite period of time.

A change in the *behaviour generating state* may be said to be a gain of experience, as a result of and following which new behaviours are 'generatable'. A measure of experience gained or created is the increased capacity for generating behaviours that did not exist prior to the 'gain' of experience.

'Learning' and 'experience' are very closely related but learning is the process by which experience is created, so that when we infer that experience has been created from reference to a lasting change in the repertoire of behaviours and that this experience has been assimilated so as to have produced a change of state (understanding) within the system which engenders the behaviours, we may say also that a process of learning has taken place to bring about these changes.

Footnote

* Where there is virtually no discrepancy the experience is 'confirmatory'.

UNDERSTANDING

9. *Understanding* is the adaptive behaviour-generating state or capacity for generating experience-creating observations, and for (continually) undergoing changes of state as a result of such assimilations.*

10. *General Understanding (GU)* is defined as that adaptive capacity which is the core of understanding common to all humans and which is relatively free from environmental singularity and cultural bias.

The dynamic state of understanding whether we are subjectively contemplating our own understanding capacities or considering those of another person, animal or adaptive machine, is only accessible by way of the observation of its realised and (from the point of view of an outside observer) exteriorised behaviours. There is no way of knowing of, or even suspecting its existence except in the realisation of its behaviours, that is to say, in its actively making observations or acting on its world.

This means that in observing another person, animal or adaptive machine we must infer the state of understanding from its behaviours and a change of understanding from the appearance of behaviours which were not observable prior to some instant but which are recognisable over a finite period of time following that instant.

Therefore, without invoking the 'inside knowledge' of the engineer whose adaptive machine actively evidences a physical or physiological 'enduring change' in its 'known' state, as for example a unit increase in the charge on a capacitor or a newly tripped relay, it is the *change* in the repertoire of the machine's or animal's behaviours which evidences the gain or creation of experience or more accurately *is the experience created*.

A state of the behaviour-generating system may endure over a period of time during which the component unit behaviours remain constant in form. Each individual unit behaviour is defined as a temporary and repeatable change in the disposition of bodily parts or a distinct change of posture.

If from some instant one or more unit behavioural types is added or deleted from the register or if there is some distinct modulation in the frequency of occurrence of one or more unit behaviours we may say that the state of the behaviour-generating system has undergone an enduring or lasting change. This we would recognise as an enduring or lasting change in the behaviours of the animal or adaptive machine.

Footnote

* It is assumed that realised experience, as opposed to its precursor 'potential experience', implies at least some degree of assimilation.

When we say that experience has been created during a change in the state of the behaviour evincing system it follows that the difference between the former and the latter states represents the created experience.

Novel experience is that which when added to or assimilated into a behaviour-producing state changes the behaviour producing properties of that state.

If the behaviour producing state is referred to as the condition of understanding (or knowledge) then the creation of novel experience may be said to increase the understanding (or to add to the state of knowledge).

The act or process by which this change of state or creation of novel experience is brought about, is called *learning*.

11. An *observation* is a defined behaviour selected from the organised repertoire of observation designs which defines the state of general understanding. Each actualised observation is an event which approximates to at least one of the variants of the design which engendered it.

12. An *observation-design* consists of a bundle of variants (or variant possibilities) any one of which is defined by that design, and each of which represents a possible observation-event.

REINFORCEMENT

13. The activity of the sensory receptors and perhaps more particularly the events within the central nervous system which immediately follow this receptor activity is, at some level of perception involving apprehension of pattern, accompanied by, or effective in inducing, an access of forces which *directly influence the probability of recurrence of the pattern* which induced the forces, or of similar or related patterns.

14. This effect is referred to as reinforcement.

15. It is postulated that some factor (or factors) marks the occurrence of each sensory receptor pattern according to its significance, so determining the overall probability of its recurrence. Such a factor, to be called a reinforcant, may be either positive or negative according to its influence on the rate of appearance of the behaviour producing the sensory receptor activity.

16. These factors or forces which when mobilised persist for a brief but finite period before dissipating are of two opposing kinds, a positive reinforcing agent - *posiforcant*, which increases the likelihood of recurrence of the pattern which actuated it, and a negative reinforcing agent - *negiforcant*, which diminishes the likelihood of the pattern's recurring.

17. Posiforcant and negiforcant when of sufficiently high titre become sensible to awareness and are experienced as the sensations here called *pleasure* and *unpleasure* respectively.

18. *Pleasure* is here defined as a state or condition due to the presence of posiforcant, and associated, when the level is above a certain threshold, with a characteristic 'sensation', which creates a positive state of awareness or positive *mood*, and which can be inferred from a behavioural tendency or striving of the organism to maintain, repeat or to seek after that state or condition.

19. Posiforcant is the primary source of the sensation of pleasure as well as the primary factor in reinforcement; however, it is not necessary to assume that the *sensation of pleasure* is necessary either to reinforcement or to motivation.

20. *Unpleasure* is here defined as a state or condition due to the presence of negiforcant, and associated when the level is above a certain threshold with a characteristic 'sensation', which creates a negative state of awareness or *mood*, and which can be inferred from a tendency or striving on the part of the organism to escape from or avoid that state or condition.

21. Negiforcant is the primary source of the sensation of unpleasure as well as the primary factor in negative reinforcement.

22. It is the posiforcant and/or negiforcant accompanying apprehended nerve impulse patterns as a sort of halo which all together produces *the realm of awareness*.

23. *The quantity of affect* (pleasure and unpleasure sensations accompanying the production of posiforcant and negiforcant) is directly proportional to the capacity size of that fraction of the realm of awareness which is available to observation at any one time - the awareness capacity.

24. The realm of awareness is defined as the whole region of physical and mental space which, for any individual, can be consciously apprehended by that individual.

25. The awareness capacity is defined as that region of physical and mental space which can be attended to at any instant during an observation.

26. *Consciousness or self-awareness* which confers the ability to relate understanding to past events and to anticipate future events or to plan ahead is assumed to be a function of the state of general understanding.

27. At any instant the ratio of posiforcant to negiforcant, and the proportion of pleasure to unpleasure is related to the *familiarity content* of any *perception* or observation.

28. Perception is defined as the active attending to that part of the total realm of mental and physical space which can be apprehended at any instant during an observation together with the patterns which are apprehended.

29. *Familiarity content* is defined as that proportion of the component patterns within the realm of awareness of a perception which is adequately recognised. Signal to noise ratio.

30. The quantity of *posiforçant or pleasure* induced in association with a perception is *directly proportional* to the fraction of awareness which is familiar- that is to say, the higher the proportion of familiarity the greater the quantity of positive reinforçant or pleasure.

31. The quantity of *negiforçant or unpleasure* induced in association with a perception is *inversely proportional* to the fraction of awareness which is familiar. That is to say, the lower the proportion of familiarity the greater the quantity of negiforçant or unpleasure.

32. Posiforçant and negiforçant and their sensible equivalents, pleasure and unpleasure, are independent variables and *in no way are they extremes of a common continuum*.

33. *Learning*, or the realisation of experience, is defined as the transient process as a result of which an enduring change in behaviour, which represents the creation of experience, occurs.

34. New or changed behaviours, once manifested, are rendered more or less likely to be repeated according to the amount and balance (of proportions) of accompanying affect - positive and negative reinforçant.

35. All sensory activity reaching a perceptual level is accompanied by the release of positive and negative reinforçant (pleasure and unpleasure), whose total and relative quantities are proportional to the total and relative familiarity of the perceptual content.

36. The positive and negative reinforçants effect their influences continually during the activity which produces change in the sensory receptors but cease as primary reinforçants at the cessation of the activity.

37. Reinforçant induced by patterns in perceiving tends to linger a little beyond the duration (after the cessation) of the perception. In this way it is possible for reinforçant to accumulate temporarily and to be available to mediate indirect or non-specific reinforcement. These excesses or rather their sensible concomitants also colour the emotional state or mood.

38. The specific sensations which accompany receptor activity confer specificity on the accompanying affect, so as to imbue it with a flavour, so to speak, of the sensory modalities and the perceptual patterns involved. Primary reinforcement is therefore specific to the event being learned.

39. Posiforcant is of itself initially characterless, its subsequent particular nature deriving from its initially loose 'attachment'* to particular pattern(s) in the particular sensory modality which evoked it. This attachment is ultimately to the core definition (definer-design) of an observation as it emerges, and is therefore much accentuated by the repetition; this means that the attachment is less intimate with an individual pattern-event than with the definer design which results from innumerable similar patterns. Just as a particular sensory receptor activity pattern's evocation of a reinforcant (posiforcant) enhances the probability of that particular pattern's being repeated, so sensory receptor activity patterns in general enhance the probability of future sensory receptor activity in general. This tendency for receptor-activating movement to promote the likelihood of subsequent movement I refer to as 'motivation'.

Note * Attachment as a marker singling out the significant from the less significant according to the 'amount' of associated reinforcant.

MOTIVATION

40. Motivation or drive is the active striving for/seeking after the condition of maximal posiforcant (pleasure) by direct or indirect self-stimulation of the sensory receptors.

41. Since the most consistent and dependable way of stimulating sensory receptors is by actively moving the bodily parts, *motivation*, for a child, is in effect the *tendency to move*.

42. Motivation is blind and independent of specific interest; however, since the design for an active movement must be 'chosen' from the repertoire of observation-designs which go to make up the general understanding (GU) it follows that the more well-established and familiar, or more recently utilised designs will tend to be selected more often than the poorly understood or the little used.

43. Motivation is the motive power which drives all human activity. Since it must drive an increasingly large and more complex body and understanding, motivational power must continually increase compensationally throughout the period of physical growth.

44. Motivation is self-replenishing motive-power but it is more than this, more than power lying dormant waiting to be used. It is urgent pent-up power temporarily restrained/suppressed but continually seeking controlled release into purposeful action.

45. Interest is a function of understanding and understanding is related to the frequency and significance and familiarity of receptor activity patterns, etc.; however, it will be seen that, although motivation is thus related to levels of interest in general, it is not 'directional' and it is not the interest in an activity, etc. which motivates. ***Motivation is thus learned and blind.***

The antithesis of motivation is *incentive* or *incentivation* which, bearing the same relation to post-activity reinforcement as motivation does to simultaneous reinforcement, tends to induce completion or closure.

46. An RAP (actor¹) when reinforced or marked for future use becomes an element in the gathering bundle of elements which forms a definer-design or blueprint for an action or *observation*. This process of assembly, construction or definition is associated with an increasing likelihood of the recurrence of any member variant of the definer-design. We might say that that kind of action or behaviour has become an integral component in the child's repertoire of behaviours or *general understanding*.

A foundation of such definers is learned during the early months which will give rise in due course to derivative or variant definers and also to compound-definers composed of two or more 'fundamentals' in 'series' or 'parallel'.

Once established, observations² consisting solely of definers give rise to those which are directed towards specific locations relative to the child - most commonly locations occupied by objects.

Such 'full' observations will be interpreted by an adult observer as the child's 'looking at a spoon', or 'poking a cube with her finger', or 'picking up a cup' etc. Hence the reinforcement of the primary definer-design somehow leaks over into the reinforcement of the associations of the realised definers, especially to the RAPs associated with the objects acted upon and their own behaviours.

The reinforcement of an observation then implies a tendency or increased probability for that complete observation - directed definer - to be recognised, recalled or re-realised. This excess of reinforcant can further leak so as to cement other more remote associations. (See Associational learning + 'Operant Conditioning', Appendix A).

Footnote

1 That is to say, the sensory receptor activity pattern associated with an active physical movement as opposed to an RAP from some other source.

2 An observation is the expression of an 'understanding-design'.

47. Motivation is the capacity for discharging/directing *active effort* via physical action, emotional response or cognitive behaviours, as if from a store of potential energy.

Initially motivation is realised entirely in the effortful physical activity of movement, which expresses the understanding and creates new experience, but subsequently the necessary additional regulation of such behaviours (involving the integrated co-operation of several functional departments – physical/mental/affective) involves sensations of the kind we call 'emotional strain'. This to some extent consumes effort in a way analogous to that of physical activity, and eventually comes to be expended in the scanning, selection and design for action of an observation, both outwardly expressed and 'internally realised'.

In the early years however, physical effort involving movement of the bodily parts and the active sustaining of bodily postures, represents the source and expression of motivation. Every active movement evokes positive reinforcement whose function is to render more probable the recurrence of that movement, or closely similar or related ones. Since all movements are so reinforced and ranges of tolerance (and other factors) ensure that much variation in movement and the assumption of definitive postures is likely, any and all movements tend to promote an increase in the amount and range of future movements, or putting it another way, potentiate motivation.

Furthermore repetition of individual movements and increasing total amounts of movements in the face of increasing bodily loads and requirements (increasing mass, lengthening limbs, increasing responsiveness) implies great increase in the amount of work being done and an equivalent increase in the necessary expenditure of physical effort.

It is clear then that motivation is this increasing capacity for (more than adequately) powering the growing child and might be expected to continue to more than compensate for increasing demands. Motivation is the tendency/inclination to engage in effortful activity. Motivation may be exploited/may find outlet and be potentiated through the use of *any movement of any bodily part* so these functions *need* in no way be associated with unpleasure or anxiety.

Significance, primary reinforcement, in the foetus and neonate

48. A significant pattern (receptor activity pattern) whether due to an active movement sequence (overt behaviour) or perceived as resulting from some external/environmental influence/force, is defined as one which is 'marked' for a change in the probability of its future occurrence.

49. Positive significance will be marked by posiforcant whilst negative significance will be marked by negiforcant.

50. *Primary* significance, which will be initially almost if not entirely positive, it is postulated, is conferred by - or may be said to be a function of - the familiarity of the RAP.

51. The familiarity of a RAP will be due primarily to its relative frequency of occurrence.

52. Relative frequency of occurrence refers to the rate (and recency) of occurrence in relation to the totality of RAPs.

53. The RAPs registered are those due to an active observation or of an external origin but to which an active observation is directed (or on which an active observation is focused).

54. Registration of a RAP, in view of the innumerable patterns of sensory receptor activity exciting afferent flows of nerve impulses, must somehow depend on a certain signal-to-noise ratio, the signal status being conferred by its significance which is a function of its recent frequency of occurrence.

55. The earliest RAPs will be those produced by the 'spontaneous' movements of the foetus and infant and given form by the physical constraints of the bodily physical structures and by the forces that govern the expressions of the 'postural reflexes' (See paper three, 'Movement and Sensibility: Tolerance and Constraint'). These relatively few movement patterns/postural changes will necessarily recur frequently during early life and will therefore incur highly significant receptor activity patterns in virtue of their high actual frequency and high relative frequency (or high signal-to-noise ratio). This means that as the realm of awareness forms in association with organismic development the RAPs associated with these early basic movements or *fundamentals*, from which all other behaviours will subsequently derive, must assure/guarantee a very high familiarity content from or within virtually all perceptions. (See 4.2, Proposition 9, para 4.)

56. Despite the fact that every RAP registered by the higher reaches of the CNS induces a quantity of reinforcant potentially consisting of a combination of posiforcant and negiforcant, the nature and form of the developing organism is such that all early patterns generated, which in due course will lead to the creation of an organismic awareness, must necessarily have an almost total 'familiarity content', so that the ratio of posiforcant to negiforcant will be almost 1:0 (one to zero – 100% posiforcant). Hence until at least the early stages of organism formation, reinforcement and learning will be almost entirely positive.

57. Meaning The meaning of a behaviour is not a property of that behaviour but a measure of the interpretation of that behaviour by an observer. That is to say, the meaning of a behaviour is a function of the response to that behaviour by an observer.

58. Interpretation The interpretation of (an observed) behaviour is the form of changes, and the degree to which these changes occur, in the understanding, or behaviour-generating state, of the observer.

APPENDICES

APPENDIX A

A Note on Operant Conditioning

Operant conditioning and behaviour modification

No attempt is to be made here to discuss these processes but a very brief outline description of the basic mechanism is given so as to facilitate the suggestion that it is a contingent mechanism/process of the more general reinforcing and controlling mechanism outlined above.

Operant conditioning is said to take place when a given consequence - the reinforcer - is contingent upon 'certain physical properties of behaviour' - referred to as an operant, and the behaviour can be observed to increase in frequency. In operant conditioning the 'reinforcer' is contingent upon the operant behaviour, unlike 'classical' or Pavlovian conditioning in which a 'reinforcer' is paired with a stimulus (an event which might be expected to produce a consistent response). In operant conditioning the event of a reinforcer is said to 'strengthen' the operant behaviour or to render its occurrence more likely - as may be observed in its subsequent frequency of occurrence.

The deliberate and conscious controlling or 'shaping' of behaviour by operant conditioning is referred to as 'behaviour modification' or more accurately as 'operant reward-training'. So far as I know the standard behaviouristic attitude would not attempt to 'explain' behaviour modification techniques in terms of an entirely hypothetical entity such as a reinforcant, and a reinforcer is defined basically as an environmentally (potentially) observable consequence that does strengthen the antecedent operant behaviour. When the influential consequence (event) may be said to accrete, the reinforcer is said to be 'positive'; when the influential consequence is diminished it is said to be a 'negative' reinforcer. However, at least some reinforcers are considered as events which supply some biological or survival necessity so that there is an implication of some non-demonstrable 'factor' being involved in the mechanism.

My only concern is to suggest how the undoubted process of operant conditioning can be seen as a kind of occasional spin-off from a much more fundamental learning process.

Positive reinforcement of the entirety of an observation, consisting of a definer (or definers), directed to certain locations and to the objects occupying those locations (directors), and anticipating certain effects upon the environment, including the body of the observer (experience-creator), will involve the induction of posiforcant in association with the RAPs produced by all phases of such an observation. It will be seen that the posiforcant associated with the definer (action) will accompany a temporal sequence of RAPs ('praxic

perception' RAPs): the changes in reinforcement result from the changes in the definer and direction of the observation itself. By contrast, although the directors (objects) may themselves manifest behaviours (that is, undergo spatial translation, re-orientation and/or deformation), the RAPs associated with them tend to be of the 'constant image perception*' variety, with the 'passive' effects of the image of the object on the observer.

The posiforcant induced by the definer RAP in its excess due to its assuring a high familiarity content within the observation (perception), and in its tendency to persist for a short but finite time before dissipation, is additionally available and able to reinforce the relationship between the definer and the director (target or object of its 'interest') of the observation.

Such excess or superfluous reinforcant (let us assume posiforcant for this argument) is thus available for the cementing of adventitious associations between actions, events, actions and events, objects and patterns, events and objects etc., actions and objects, etc. It follows that the deliberate production of a *familiar, high-level-of-posiforcant-producing-behaviour* represents an effective **reinforcer** in the mechanism of *non-specific reinforcement* or *training* as practised in *Operant Conditioning* and *Behaviour Modification*, (as well as in what BF Skinner refers to as 'superstitious' conditioning), which will thus be seen to be exploitable by-products of the *primary mechanism of positive reinforcement*.

A similar argument 'explains' the origins of the excess or superfluous negiforcant exploited in negative conditioning and 'aversive' therapy (as well as that of both rational and 'irrational' phobias).

* See essay (*The processes of Sorting and Matching*, section 4.3, Waldon Association website, for an explanation of the distinction between constant/sustained image perception and praxic perception.

APPENDIX B

Personality and Handicap

The mechanism within the learning process which regulates the probability – the rate and frequency – of recurrence of a behaviour is itself subject to learning.

A single encounter evoking a great excess of negiforcant may result in extreme repulsion virtually ruling out the possibility of future encounters.

Frequent encounters which nevertheless persist in evoking relatively high proportions of negiforcant may lead to the learning of elaborated behaviours which tend to bring about active physical retreat, amounting to *escape* from conditions eliciting these excesses of negiforcant.

Such a condition may be associated with a concious recognition of feelings of unpleasure - which emotional discomfort, if severe, might be termed *fear*; or if an apprehension anticipating escalation it would be called *anxiety*.

Conditions like these, especially or perhaps only when associated with an awareness of emotional discomfort – unpleasure – provoke the appearance of behaviours and the learning of more complex behaviours which act as an escape from or to prevent future meetings with the noxious, offensive, objectionable object, situation or behaviour.

The escape and/or avoidance behaviours if awakened repeatedly are mobilised more readily and earlier, becoming associated with and initiated by signs, events, etc. which usually tend to signal the imminence of the impending noxious event and its consequent sensations of unpleasure. These signals then come to trigger the 'defensive' behaviour prophylactically/preventatively, and if effective may completely obviate any chance of the child's encountering the menace.

Such a situation, in which certain behaviours and certain places or things are proscribed from the repertoire and interests of a child, carries a distinct risk of the originally adaptive behaviour's becoming an habitual response to the 'trigger,' irrespective of its necessarily being followed by the offensive element. Once habituated, any delay in the trigger's being followed by the 'defensive' behaviour actually engenders unpleasure ('anxiety') only to be dissipated effectively by the onset of the behaviour in question. Now the behaviour, in generating its own necessity (the need for its reappearance), has become a true habit, no longer necessarily related to the conditions which originally engendered it. This is why inadequate attempts to eliminate 'undesirable' behaviour often lead inadvertently to its reinforcement.

In addition to escaping from, disposing of or avoiding noxious situations, and especially when such defensive ploys are unsuccessful in so reducing the causes of the emotional discomfort, it is possible by engaging in a thoroughly familiar activity to generate the positive sensations which accompany positive reinforcement, thereby neutralising the sensations of unpleasure.

A particular individual, especially when exceptionally vulnerable to the exigencies of life, will tend to habitually adopt certain behavioural ways of coping with strains which together go to make up his typical behavioural tendencies or 'personality'.

The very vulnerable child may early become so dependent upon such defensive avoidance behaviours that he rarely gets/makes the opportunity to meet with the potentially experience-generating situations that are appropriate to his current state and essential to the normal growth of understanding.

Such an individual, who constantly finds himself in a state of emotional discomfort due to his interpreting his state to be one under excessive demand, regularly seeks release from this *state of handicap* by recourse to *handicap behaviours* which relieve his discomfort in the short term but, by interfering with the normal creation of experience, prevent a satisfactory development of understanding and may be regarded as a learned *secondary impediment* to normal development.*

Note * Secondary in that the impediment that initially led to the state of understanding is considered as primary, for example a 'movement impairment' or 'sensory loss', etc.

APPENDIX F

Note on the use of the terms Pleasure and Unpleasure

In the popular version of the 'naive' theory I have used and continue to use the term 'pleasure'. The word pleasure normally refers to a particular sensation or group of sensations and therefore to something which is private to the one experiencing it. However, an individual can claim that various 'stimuli' or the same stimulus on various occasions can be expected, with a fair degree of predictability, to produce the sensation of pleasure. Furthermore certain behavioural expressions, sometimes observable in oneself at the time of experiencing pleasure-sensations, are sometimes to be observed in others who admit to such sensations; hence one may sometimes infer to the presence of pleasure-sensations in others with reasonable confidence. We also recognise pleasurable sensations as those we most wish to relive and activities which occasion or are accompanied by pleasure-sensations, as those we would wish to repeat.

Intuition might then suggest that the sensation of pleasure might be *a* or *the* positive reinforcing agent. However, learning takes place in animals (e.g. an earthworm or squid) which we have no reason to suppose do experience sensations of pleasure, and when we witness the creation of experience in others it is rarely accompanied by behavioural signs which clearly indicate the learner's consciously recognising pleasure. Our model must not have necessary recourse to private sensations. Even if we postulate a factor which we cannot demonstrate except via its effects we must also postulate its potential demonstrability. For various reasons I do postulate 'pleasure' as the positive reinforcant but do not suggest that it is the *sensation* which prefers its positively reinforcing influence. That is to say, there is a positive reinforcant (posiforcant) which might for convenience be termed 'pleasure' which, largely independent of its reinforcing power, when reaching a sufficiently high level or titre or when above a certain threshold level, may be experienced by humans and perhaps other mammals as the *sensation of pleasure*. The sensation is not essential to the reinforcing effect.

The same arguments apply to the relationship between negative reinforcement (negiforcant) and 'unpleasure'.

POSTSCRIPT

Writing to Chris Holland ('Letter to colleague'), Geoffrey Waldon goes into more detail about his thoughts and feelings about the Five Essays -

<http://www.waldonassociation.org.uk/pdfs/library-index/waldon-associates-book2gw.pdf>

The first essay is listed on the Waldon Association (WA) website as *Sorting and Matching* (full title: *Sorting and Matching as Mental Operations Generating New Experience in Child Development*).

The second, *Learning, Reinforcement, Motivation and Control* and the third, *Movement and Sensibility: Tolerance and Constraint*, are in early draft form only.

We have left these substantially untouched, confining ourselves to 'tidying up' punctuation and other small textual details so as to allow the clearest possible expression of Geoffrey Waldon's meaning in his own words.

In addition, we have put in references to his other writings – all on the WA website – when it has seemed useful to add relevant detail.

Unfortunately, we have no drafts or even rough notes for the last two proposed essays - *Organismic Development and the Creation of Bodily Near-Space* and

General Understanding and Conventional Language

- but we have left in some references to them to add resonance and convey a sense of the full scope of his project.

In preparation for tackling the second and third essays you might find it helpful to read/re-read the essay *Understanding 'Understanding'*, which prepares much of the ground which is covered in greater depth and detail in these two essays.

Terry Buchan
Marilyn Crook

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