Educational Paradigms: an epistemological revolution

Fred Emery, December 1980

Introduction

In any process of increasing participation in workplace decision making one inevitably comes to a social barrier between skill based labour and knowledge based labour: between what is properly blue collared labour and what is white collared labour.

This is typically interpreted as the line where participation should sensibly cease. In what follows it is suggested that this is a social barrier: not a barrier dictated by inherited natural differences.

The inspiration for this paper came from two sources. After delivering the presidential address to the new ANZAAS section on Communications, in which I expressed my concern at finding, for twice running, that a major medium for mass communication had proven, on close examination to be quite contrary in its nature to what seemed obvious I came across, on the same day and in the same city, a copy of Northrop Frye's *Fearful Symmetry*. It had long seemed to me that McLuhan must have had a central vision in order to have been so insightful, so often, about the role of the media (See Taking Stock of McLuhan, Chapter 12, Emery and Emery 1976). I had in vain followed McLuhan's suggestion that it lay in the work of Harold McInnis. In Frye's Fearful Symmetry I had my answer. McLuhan's vision was Blake's vision. Blake had seen, with great clarity the fearful implications of the Locke/Newtonian view of the world: `May God us keep from single vision and Newton's sleep'. Frye wrote this work during the throes of World War II and McLuhan was his student shortly thereafter.

To my mind Frye provided an answer to the question of why engineers kept fouling up the design of electronic communication systems - they were asked to design for a Newtonian world.

The second stimulus came from Michael Gloster. He was deeply into the study of non formal education, he was aware of our earlier work on educational processes but asked whether there were not problems about the educational process itself, not just the democratisation of educational settings. This paper is a response to that question. I have written a number of times about ways in which we could democratize the educational process. It was only with Frye's insight and Gloster's goading that I realized that the problem was a fundamental problem of epistemology.

Some readers may feel disappointed that I did not draw on the works of Paulo Freire, Illich, Piaget and Polanyi. These writers have been convergent with the path I have taken here in (a) their criticisms of the old paradigm, and (b) their search for an epistemology (`tacit knowledge', `structural concepts') that does not deny ways of knowing that we clearly possess. However, it has seemed to me that only Heider and Gibson put their fingers on the assumptions that have led us for so long to deny the evidence of our own perceptions. Only they put us in a position to systematically demolish the so-called scientific foundations of those assumptions.

Without the contribution of the Heider-Gibson paradigm the educational reformers can expect to be denigrated, as once Chambers did to Illich for claiming that knowledge is naturally gained and giving as an example the prodigious feat of learning a new language (`prodigious' according to the assumptions of the old paradigm):

“It is also massively misleading to draw an analogy for learning in general from his claim that `normal children learn their first language casually'. Learning a native language is a very different business from learning the discipline and forms of knowledge that are built up late by using that language as a tool. The learning of a native language is of a unique kind. Indeed Chomsky suggests that the only way of explaining the ease with which children acquire their native language in all its depth and variety is on the postulating of innate structures of mind that `...permit the constitution of rich systems of knowledge and experience on the basis of scattered evidence'. That something like innate structures needs postulating is backed up by such facts as that...the number of sentences in one's native language that one will immediately understand...is astronomical; and that the number of patterns underlying our normal use of language and corresponding to meaningful and easily comprehensible sentences in our language is orders of magnitude greater than the number of seconds in a lifetime. Out there are no such innate structures that can help with the acquisition of disciplines and forms of knowledge. These have been built to the stage we now have them only through minute and painful intellectual increments by the great minds of the human race over thousands of years.

In what follows we will examine the assumption that `there are no such innate structures': in doing so it is as well to bear in mind that Chomsky's point has only very recently gained acceptance.

It seems quite probable that Chomsky has not got things quite right the first time around. It is highly probable that a gift for language and gifts for most other forms of knowing about our world and our fellow beings are what the infant human being starts with: the evidence which we will review forces us to that conclusion.

May God us keep from single vision and Newton's sleep!' (Wm Blake 1802)

Educational practice over the past hundred years and more of mass education has shown a remarkable degree of continuity. This continuity of practice has flowed over from mass primary school education to mass secondary and tertiary education, to adult education, industrial training and to management education.

The tremendous growth, in the last sixty years of psychology, sociology, linguistics and anthropology appear to have re-enforced rather than shaken traditional educational practices. The erosion of educational practices that is commonly attributed to the influence of the modern social sciences seems to be much more an incidental effect of affluence and a tolerance of wastefulness.

The other aspect of this continuity is the remarkable ability of educational institutions to shrug off repeated demonstrations of better educational practices and to live with damning indictments of their inefficiencies.

When better methods are demonstrated they are ignored or, if debate is unavoidable, they are discredited by any available means, in line with the folk saying about `any stick to beat a

dog'. When evidence is produced which questions the established practices it receives similar treatment.

When ineffectiveness takes on public and scandalous proportions the standard defence is that there is nothing wrong with the practices that could not be cured by better text books, better trained teachers, more highly rewarded and hence more highly motivated teachers, better classrooms, better teaching aids. This situation has all the earmarks of an established paradigm.

In this kind of situation we have learned that the established paradigm is, for all practical purposes, unchallengeable at the level of practical evidence. Until the paradigm is directly challenged by a new paradigm it will continue to rule. People are simply not prepared to jump from the frying pan to the fire. (Even when a challenging paradigm emerges, people are more prone to prefer the devil they know. Only those who are marginal to the established institutional arrangements are likely to see the furthermost fields as greenest.)

As current public pressures mount for a return to the fundamental 'Three R's' we have to ask *why the modern challenges to the traditional paradigm have proven so ineffective*; amongst teachers as well as amongst parents and employers.

If we look to the paradigmatic struggles that have taken place in other fields of human endeavour; e.g., science and industrial organisation, we find that there is no real battle until there is a challenge to the critical ground occupied by the traditional paradigm (what I referred to above as a direct challenge).

How can we directly challenge traditional educational practice, or even know whether grounds exist for such a challenge, unless we can identify what is at the core of that paradigm? What is the critical ground that it occupies?

Most previous challenges, and here I think of Montessori, Dewey, Neill, and Lewin, have failed to constitute a direct challenge because they have failed to see that the core of the educational paradigm lies outside of educational practices. That core does not lie in the character of the teacher-pupil relation; it does not lie in open classrooms, teacher teams, group project work and not even in the balance of rewards and punishments. Traditional educational practice can and has accommodated all of these innovations, particularly in times of affluence when efficiency in educational practice mattered little, or when the educational goals are over ridden for other purposes; e.g., child minding or instilling the sense of being one of a privileged elite. These things have been accommodated when and where they have been necessary and then expelled from the system when `real' education has been re-established as the goal.

The core of the traditional educational paradigm lies in epistemology, not in educational practice.

That is, it lies in assumptions about how it is possible for people to gain knowledge. Once the possibilities are defined the practice is prescribed.

Throughout the two hundred years of industrial civilisation educational practice has been cocooned within the empiricist epistemology that was sorted out by Locke, Berkeley and Hume. These gentleman sorted out, in the most rigorous fashion, what it was possible for

human beings to perceive in the world as it was defined by Newton. Herbart spelt out in detail what this implied for educational practice. Helmholtz and Muller reaffirmed the world of Newton in their studies of the physics of optics and Thorndike, after Einstein and Dewey, re-established the Newtonian world as that in which people transact their daily lives.

Science has been cocooned within the same empiricist epistemology and each advance of science has acted to render the paradigm more impregnable. So much so that in 1980 we can find curriculum design referred to as an applied science (Pratt, 1980).

The core of the traditional educational paradigm is to be found in the basic assumptions of the Lockean tradition of empiricism, namely:

- the individual mind is a *tabula rasa*, a clean slate, at birth;
- the perceptual world of the new-born is a `buzzing, booming confusion';
- percepts arise from the association of stimuli;
- concepts of an object or belongingness or of causal relation are inferred from associations of stimuli.

These assumptions were not casually arrived at. Locke, Hume and Berkeley argued very soundly that if the world was as depicted by Newton then the transfer of information from an object to a viewer had to obey the Euclidean geometry. Within that geometry, the light reflected from an object to the retina of the eye could yield only a chaotic two-dimensional representation of reality. Any perception, and hence any useful knowledge of a three dimensional world (such as stops one falling off cliffs) would have to come from some sort of intellectual inference. This inference from the chaotic, disordered stream of energy impinging on the sensory organs could only find a firm base in the associations that happened to occur, in time and space between different sensory feelings, including internally generated feelings of hunger, pain, euphoria, etc.

Thus, any perception of *similarity* would have to come from common associations; e.g., the redness and sweetness of both Jonathon apples and pomegranates.

Any perception of *object constancy* would have to arise from contiguity in time of similar, associated sensations.

Any perception of *causality* is impossible because in a Newtonian world an actual causal relation between A and B could not generate stimuli that were any different from those created by the chance concomitance of A and B. The laws of physical optics in a Euclidean space simply do not allow it.

Perception of *depth* could only arise from inference and calculation.

In a Newtonian world, based on Euclidean space, there was no way that the stimuli impinging on any living organism could yield direct and immediate *information* about a three dimensional world of solid, persistent objects and serially related events (transformations such as those we refer to as causal relations and musical melodies).

Locke, Berkeley and Hume proved that scientifically speaking, we could have no sure knowledge of such a world outside of us, at least, not as individuals. At the same time, Newton had released a great upsurge in the growth of scientific and technological knowledge which we firmly believed to be knowledge of a solid corpuscular world, `out there'.

The question was, “How did we acquire that information and how was it possible to accumulate and distribute (communicate) such information?” With only the evidence provided by the chaotic array of energies impinging on our sensory organs we would be like the people in Plato's cave with no more knowledge of what was taking place `out there' other than what we could infer from the flickering shadows on the walls.

Kant brought even more rigour to the questioning of how we gain knowledge. In *Critique of Pure Reason* (1781) he did not question the existence of the world and he did not dispute the fact that knowledge was being achieved. He questioned the assumptions of the British empiricists. Locke and Berkeley had proven that in a Euclidean world our senses could yield no direct knowledge of either things or events, they could only be inferred from *contiguity* of sensations. Hume had proven that we could not directly perceive causal relations if the stimulating energy flows obeyed the laws of Euclidean space, but allowed that the impression or idea of causality could be gained from the close succession of sensations. Kant, pushing the same logic even further, proved that in a Euclidean world we could have no perception of either *contiguity* or *succession* unless our nervous systems were designed so as to apply the Euclidean assumptions to the incoming sensations: the sensations themselves could provide no such ordering in time and space. This created no special difficulty for the empiricists as it was then inconceivable that the world was ordered in any way other than that described by Euclid; it was easy to assume that the human nervous system was so designed as to be an integral part of Newton's world of Mechanics, Statics and Optics.

Herbart took over Kant's chair at Konigsberg and proceeded to lay the systematic basis of pedagogy for modern society. Herbart explained how we can gain knowledge from noting what stimuli tend to occur together; i.e., associate in our intuited time and space. Herbart's Laws of Contiguity seem rather presumptuous in the light of today's knowledge but they were seen in the nineteenth century to provide a foundation for a science of pedagogy - a basis for the rational inculcation of knowledge in systems for mass primary school education. This foundation was preserved through the contributions of Pavlov, Thorndike, Hull and Skinner. These contributions from experimental science preserved the Lockean-Herbartian paradigm by allowing that a special role might be given to the contiguity of stimuli, response and internal stimuli indicating good or bad feelings (reinforcements). These extensions enabled the paradigm to be preserved in the face of Darwinian challenges as to how such incompetent perceptual systems could have had survival value.

Throughout all these historical variations in the support base of the traditional paradigm there persists a common definition of what is sound knowledge. Sound knowledge, truth, is approached by eliminating what is idiosyncratic. The one off perception by an individual of an association of stimuli is the treacherous, unstable material from which knowledge must be processed (like gold from an orebody). Knowledge is approached only as the vagaries of individual perception are replaced by repeated observations under experimental conditions or the effects of the individual nullified by a random sampling of observers. Replicability by others is the final test of whether these procedures had added to the accumulating body of truths. Each observed association that survives this testing program is another accretion, another brick added to the knowledge structure. There is not, of course, one structure. Each observed association must be checked against the observed associations most similar to itself. As these delete or subsume each other they define a special knowledge structure - a discipline.

This process of accumulation of knowledge in an Euclidean world has special characteristics. It has the characteristics of *analytical abstraction* and *logical inference*. The knowledge gained by association of stimuli is useless if we cannot generalize to something other than the properties of the immediate, transient, experienced stimuli. From our experience of similarity (supposedly the gross similarity of identical stimulations) we infer the existence of classes of objects and from our knowledge of the associations of classes of objects we infer that there are relations such as those of cause and effect. We progress from constructing a picture of the world which tells us it is `as if' to one in which we can, with varying degrees of success, assert that `if...then...'.

In this world the key role in the accumulation of tried and true associations necessarily goes to those who understand the intellectual processes of abstraction and logical inference. It is they who, by association, discover that some forms of abstraction (classification) are more productive of good feelings than are others; that some modes of deriving logical implications are more rewarding than others. The same people find that they are better able to specify what kinds of association are most likely to be sought for, under what conditions (e.g, design of experiments or surveys). They are better able to do this because they are familiar with the contradictions that emerge at the higher levels of abstraction. They have the further responsibilities of ensuring that garbage does not enter the system and that knowledge does not flow out of the system unless there is clear understanding of the degrees of uncertainty associated with the layers of knowledge that underpin it. Attempts to popularize knowledge are regarded with suspicion.

The task of education is primarily that of distribution of the accumulated knowledge. Given the tiered structure of abstractions that characterises each special branch of knowledge the educators must take care that no layer of knowledge is distributed until the underlying knowledge has been distributed and absorbed.

Three general requirements must be met if this distribution is to lead to a successful transfer of knowledge.

First, the educational system must insist that the `fitful, random individual experiences of association' are totally inadequate as a source of knowledge. Such experience is first and foremost the source of error and the educator must brook no competition between the claims of individual experience and the proven status of accumulated knowledge. The path to knowledge is the memorization of established associations and the knowledge of the rules of classification and the logic of implication. Educational progress is then measured by tests of memory and of one's ability to apply the rules of classification and logical inference. The classical measures of `Intelligence Quotient' are primarily measures of the latter abilities (Olson, 1975).

Everyone coming into an educational system possesses some of the sensory organs and hence all must be taught to distrust their personal experience as a guide to knowledge. Only a few have the high IQs that go with the ability to make higher order abstractions and determine logical implications. Only these can carry the burden of building on, maintaining and controlling access to the knowledge structures. The rest, having found that they cannot learn to be scholars or scientists are returned, enriched solely by whatever established associations they have memorised.

Second, it is not enough to just, as it were, poke the eyes out of the would-be learner. The educational process also required disciplined students (just as the industrial revolution created the need for a disciplined work force). At the heart of the disciplinary process is the need to create in the mind of students a measure of independence between their judgements of `where' and `when' education is best pursued. The natural tendency of any human being, or for that matter any living system, is to act as if there is `a time and place for everything' (the evidence for biological cycles is quite overwhelming). Within machine-based industry the clock is set to fit the requirements of the machine regardless, more or less, of the biological clocks of the workers. Similarly with learning settings. The process of distributing knowledge is `time independent'. This peculiar circumlocution simply states that the time for teaching is independent of any question of whether it is the `right time and place' for the student. The right time for teaching B is when A has been learnt. C can be taught only when B has been learnt. The disciplined student accepts that the appropriate time for studying is that laid down by the curriculum, which in turn is presumed to be dictated by the nature of the socially accumulated body of knowledge. From the earliest times, according to Marrou (1956), the pedagogue was the layer-on-of-the-cane who forcibly adjusted the student's clock to the tempo of the learning process; the controlled delivery of stimulations to ensure the student's learning was originally thought a more menial task that could be left to others.

The **third** pre-requisite for learning within the traditional educational paradigm is *literacy*. Only when one has mastered the competencies required to record in writing and to read writing can one master the processes of abstraction and logical inference:

"...The form of human competence involved in drawing logical implications from statements of unknown trust-value or plausibility is a form of competence tied largely to literacy. It may be argued that for logical analysis to occur *the statements themselves must become the reality*" (Olson, 1975, p.370).

The central role of literacy in the advancement of knowledge, in this paradigm, does not derive only from the need to pin down what we think we have perceived, it is also to pin down what is reported:

"...while speech is an ephemeral and transparent code that maps onto a picture of reality that we called commonsense knowledge, writing changes speech into a permanent visible artifact, a reality in its own right" (Olson, 1975, p.370)

Within this paradigm *numeracy* is but a special branch of literacy. It took more than a century of failed teaching before the need for a 'New Maths' was accepted.

These three pre-requisites pretty well define the aim of this educational paradigm - to produce the *critical, disciplined* and *literate* mind.

The significant variable beyond the control of education was seen to be that of intelligence. People appeared to be innately different in their abilities to abstract and infer from propositional statements in a textual form. As these abilities were essential to all of the specialized bodies of knowledge, it came to be common place to assess the IQ of a person as a basis for deciding whether it was worthwhile trying to educate a person beyond a certain level (e.g, the eleven-plus exams in the UK).

The emergence of a new paradigm of learning

The basis of the traditional paradigm was at risk from when Einstein displaced Newton's Euclidean world with that of Reimann and Lobachevski. However, Newton's *Optiks* lived on, thanks to Helmholtz's prodigious studies, as that branch of physics and psycho-physics that studies the properties of light per se and its detection by the human organism. The limits to this context were not apparent and little impact was made when Alfred N Whitehead, in 1926, pointed out that Bishop Berkeley's problems with the apparent constancy of perceived shapes disappeared if one allowed that perceptual organs were geared to Reimann's timespace and not to Euclid's. In the world of middle-sized objects and moderate speeds that humans lived in these considerations seemed esoteric.

The fundamental challenge to Lockean epistemology, and hence to the traditional paradigm of learning, came when Fritz Heider in the same year as Whitehead, stated that:

"the question has never been raised whether something that serves mainly as a mediator (eg, air for light) has not from a purely physical point of view, characteristics which are different from those of an object of perception" (Heider, 1959, p.1)

Heider was correct. From Newton through Helmholtz to even the present day; e.g., R K Luneberg's *Mathematical Theory of Optics*, 1975, this seemed an irrelevant question. The properties of light had to exist in its particulate or wave-forms and the perception of light had to be based on the properties of the rods and cones that formed the retina of the eye. This was all we needed to know in order to determine whether something was `perceivable'. Content was irrelevant to the perceptual stage. Following the Lockean school it seemed obvious that content, the meaning of the perceptions, could only emerge at the stage of cogitation.

The observations made by Heider sustained the relevance of his question. First he noted that in the perception of objects we are dealing with ambient, reflected light, not the radiant light that is so central to the studies of optical physics. Reflected light, except for mirrored light, has the property that:

"the order of the direction of light rays is changed at the surface of an object. All rays, whatever directions they come from, are absorbed to produce the one vibration which conforms to the surface of the object at each point. The rays are not reflected independently of each other as far as direction is concerned. With an object which has not the properties of a mirror, however, the kind and direction of incoming light rays are more or less irrelevant, if only enough energy reaches each point to set its free vibrations in motion... the waves at the single points of a solid body are independent of each other, nevertheless in a certain sense they form a unit, because the many points themselves are part of a unitary object... If an illuminated body moves, all the vibrations on it move in a certain order...the light rays are coupled because they are reflected by coupled points. These light waves always appear together, although changed as a result of their illumination, position, etc. *They contain an order* which becomes meaningful only if one refers them to the corresponding object" (Heider, 1926, 1959, pp.l6-17)

The order in the reflected light rays is still there as we change our viewpoint, turn our head, move around or touch the object. This is the truly critical point that Heider made. In the sea of changing sensations we see the unchanging, invariant order that is imposed by the object on the light rays that reach the eyes. It is misleading, however, to suggest that we have to refer them to an object for them to be meaningful. The object or event is the order we are

directly given in our perception, no more and no less. Nothing corresponding to this transmission of information about order is the subject of physical optics or physiological studies of the eye. With the recognition of this transmission the so called paradoxes of size constancy, colour constancy, depth perception, etc simply vanish. Kant, it turns out, was solving a problem we had caused for ourselves by an inadequate theory of perception.

The critical step that Heider took in this paper was to "explain some of the characteristics of the `sensations' on the basis of the characteristics of the correlates among physical events" (p.34). With this step he laid the basis for `ecological optics'. With his next paper, `The Function of the Perceptual System' (1930), Heider completed the foundation of the alternative scenario of how we learn to know. He established that the environment had an informational structure at the level of objects and their causal interactions, and that the human perceptual systems were evolved to detect and extract that information.

Nothing was done by physicists to build on these foundations, they were into lens systems and the micro-world of electrons and photons, not the everyday world of ecological optics. Psychologists were uninformed or unimpressed. Heider's circle in Berlin was broken up in 1933-4 and his papers not translated into English until 1959. More seriously, Egon Brunswik launched a serious and very public program of research along these lines in the l930s. His program got nowhere. Assuming that the coupled information at the source of reflected light was being transmitted to a perceptual apparatus designed for a Euclidean world he could not see how any other than doubtful probablistic information could be received - as Bishop Berkeley could have told him.

The program of research indicated by Heider's work could not come to fruition until the assumption of Euclidean space was dropped, at least in the consideration of visual perception. This was done by James J Gibson. In 1938 he published *A Theoretical Field-Analysis of Automobile-Driving* which presupposed a projective geometry freed of Euclid's Fifth Postulate, that parallel lines never meet. He showed that the critical information required by a car driver was present in the flow of light rays reflected from the environment to any point at which there was a potential driver of a moving vehicle. Given the properties of reflected light and the nature of reflecting surfaces, that information would still be there even if no one had invented fast moving surface vehicles, or no one in a car had ever driven on that course. A tumbleweed blown along that same course would not have picked up the information as such a pick-up presupposes perceptual organs evolved to do so. Through the forties and fifties Gibson was deeply involved with such perceptual problems as controlling high speed landings on aircraft carriers. This provided a critical practical test for his theory of perception in a non-Euclidean world. Within the Lockean framework perception of depth required calculation and inferences from cues given by binocular vision. Within Gibson's perspective geometry depth was directly given in the flow patterns of the visual field - one eye was all that was needed to pick up the flow patterns. The test, in whose design and execution Gibson had no part, was simple. Pilots barrelling down to a pitching flight deck at 140 odd knots had vision of one eye blacked out. This did not increase the accident rate.

Twenty years after the first paper, Gibson published *Visually Controlled Locomotion and Visual Orientation in Animals* (1958). With this publication it could no longer be doubted that the Lockean paradigm had to go.

Heider had established that the Lockean paradigm was incompatible with the notion of the perceptual systems having survival value. Walls (1942), had shown the remarkable relation

between the various eye structures that had been evolved and the ecological demands upon the species having those different structures. Gibson determined the non-Euclidean geometries which allowed for the direct transfer of light-borne information from the environment to eyes such as those possessed by human beings and other living beings. As of 1958 he had only proven the case for visual orientation and visually controlled locomotion. However, for organisms that can only survive and reproduce by moving toward `goodies' and away from `baddies' that was no trivial achievement. If the concept of Euclidean space had to be dropped in order to make that achievement what grounds existed for hanging on to the Lockean paradigm? On the face of things there were no such grounds. In all the other areas of perception - taste, smell, touch, auditory etc - the assumptions of the Lockean paradigm had created problems as insoluble as those of depth and the constancies in visual perception (Gibson, 1966).

The striking features of this Heider/Gibson paradigm are:

- the environment is recognized as having an informational structure;
- this informational structure of the environment is embodied in the invariances that exist in the relations between energy flows despite fluctuations in the individual flows and regardless of whether they impinge on the sensors of an organism;
- the perceptual systems of living species have evolved so as to detect and extract this information from their environments despite a great deal of `noise' at the sensory level;
- our conscious feeling of sensations is all but irrelevant to the role of the senses as discriminating perceptual systems (Johansson, 1975).

This new paradigm allows us to think in strict and non-mentalistic terms about perception, not just sensations. It is also a paradigm that forces us to think in non-mentalistic terms about `things' and 'media'. Such considerations were extraneous to the old paradigm of perception but now they are to be seen as intrinsic to the questions of what we perceive and how we perceive, and hence intrinsic to questions of human communication.

This paradigm rejects the two assumptions that underline the traditional paradigm:

- Locke's assumption of the *tabula rasa*, the blank tablet of the mind at birth (1690);
- Johannes Muller's doctrine of the specific qualities of nerves (1826), implying the “booming, buzzing confusion” of the infant's perceptual world.

The puzzles about how we build up the associations enabling us to `unconsciously infer' three-dimensionality and perceptual constancies (Helmholtz, 1865) go by the board.

“Sensations are not, as we have always taken for granted, the basis of perception.

When the senses are considered as perceptual systems (`systems of detection', p.1), all theories of perception become at one stroke unnecessary. It is no longer a question of how the mind operates on the deliverances of sense, or how past experience can organise the data, or even how the brain can process the inputs of the nerves, but simply how the information is picked up. This stimulus information is available in the everyday environment, as I have shown. The individual does not have to construct an awareness of the world from bare intensities and frequencies of energy; he has to detect the world from invariant properties in the flux of energy. Such invariants, the direction of gravity for instance, are registered even by primitive animals who do not have elaborate perceptual organs.

Mathematical complexities of stimulus energy seem to be the simplicities of stimulus information. Active perceptual systems, as contrasted with passive receptors, have so developed during evolution that they can resonate to this information" (Gibson, p.319).

Johansson and the Uppsala school have confirmed Gibson's finding that the physical correlates of the perception of visual motion are the invariants in environmental stimulus flows that are described by projective geometry and vector analysis of the components of those flows. They have established, alas, that there is no conscious choice involved, "...the observer is evidently not free to choose between a Euclidean interpretation of the changing geometry of the figure in the display and a projective interpretation" (p.86). In computer language, the visual system is obviously `hard wired' to extract this kind of higher-order information from the stimulus flux before it reaches consciousness.

In the field of colour vision Edwin Land and his colleagues have been able to demonstrate that "... the stimulus for the colour of a point in an area is not the radiation from that point" (Land, 1977, p.115)

They have gone beyond this to establish that:

"Whereas the initial signal produced in the outer segment of the receptor cell is apparently proportional to the light flux absorbed by the visual pigment, the final comprehensive response of the visual system is `lightness' which shows little or no relation to the light flux absorbed by the visual pigment" (p.110).

The information people extract to establish the biological response of "lightness" turns out to be a complex mathematical function of absorption and reflectance properties of the surface, and the properties of the illuminates; and not of their absolute values but of their ratios as established for each of three levels of wave-length reception,

"After the three lightnesses of an area have been determined by the three retinex systems (something between retina and cortex) no further information is necessary to characterise the colour of any object in the field of view...for each trio of lightnesses there is a specific and unique colour" (ibid, p.115).

It goes against the grain to grant such complex analytical capabilities to the perceptual systems. Why, however, should we readily accept this order of capabilities in organs like the liver and the kidneys and expect evolutionary adaption would be successful with any less capability in the perceptual systems?

The other side of this biological picture of the perceptual systems must be noted. Much of the information present in the environment of the evolving species must have been irrelevant to survival and "...accordingly the perceptual machinery provides no means for their extraction" (Julesz, 1975, p.3). Julesz has discovered such a limitation in the extraction of information from the `ground' in figure-ground perception. Those things that take on figural properties can be distinguished at very high orders of complexity but `grounds' take on the properties of textures and:

“Whereas textures that differ in their first- and second-order statistics can be discriminated from each other, those that differ in their third- or higher-order statistics usually cannot” (ibid, p.35).

He has established that this is not a learnt effect. It appears to be a limitation we share with other forms of animal life (as witnessed by their evolved forms of camouflage). In dyslexia and in the figure-ground reversal of high speed motor racing we appear to approach our perceptual limits. The implications of the Gibson/Heider paradigm go beyond our perception of the physical environment.

Asch has made similar advances in analysing the informational properties of face-to-face social environments (Emery & Emery, 1976, pp.20-26). Heider and the socio-linguists have made real beginnings in the analysis of the invariances that carry the informational properties of conversational fields.

This latter has probably been one of the most striking challenges to our everyday conceptions and bids fair to revolutionise our ideas about speech as a medium compared with text.

In keeping with the traditional paradigm we have tended to assume that in listening to speech the sounds we hear are assimilated to learnt vocabularies and grammars and that we make use of other clues to infer what the other is meaning. For a long time psychiatrists, particularly those working in small group settings, have had their doubts about this. They have become convinced that sometimes they can hear another level of communication, what they call the `music' of the conversation, and that it is out there to be listened to and not at all like the process of making conscious inferences from a few clues. Studies such as that by Labov and Fanshel (1977) leave us in no doubts about that. They show that perceivable invariances in conversational fields directly yield us information about invariances in the dynamics of interpersonal interaction (see also Heider, 1958). They find this so compelling that they insist that speech must be seen as an action that directly changes the environment of the other (Emery, 1980).

These findings have been generalized to cover music as well as speech by Jones (1976) using the mathematics of invariances found in group theory. In this, and in Gibson's most recent work (1979), we find that our perceptual systems appear to have evolved to cope with a world that is remarkably similar to the world to which modern physics subscribes: a world which is a nested hierarchy of spacetime events structured by invariant relationships of relations. The world in which we perceive is, like the world perceived by modern physicists, inhomogeneous, an-isotropic and discontinuous. So long as we thought that the problems of epistemology were the problems of how we perceived objects in a homogeneous, isotropic and continuous Euclidean space, existing as an absolute, independent of objects, and of how we perceived change in a time that was independent of space and objects, then, for just so long, we were bound to be defeated in our task.

The convergence with modern physics extends to the very concept of `object':

“For now, we regard the object as an abstraction of a pivot or invariant structure, but not as a basic element, which exists separately, and serves as the source of casual action on other objects, and which is in turn the recipient of casual actions by these other objects. Thus, it would be wrong to think of the centre of a vortex as a separately existing entity, capable of exerting `forces' on other centres. And more generally, such centres, pivots or invariant

structures do not do anything at all; they just are invariant. In other words, *it is the movement that possesses a certain invariant, and not the invariant that creates the corresponding movement.*

Our customary mode of using language tends to confuse us on this problem, for it is based on the conception of what is as a set of objects, as symbolized by our words" (Bohm, 1963, p.49).

As a theoretical physicist who has made significant contributions to the history of science David Bohm has explicitly considered the import of the Gibson paradigm (1965). In this light he sees science as an extension of our perceptual activity of extracting information from the invariant features of our environment and not primarily as an activity to accumulate a body of verified knowledge. The latter is in his terms only an adjunct to the process of extended perception (p.228).

Extraction vs Abstraction

In discovering how we perceive, Heider, Gibson et al did not only lead us to a new ontology. If that is all they did, it would not challenge the traditional paradigm of education. We could, as we did with the New Maths, teach it as a subject in the old paradigm.

It is the new epistemology that emerges with Heider/Gibson that constitutes the challenge to the traditional education paradigm. I will later discuss ways in which this challenge has emerged in educational practices but first it seems desirable to consider the challenge at the most general level. This is the level at which we conceive of moving from perceiving to knowing, any kind of knowing, and of moving from `percept' to `concept'.

The traditional paradigm took over from Aristotle and the medieval Schoolmen the assumption that this transition is achieved by a process of abstraction. The process of abstraction provides the bridges, in the traditional paradigm, from sensation to the higher levels of thought about the nature of inferred reality. It is essential in the process of getting from the flux of sensations to the concept of thing; it is equally essential in getting beyond this to generic concepts of classes of things and classes of classes. The advancement of knowledge is seen quite literally as a ladder of abstraction, as these bridges all lead away from the impossibly rich flux of sensations to levels of conceptualization that are increasingly more general in their reference to larger and larger classes of things and decreasingly specific about the qualities of the things to which they refer; i.e., more abstract - less concrete.

This is the process that is identified with Aristotle, of *abstracting the universal from the particular.* This is a process that depends upon association of sensed imilarities, some storage of these experiences in memory traces and some interaction between these traces and subsequent experiences of the particular association. The traces and the new experiences have, of course, to find each other for a strengthening of the memoried association and presumably this is because the traces retain an image of similarity.

So long as we start from the basic assumption that information about the outside world is conveyed by radiant light in a Euclidean world then this is indeed the only way we could have built up our scientific and other bodies of knowledge. Even the Gestaltists who firmly asserted that we had a knowledge of a structured world `out there' were stuck with the problems of similarity and memory traces. The best they could do was to suggest that the

`brain fields' that transformed the sensory inputs were like electrical fields with non-Euclidean properties (Brown and Orbison, 1939).

Adopting a new language, the language of computers, has not freed thinkers from this traditional paradigm (Weimar, 1977, pp.269-70).

As we have come to expect in paradigmatic conflicts this persistence has occurred in the face of quite startling contradictory evidence. In a long series of experiments Erich Goldmeier showed that our primitive assumption that `we knew similarity when we saw it' was certainly true but it conformed in no way to what the traditional theory of abstraction required - similarity of retinal images. The dimensions within which he was able to demonstrate perception of similarity were such that "In general it is not possible to rotate the space and refer it to rotated axes, as can be done without restriction in Euclidean spaces... Besides not being Euclidean, similarity space is unusual in another way: it is far from continuous" (1972, p.125).

It was also assumed that for the brain to perform the abstraction process, incoming information had to go from the projection areas of the brain to the so-called `association' areas where they would link up with similar memory traces. However, destruction of the tissues connecting these areas does not prevent concept formation (Pribram, 1971).

Within this paradigm one would also expect that the more stable one could hold the retinal image (by eye movements, turning the head etc) the stronger would be the impression that one gained. Imagine the surprise when, after techniques to experimentally ensure stability of the retinal image had evolved it was found that a stabilized retinal image rapidly breaks up and is lost to sight (Pritchard). Carefully controlled experiments with the development of vision in kittens led Pribram to a strong conclusion: "the tuning of the cortical cells to the environmental situation which remained invariant across transformations of head and eye turning was behaviourally effective; the tuning of the cortical cells to consistent retinal stimulation had no behavioural consequences" (1977, p.93).

The deep-seatedness of this part of the traditional education paradigm cannot be over-stressed and it is intimately entwined with literacy at the core of the paradigm.

In his study of our historical concepts of *Substance and Function* (1923) Ernst Cassirer noted that:

"In the historical beginnings of logic this fact is most evident. Concept and form (images) are synonyms, they unite without distinction in the meaning of eidos. The sensuous manifold is ordered and divided by certain spatial forms, which appear in it and run through all diversity as permanent features. In these forms we possess the fixed schema by which we grasp in the flux of sensible things a system of unchanging determinations, a realm of `eternal being'. Thus the (Euclidean) geometrical form becomes at once the expression and the confirmation of the logical type. The principle of the logic of the generic concept is confirmed from a new angle; and this time it is neither the popular view of the world nor the grammatical structure of language, but the structure of a fundamental mathematical science upon which it rests" (1923, pp.68-9; my inserts).

The reference to grammatical structure is emphasized in Olson's remark that "...while the Greeks thought that they were discovering eternal truths about reality, they were in fact

merely reflecting on the logical structure of ordinary (written) language" (ibid, p.367; my insert).

Within the new paradigm *the universal is grasped in the grasping of the particular*: the universal is not achieved by a separate intellectual process of abstraction. The kinds of concepts that represent this perceptual achievement are serial-genetic concepts - the concepts yielded by the perception of the serial order generated in nested spatio-temporal events. They are not the generic concepts yielded by a process of abstraction and naming; e.g., of naming species and genus.

Ernst Cassirer, in 1923, was able to show that the advance of modern physics and chemistry was founded on the use of such serial-genetic concepts. By reference to one of Helmholtz's observations he was able to point to the perceptual activity that yields such concepts:

"From the standpoint of logic, it is of especial interest to trace the function of the concept in this gradual process of construction. Helmholtz touches on this question when he affirms, that even the presentation of a connection of contents in temporal sequence according to law would not be possible without a conceptual rule. `We can obviously learn by experience what sensations of vision, or some other sense, an object before us would give us, if we should move our eyes or our bodies and view the object from different sides, touch it, etc. The totality of all these possible sensations comprehended in a total presentation is our presentation of the body; this we call perception when it is supported by present sensations, and memory-image when it is not. In a certain sense, although contrary to ordinary usage, such a presentation of an individual object is already a concept, because it comprehends the whole possible aggregate of particular sensations, that this object can arouse in us when viewed from different sides, touched or otherwise investigated.' Here Helmholtz is led back to a view of the concept that is foreign to traditional logic and that at first appears paradoxical even to him. But in truth *the concept appears here in no mere extravagant and derivative sense, but in its true and original meaning as was the `serial concept', in distinction from the `generic concept'*, that was decisively revealed in the foundations of the exact sciences, and that, as is now seen, has further applications, proving itself to be an instrument of objective knowledge" (Cassirer, 1923, pp.292-3).

Helmholtz is referring here to what we perceive when we act as a percept-generating system with two eyes, a head for turning, a body for moving about and overlapping sensory modalities. Unfortunately the paradox between the yield of this perceptual system and the yield of the retina in isolation did not budge him from his dedication to Newtonian optics. Ironically, Cassirer also failed to make the jump. He was in Berlin at a time when the psychology of perception was literally in a ferment, thanks to the emergence of the gestaltists, but he could conceive of no theory of perception that would encompass Helmholtz' insight. He settled for an objective idealism somewhat like Kant's: some sort of thinking was achieving the structural concepts, not perception. Lewin was emerging in the same heady Berlin atmosphere and was deeply influenced by Cassirer but also became locked in by the Lockean assumptions to a closed `life space'. It was left to Heider to complete the foundations of the new paradigm and exorcise the `ghost of abstraction' that still lurked on in the work of Cassirer and Lewin.

Some of the contrasts between the two paradigms may be summed up as follows.

Traditional paradigm	**New paradigm**
Abstraction	Extraction

generic concepts permanence-change achieved by thinking and memory	serial-genetic concepts relative persistence achieved by perceptual activity

The implications of the challenge to the logic of abstraction are substantial. In the first place we can consider the implications for the social ownership of knowledge. There are bodies of `knowledge' that have been built on the logic of abstraction. Cassirer has shown how they have necessarily used structural concepts to determine what will be abstracted out. These tacit `rules of abstraction' are the inner mysteries of the various bodies of scholars and theologians. They provide a ready operational definition of an `outsider'. Such boundaries abound in science. However, as Bohm has pointed out, there is, in the new paradigm, no such boundary between perceptual and scientific activity:

"...fundamentally both can be regarded as limiting cases of one overall process, of a generalized kind of perception, in which no absolute knowledge is to be encountered" (1965, p.230).

In this new paradigm it is pointless to speak in absolute terms of the advances of science; it becomes necessary to speak of advances relative to the perceived knowledge of invariants available to the 'non-scientific' members of the community. With regard to bodies of knowledge that are more akin to theology it is necessary to ask whether they measure up to what is known to people through their direct perception. I suspect that little, for instance, of the psychology of personality and interpersonal relations would stand up to such a test (Heider, 1958). The general and undeniable consequence of the new paradigm is that no firm barriers can be drawn between common sense and bodies of scientific or scholarly knowledge.

Concepts

The so-called special skill of identifying the universal (the invariances) through logical abstraction and logical inference is a myth. It was of course a convenient myth for preserving social hierarchies.

This is not entirely correct. It is certainly true that we have direct perceptual access to a good deal of the order present in nature (and by the leverage of instrumentation to a very great deal of the order that our perceptual systems have not evolved to directly detect). Finding order in our symbolic representations of our observations is a very different kettle of fish: particularly when those records are contaminated by the ordering principles invoked to create our symbolic systems. The dominant symbolic systems are written languages and numbers but there are hosts of minor ones such as regimental insignia for military bodies. There are special skills in logical abstraction and inference within those symbolic systems, and they can be tested and measured. Furthermore there appear to be significant and relatively stable individual differences in ability to exercise this class of skills (e.g., the studies of IQ). The point is that these skills in identifying and handling abstract similarities are:

- not predictive of ability to identify serial-genetic invariances in non formal systems; i.e., to detect order when we see it. (Formal education is of little help to the tracker or the policeman on the beat. It is possible, however, that skill in identifying serial-genetic invariances in formal systems; e.g., the number series and graphical representations of chemical structures, is predictive of ability to identify such

invariances in non formal systems. The reverse need not hold because of unfamiliarity with or disdain for formalized systems);
- highly dependent on long periods of motivated engagement with formal (symbolic) systems. Otherwise known as `schooling'.

Less abstractly, a high IQ does not indicate an ability to behave intelligently outside the narrow world of academic scholarship although higher average IQs can be expected from social groups that spend more years in academic studies and/or are more involved in handling formalized, symbolic systems. Therefore, being governed by the more schooled, higher IQ strata of society does not ensure more intelligent government. That is a point that could be made even about the government of universities.

It is important to look closely at both of these points.

Regarding the first the critical question is that of `intelligence'. We do not know what intelligence is but we do know that behaviour is more or less intelligent insofar as it reflects "the apprehension of the relevant structure of the total behavioural field, relevance being defined in terms of the immediate and presumptive future purposes of the actor" (Chein, p.115). A vast amount of empirical study has been devoted to the development of tests of intelligence and the results of these tests have been widely used to select who shall be given further education; e.g., the English 11+ exams. They have been extensively used for selection of potential officers, managers, etc. on the unproven grounds that those who were best able to benefit from schooling were also those best able to learn in non academic settings, and therefore most likely to develop into effective officers or managers.

From the very beginning IQ tests were constructed so that they predicted, as well as possible, the results that could be expected from examination of schooling. They were designed to reflect the requirements for success in schooling.

Success in schooling depends primarily on being able to learn from being lectured to. This requires:
- an ability to sit still and attend to the narrow range of stimulation provided by, and dictated by the teacher (range of attention and degree of concentration);
- an ability to remember what is not understood (ie, to find a frame of reference that is not provided by one's own experience);
- a willingness to engage in the repeated rehearsals necessary to establish such an independent framework.

The ideal of such rote learning is clear and exact reproduction of the lessons that have been taught or prescribed. The ideal qualities that are sought in the student are obedience (first and foremost), diligence (constant and persistent application to the set tasks) and conscientiousness (striving to meet set standards of performance). The second qualities are truthfulness, straightforwardness and stoicism. These are secondary only in that they relate to the student's acceptance of the coercion of the teaching relation. It is helpful to that relation when the students accept that they must not seek to avoid the compulsions by lying, deceit and evasion, and it is easier to maintain those pressures if they accept their punishments `like a man'.

Performance on IQ tests directly measure ability to master the unnatural tasks of abstracting and inferring with man-made symbol systems and indirectly measure the extent to which the

student has been able to internalize, or systematically cheat, the coercive relation of teacher and student. The student-teacher relation absorbs one aspect of the child-parent relation. It is obvious that no child would willingly opt for the coercive relation that traditional education (schooling) demands. It is equally obvious that this relation will not be effectively imposed unless the family gives its active support or the student-teacher relation is granted significant autonomy, as in boarding schools.

What is clear is that the `educational reproduction' that we see with our formal educational systems has as little to do with the natural reproduction of intelligence as eunuchs have to do with sexual reproduction.

In the second place we can consider the implications for education in general. We have conceived of education as a filling up of minds with information and a training, where suitable, in the logic of abstraction and inference. We are now confronted with the fact that people are equipped to directly achieve information for themselves and they achieve that in conceptual form - the same form of serial concept that stands as the highest achievement of modern science. The central problem for education is no longer which minds can achieve conceptual knowledge and undertake conceptual operations. In the new paradigm the central question is what kinds of environments best enable all minds to exercise their ability to perceive deeper orders of invariance. Educationalists will be in the business of manipulating the L21 not the L12 (Emery, 1977, p.90; McLuhan, 1977).

“When the behavioural situation is too simply structured the organism tends to behave in a stereotyped fashion and learning takes place by a blind conditioning process; when it is over-complex, the organism tends to display random behaviours and learning is by vicarious trial-and-error. Organized behavioural sequences and insightful learning presuppose a degree of structure that is optimum for the particular organism” (Emery, 1959, p.66).

This is quite contrary to our traditional practice of minimizing environmental variations by standardising schools, classrooms, teacher training, text-books, curricula and grade-work.

Confronting the challenge

In theory, that is, in the theory of the Lockean paradigm of knowledge and education, the Heider/Gibson contribution should have led to the ransacking of the established stores of knowledge and a massive re-thinking. In theory, the program for accumulating knowledge and distributing it is controlled by impersonal criteria of validity and consistency. The criterion of validity has an important modifier, generality; it is not expected that a new truth will necessarily displace an accepted truth at a higher order of generality. This new paradigm was proven more valid in critical areas of perception: it had consistency where the old paradigm was riddled with long-standing and apparently insoluble paradoxes and, more significant, it challenged at the highest order of abstraction of the old paradigm, its geometrical model of the world.

History, not theory, is a better guide in these matters. The challenge is so profound that we have to accept that we are confronted with a clash of paradigms.

As an historian of science Thomas Kuhn documented the lengthy strife that has accompanied past conflicts of paradigms. He was not optimistic enough to think that this process of radical change could be accomplished more easily once we were aware of what we do to each other.

He was not, on the other hand as pessimistic as Max Born, a celebrated leader of the new paradigm of quantum physics, who suggested that the fight was over only when the believers in the old paradigm were buried, literally.

In this case we are dealing with a paradigm that has effectively structured the allocation of statuses and resources throughout the lifetime of industrial society, in education, science and the arts. There is more to the reallocation of statuses and the shifting of institutionalized priorities than the validity, consistency and generality of scientific findings. Persons and institutions will seek to defy any down-grading of their standing; as the eminent representatives of an order of knowledge that has long served the society they will always be well placed to powerfully oppose change. Against this there are forces in a rapidly changing society toward gaining a better understanding of what it is doing.

We have noted how the development of airborne weapon systems gave a powerful impetus to Gibson's line of thought. Untoward developments in the telecommunications industry gave rise to convergent challenges to the Lockean paradigm that had guided the telecommunications engineers (Emery & Emery, 1976, 1980).

The critical confrontation of the paradigms that we see today is not a direct result of the scientific work of Heider and Gibson nor a flow-on from military research. The confrontation arises from the mass utilization of electronic means of communication; e.g., television and visual display units. Within the Lockean paradigm these should constitute remarkable advances on the information communicating capabilities of speech and text: they do not. Theoretically, again in the Lockean paradigm, they should have transformed education; they have not.

Clearly something was wrong. Something is wrong. The Lockean paradigm has been proven to be a thoroughly misleading model of how we gain knowledge. In the field of education Herbart, Thorndike, Hull and Skinner built on the assumptions of that paradigm. Our programs of mass education are premised on the assumptions of the Lockean paradigm. Dewey, Montessori, Neill and Lewin were not able to challenge the epistemological assumptions of the Lockean model, the Euclidean geometry assumed by Newton, and hence their efforts were as futile as Blake's poetic fulminations against `Newton's single vision'.

We are now faced with the stupendous task of redesigning a system of mass education that is powerfully supported by entrenched social interests. The task of redesign is not idealistic. As pointed out above the existing educational systems are fatally flawed. They blind, not educate their students. In a bureaucratized society this may be a stabilizing factor. To quote from de Bono, ”A headmaster once told me that it was *unfair* to teach people how to think. He said that most of the pupils from his school were going to spend their lives at factory benches and that thinking would only make them dissatisfied” (1978 p.20).

In a society trying to cope with turbulence, the pressures toward participative forms of work, planning and governance are building up a ground swell of resentment against an educational paradigm that does little to develop the confidence or competence of most people. The emergence of the new paradigm shows that this is not inevitable and it points to the directions in which changes can be made.

Some Educational Implications

Some of the educational implications of the new paradigm can be spelt out. **First**, since limitless information is present in our environment then any person with some intact perceptual systems can access as much or as little as he or she needs for as long as they live. Access is restricted only by habits of and lack of confidence in perception. The pretence that knowledge can be accessed only through years of schooling in certified educational institutions is a sham.

The claims that the real knowledge is locked up in the storehouses of knowledge that are so jealously guarded by a priesthood of scholars and scientists is also a sham. There is some kind of knowledge in those storehouses and there are extensive social and economic limits on what can be accessed but these are not the fundamental limits on knowing implied by the traditional paradigm; limits that denied to most people the knowledge that they could gain valid knowledge without being schooled in it.

Second, education is first and foremost the education of our perceptual systems to better search out the invariant characteristics and distinguishing features of our personal, social and physical environments. It is an education in *searching* with our own perceptual systems not an education in how to someday *research* in the accumulated pile of so-called social knowledge. An education in searching is an education in generative thinking (these are de Bono's terms. Elsewhere I have characterised it as `open systems thinking' (Emery, 1967). An education for research is a schooling in bodies of organized knowledge, in the workings of formal logic and in fluency of textual expression. Whilst Edward de Bono appears to be unaware of the revolution wrought by Heider and Gibson he very clearly locates generative thinking in their paradigm. Drawing on his remarkably extensive experience he has shown that generative thinking about our environment and our place in it is a matter of perception, of seeing things more clearly and of seeing things in context, not a matter of puzzling over images and abstract ideas in our mind:

“Perception is the processing of information for use. Thinking is the processing of information for use. We have defined thinking as the `exploring of experience for a purpose'. That is why perception and thinking are the same thing” (ibid, p.82).

“Thinking arranges and re-arranges perception and experience so that we may have a clearer view of things” (p.41).

“The teaching of thinking is not the teaching of logic but the teaching of perception... I wish to make this point very strongly... In its proper place logic is a tool of perception” (p.77).

In the traditional paradigm it seemed obvious that “thinking itself was not possible without a repertoire of language-based concepts; that language was the very stuff of thinking and not just the means of expression” (p.36). It was easy in this context to “...regard thinking as semantic manipulation and all errors in thinking as semantic mismanagement” (p.37).

This has not been without its consequences, “...it is a very bad mistake - for which our academic institutions are solely responsible - to equate semantic tidiness with thinking skill... It could be said that the main obstacle to our development of a more effective thinking system has been our obsession with semantic thinking ‘ (pp.40-1).

In the new paradigm “Thinking does not have to take place in words. Nor are concepts limited by the availability of words to describe them. Thinking can take place in images and

feelings which are quite definite but too amorphous to be expressed in words" (p.36). "The very first step in teaching thinking must be to provide a bypass to (this) instant judgment by requiring the thinker to direct attention to all the relevant and interesting points in the situation" (p.42).

De Bono has demonstrated that thinking is a skill which can be learnt by anyone prepared to learn, that is, anyone not too conceited about their innate cleverness. He has shown that it is a skill which improves the performance of young or old, bright or dull, literate or illiterate.

It could appear from the above that I am saying that if we recognize the human potentials for perception revealed in the new paradigm, and proceed to teach thinking along the lines developed by de Bono, then we will raise the intelligence of people. In the context of the long standing debate about IQs and genetic inheritance this would certainly seem to be a reckless claim.

However, as Olson (1975) has pointed out IQ tests are overwhelmingly measures of how well the person has mastered the arts of abstraction and logical inference from textual propositions. These tests certainly correlate well with performance in schoolwork (and so they should as the items in the test are selected because they show such a correlation or are highly correlated with items that do) and they show lesser but stable significant correlations with social class, ethnic status and other such variables that are correlated with spread of literacy.

The nub of the matter, however, is the definition of intelligence as `thinking abstractly' or `ability to learn'. In this debate learning, or the evidence for such an ability, is always pushed back to an ability to learn from texts or the blackboard so that `thinking abstractly' is the issue. We need go back only thirty-five years to find this issue thoroughly disposed of in Isidor Chein's conceptual analysis *On the Nature of Intelligence*:

"If `thinking abstractly' were to define intelligence, it would follow that intelligence could only be manifested in thinking behaviour and that the more abstract the thinking the greater the intelligence. Neither of these conclusions accords with usage; they do not apply to all of the facts that have been meaningfully described in terms of intelligence.

Of two people confronted with the same problem, not the one thinking most abstractly, but the one thinking most to the point is thinking most intelligently. It is not the degree of abstraction in thought, but its quality that makes the difference. Moreover, the possible implication of this definition that it is the frequency of indulgence in abstract thought that differentiates between greater and lesser intelligence also carried with it the further implication that a single thought cannot be intelligent, an implication that cuts us off completely from the observable referent, the behavioural act. This definition in terms of abstract thought is clearly beside the point" (1945, p.115).

As Chein develops the point it is clear that when we talk about intelligence we must be careful to identify what it is we are talking about, namely, intelligent behaviour. We then have little difficulty in seeing that "an activity is as intelligent as it occurs with reference to all of the relevant factors in the behavioural situation" (p.115). We then find that "*Intelligence is the apprehension of the relevant structure of the total behavioural field*: relevance being defined in terms of the immediate and presumptive purposes of the actor" (p.115).

It will be now seem that I am claiming that with the emergence of this new paradigm and guidelines such as those worked out by de Bono, we will find significant increase in intelligent behaviours. This will not necessarily be reflected in greater skills in textual analysis, and hence IQ measurements. It is a conclusion I find very easy to accept after three decades of experience with the effects of participative democracy at the work-face.

Third, the new paradigm leads to a `re-centering' of the teaching process. It seems appropriate to examine this in the context of the basic skills of thinking, conversing, reading, writing, arithmetic and motor skills. The world wide expressions of dissatisfaction with the educational process have been focussed on the failure of the educational systems to establish the basic skills. Not unnaturally these expressions of dissatisfaction have been accompanied by an insistence that the educational practices return to a more rigourous practice of the traditional modes of education.

This is a simple minded solution that would get no marks in Dr de Bono's book but it puts the educational systems in a dilemma. In a world that increasingly frowns upon the use of the stick and allows children unlimited access to television it simply may not be possible to return to pedagogics. If they could return it is by no means sure that they could, by those traditional educational practices, produce people who have a command of the basic skills and yet be productive members of self governing communities or of the 'quality control circles', project teams and self managing work groups that industry increasingly demands. The problem is even more complicated than that. The demand for the rigours of pedagogy typically come from the backward employer who sees himself producing in the bureaucratic mode for years to come. The employer who has seen that more participative modes of production are required sees some part of the problem, but finds no way to express his demand. The self employed are practically voiceless in a society which is overwhelmingly bureaucratised.

The recentering of teaching in the basic skills is necessary as we can now see that the essential skill, in each case, lies in the perception of invariant relations and distinctive features that are present in characteristic stimulus arrays to be found in each skill area. This contrasts sharply with what is seen as appropriate teaching if knowledge is only that which has emerged from the logical, abstractive layouts of others: in this latter case the methods of rote-learning and stimulus-response (S-R) reinforcement are efficient. Eleanor Gibson, life-long co-worker with James Gibson, has formulated what this recentering means:

“The S-R formula does not apply to perceptual learning because it is not a response that is learned but a distinctive feature, an invariant, or a structure that makes order out of chaos and produces information. Collating of features, finding, permanent, invariant attributes of things and places and predictable relations in events, is adaptive and achieves cognitive economy” (p.34).

“ ...R D Bloom (1971) concludes, `There is surprisingly little clear-cut evidence dealing with the ability of operant techniques to alter such covert features of reading as comprehension or the formation of inferences' (pp.7-10). We know of none and expect none, for a schedule of reinforcement cannot even be imposed on let alone produce, comprehension or inference. They must come from within the learner” (p.275).

“Because a learning process that involves abstraction of invariants or inducing rules is of necessity largely internally regulated, the question of motivation and reinforcement becomes very important. If the child must essentially `do it himself', what will make him do it, keep him at it, and tell him when he has perceived a useful relation?” (p.265).

The issue is put into the broader context of education as a social institution by a study that was simply concerned with measuring what actually appeared to be going on in a primary school:

“The child's relationship to the learning materials is given little opportunity to develop into a spontaneous interest relation because it is overshadowed by the teacher-child relationship. The teacher generally decides what material should be worked on, the relative importance of the different aspects, how it should be worked, the standard of achievement and when work should cease. It is only rarely that the child's behaviour is spontaneously oriented towards problems posed by the material itself or guided by the demands implicit in the structure of the material. Because the initiative and guidance comes from the teacher the *behaviour of the child is oriented primarily towards the teacher and not towards the material to be learnt*” (Emery & Oeser, 1954, p.182).

In the old paradigm the perceptions of the student were a useless and potentially dangerous distraction from the task of instilling proven knowledge and the authority of the teacher had always to be preserved. In the new paradigm this is destructive of learning. If the student is caused to be looking over his shoulder at his teacher he is distracted from attending to what is before his eyes. In the new paradigm the teacher must act so as to vary what is before his student's eyes whilst his own presence passes unnoticed.

Such a different concept of teacher is implied that it might be wise to speak just of the educator.

Some understanding of the role of the educator may be gained from close study of three of the most developed educational practices within the new paradigm Hughes, Catherine Stern's *Structural Arithmetic*, and de Bono. De Bono, working with highly literate adults as well as five-year olds, found it necessary to provide tools that would block, or at least hinder, the established perceptual practices of taking a quick sampling of the perceptual offering, making a snap judgement about what was offered and retreating into further abstraction and logical inference. To devise these tools he had to abstract from the invariant features of perceptual differentiation. He did not see himself in the business of providing concepts that generalized the contents of the subject-matter his students were thinking about. He depicted the contrast in the following two diagrams.

Diagram 1. The Process of Abstracting

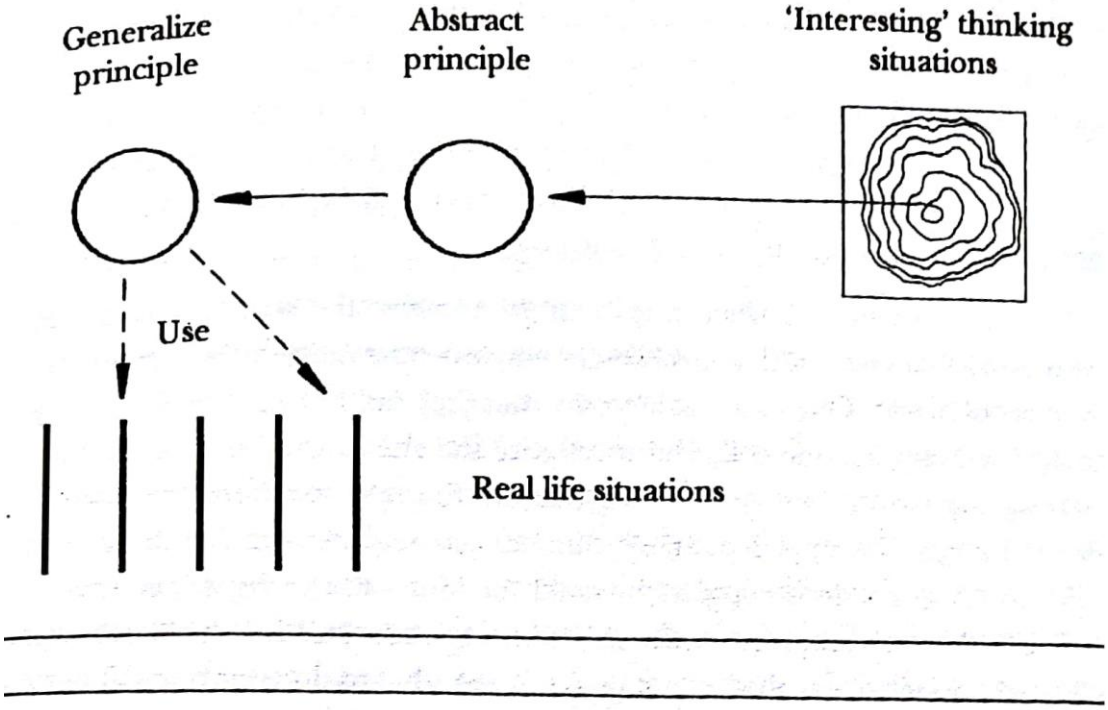
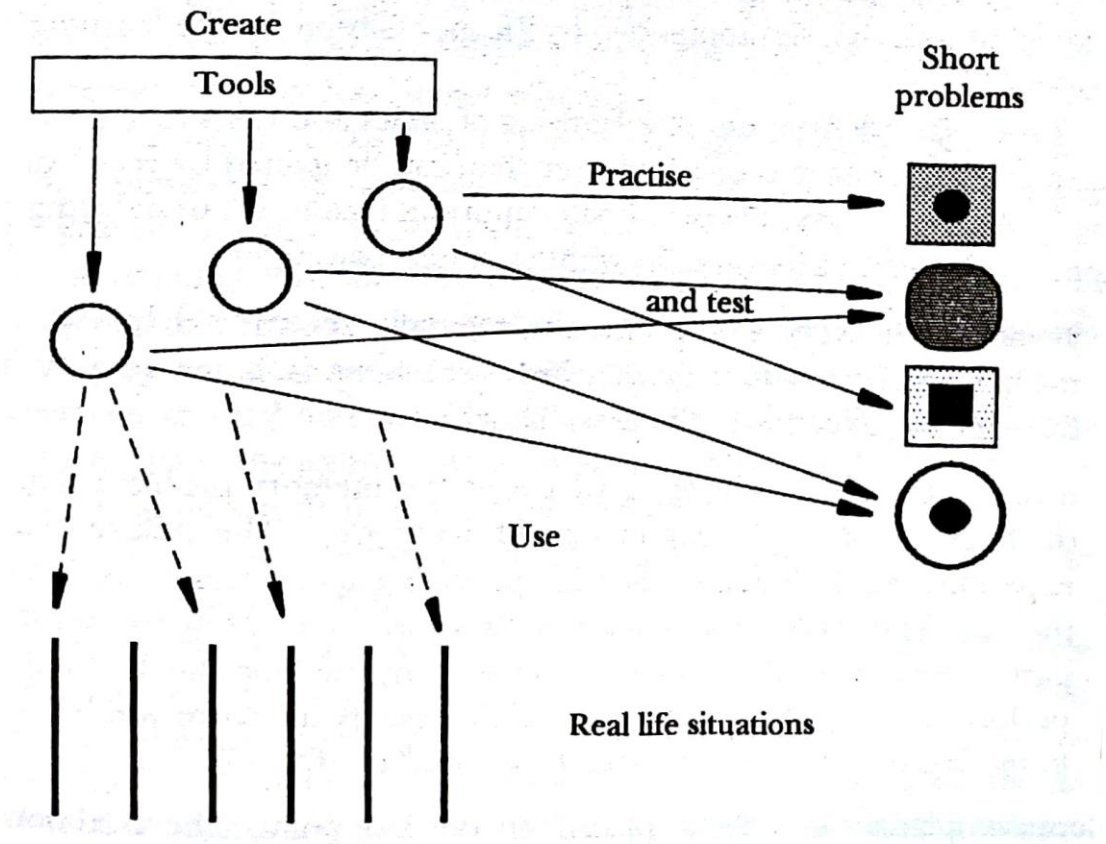


Diagram 2. Tools as Attention Directors (Adapted from de Bono)



The tools are contrived to help the learner by blocking his easy slide into perceptual error or making snap judgements. In effect they are reminders to look again, to inspect the broader context over a longer time span, to look for higher order invariants than might emerge from a casual glance. A teaching role is sometimes necessary in order to convince people who have been brought up in the old paradigm that there is information to be gained from perceptual work that cannot be gained by the mental processes of abstraction, classification and generalizing. The blocks make them conscious of processes that are normally habitual.

In Catherine Stern's *Structural Arithmetic* we find the emphasis is upon discovery not on unlearning old habits. The tools she has created allow children to perceive for themselves those invariances and distinctive features that we associate with arithmetic and our number systems (see following page).

"Structural Arithmetic provides materials to be used in experiments that reveal the structural characteristics of numbers and number relationships. Accordingly children learn arithmetic by insight and not by drill" (Stern and Stern, 1971, p.15).

The teacher introduces these materials for the child to experiment with. Such introduction may require demonstration of the task to be mastered. Thanks to the design of the materials the child can see when he has got it right. The teacher can not only observe whether the child is grasping the relations but also when they are failing. Stern indicates the role of the teacher when the child in failing as follows:

"What can a teacher do when pupils fail to perceive the structure of the stair and cannot succeed in this task? Some may even be satisfied by a random sequence of blocks. Others are able to see that they did not succeed in the given task. For example, one child did not notice the size of each step as he was inserting the blocks, but upon looking at the finished structure said sadly, `It looks bumpy, bumpy! No Stair!' Should the teacher correct these errors directly? No, this does not give the child the kind of learning experience that will help him to comprehend the structure of a stair. Instead she re-structures the task in such a way that he not only can see what to do next but will be able to learn by insight" (ibid, p.41).

Stern goes on to illustrate some of the ways the task can be restructured to aid the child gain insight but the significant point is that the approach is identical with that recommended by Eleanor Gibson for the learning of reading.

This is a far call from the rote learning of tables and leads to a grasp of mathematical principles that is clearer than can be gained by rote learning of the New Maths. There are two important lessons for us in trying to appraise the likely achievements within the new paradigm:

- it enables the very young and the mentally retarded to grasp the mathematical principles upon which arithmetic is based (see W W Sawyer's Introduction to the Stern book);
- it solves, or more correctly, it by-passes the memory problem that is the bug-bear of all learning in the old paradigm – "The children have experimented with materials that provide experiences from which they can learn and grow. Whatever they have once grasped becomes part of their mental equipment forever. Anyone who has learned to perform a task by having gained insight into its structure will be able to reconstruct whatever has been forgotten" (ibid, p.46).

Some emphasis can well be placed on the last point. The traditional paradigm of learning is also a paradigm of memorizing. Within that paradigm great stress is necessarily placed on forming and strengthening associations and examinations that supposedly test the continued existence of those associations. On the assumption that there are no directly perceivable structures `out there' this dependence on memory is unavoidable. On the same assumption the prototype of the memory process is the memorizing of nonsense syllables that have no previous associations attached to them and the most important means for building associations is repetition, drill. The fact that the human memory is highly unreliable and prone to forgetfulness and that drilling de-motivates people have to be put up with as some of the unpleasant facts of life.

A great deal of evidence has accumulated to support everyday experience that a lot of learning does not seem to involve such a memory process (Rock, 1958; Asch, 1960; Katona, 1940). This evidence makes sense within the Heider/Gibson assumptions. When structure in the environment can be directly detected, as children detect the principles of arithmetic in Stern's material, then learning is not dependent on drilling and memorizing. In learning to detect the higher invariants in that material they do not have, as it were, to store away `memory traces' and subsequently engage in some mysterious process of `retrieval'. Having learned how to detect these invariants they can more easily detect them again in some other setting where that information is needed. The problems of memory, like those of thinking are problems in perception. We are not designed like computers but it may well be that computers are designed on a mythical image of man.

To round out our picture of how the basic learning tasks might look in the new paradigm we turn now to reading and writing. Fortunately a good deal of the groundwork has been done. Eleanor Gibson and Harry Levin have completed an exhaustive study of *The Psychology of Reading*. Doman and Hughes have evolved a teaching practice that, like Gibson and Levin, takes these tasks as tasks in perceptual learning.

Learning to read and write is, in the traditional paradigm, critical to gaining access to the stores of knowledge in society. Without such literacy education could hardly proceed. Conversely any studies, such as the arts, craft, sport and rhetoric that did not require literacy could hardly be regarded as serious studies.

However, learning to read and write appeared to be truly formidable tasks. It was a fact that practically every child had learnt to comprehend and to produce comprehensible speech before they began their formal schooling. This was not seen as lessening the task of learning the alphabet, developing a vocabulary, learning to spell, learning the rules of grammatical construction and, of course, the skills of writing. All of these appeared to require years of drilling to build up the necessary mass of remembered associations. The complexities were such that it is little wonder that experimental psychologists left the matter alone for the first sixty years of this century (E Gibson, p.xi). It is also not surprising that major attention was given to the question of when a child's nervous system might be sufficiently mature and robust to undertake these tasks.

In the new paradigm these matters no longer have the same relevance. The appropriate question becomes, `what information is present in the visual and auditory structures of speech and writing that enable us to extract constant meanings regardless of the sensory modality and regardless of the wide variations in the stimulus array?' When we ask this question it

becomes obvious that the unschooled toddler is already well versed in extracting information from his physical and social world. In learning to comprehend speech *and* to produce comprehensible speech the toddler has demonstrated a grasp of the world-with-symbols. The critical passage from a world-without-symbols to a world-with-symbols has been made before formal schooling even begins.

It is as well to pause here and consider how that particular transition is so frequently achieved with so little apparent effort at teaching - this might tell us something about what could be expected with reading and writing if we are not blinded by epistemological assumptions.

First, it is very relevant that the Wernicke and Broca areas of the left cortex "seem to be organized explicitly for the processing of verbal information" (Geschwind, 1979). The audible component of speech, but not other kinds of sounds, and the visual signals of writing are both apparently processed in the Wernicke area and proceed to the Broca area for speech production. Obviously people have evolved for speech in much the same way as musk rats have evolved pheromones for intra species communication.

Second, "The list of distinctive features that exist in the languages of the world is supremely restricted" (Jakobson, 1971, p.7). All of the known languages have evolved to use a finite and limited set of perceptually distinctive features for their phonemes and their morphemes. These features are clearly based on the inherited capabilities of the human species for modulating, sustaining, starting and stopping the flow of air in their air pipes, in a limited set of ways (Studdert-Kennedy, 1974).

And, as noted above, there is an ability to extract these kinds of sounds from the auditory field. "There is a directness in perception that makes it difficult to hear the sounds, even of a totally foreign language, as purely auditory events. We hear them instead phonetically. That is to say, we hear them as sounds generated by the vocal organs of humans...this level is no longer one of sound, but rather of some intricate, abstract derivative from the initial auditory analysis" (Studdert-Kennedy, 1974, p.2351). The distinctive features that characterise speech are invariant over a wide range of differences in conditions of production (eg, in a party). These three characteristics, economy, reproducibility and detectability, are what we would expect of a communication system that has evolved to support survival of a species.

One further question remains. The ease of transition to spoken words would be readily explained if the spoken words shared some of the distinctive perceptual features of the objects or events that they symbolize. In onomatopoeic words, such as choo-choo for steam engine, such a direct mapping of phonemes to a distinctive feature of the referent is obviously present. Such instances are rare and probably misleading. Nevertheless the study of poetry and the path breaking work of Heinz Werner on the physiognomy of words, particularly with non literates, are an insistent reminder that there is probably something there. Since Jakobson has shown that phonemes are unique clusters (combinations) of a few distinctive features it would seem that if we are to disclose the mapping it will be at that level. We would not expect all spoken words to have strong physiognomic features because of their own evolution to provide context for each other, but awareness of those that have might make it easier to introduce children to the perceptual task of `seeing through hearing'.

To resume the main trend of this discussion: we are discussing how easily young children make the transition from *seeing through hearing*. The next transition, the transition to literacy, is to *hearing through seeing*. This transition is greatly facilitated by the fact that the

young learner is already skilled at producing speech. He or she is thus able to test whether they can uniquely match what they see in a grapheme with a morpheme or phoneme. Initially, of course, a child is introduced to the written word by someone who is already literate in that language. The first learning task is then to produce a phoneme or morpheme that matches the speech sounds that someone else matches to the particular visual symbol. Remember that they are already well-versed in producing speech to match the speech of other. The only problem they face is that of identifying the uniqueness of the visual symbols before them. Thus, for instance, they already know dogs and they know they are the invariant referent of the spoken word dog (a dog does not get called cat although lots of other things might occasionally get called dog). The visual symbol of `d o g' is novel only in that it is a certain kind of visual symbol; it is not novel to find a symbol referring to dog.

In the traditional paradigm we confronted this as another task that required the build-up of a massive apperceptive structure of stable associations. We seem to have made a mountain out of a molehill.

If we regard this as a perceptual task all we have to do is help the learner to perceive what is unique and invariant:

- identify those few distinctive features that, in combination, define the uniqueness of graphemes and encourage the learner to look for these;
- present the graphemes writ very large so that the distinctive features are readily perceivable to young people who have developed no strategies for searching text (Hughes, 1971);
- introduce only a few grapheme at a time. Rock's studies and Asch's, demonstrated quite clearly that what we have called an association is a perception of a unique relation; this perception is retarded by undue clutter or too many conflicting perceptual demands just as surely as it is by absence of obvious distinctive features (the above two points).

Repetition *per se* has no role in making this transition to `hearing through seeing'. The role of repetition is practice in detecting the unique relation in differing contexts.

This seems ridiculously simple, but that is the message coming from the meticulous study by Eleanor Gibson and Barry Levin and the down-to-earth practice of Doman and Hughes.

By basing this education on the perceptual capabilities that children already have we are able to achieve a simple self-motivated transition to reading as soon as spoken language is learned; i.e., well before the age of formal schooling.

The further transition to writing offers little problem if the distinctive features of graphemes have been grasped in learning to read. As might be expected in such a perceptual task the transition to a `world-with-symbols' is heavily influenced by the extent to which the child is growing-up in a world-with-symbols: “Children seem to develop tremendous sensitivity to differences in graphic materials simply by having plenty of graphic displays around to look at” (E Gibson, 1975, p.239). Nevertheless there is “some early, painless, and apparently self-motivated learning about the writing system for the school to build on later” (ibid, p.233). In a review of studies of the development of children's spontaneous scribbling Levin concluded that by three years of age they are producing forms that “contain features that are characteristic of writing and not of pictures” (ibid, quoted, p.233). By the age of three

children, even those in environments that were impoverished with respect to symbols, distinguished writing from pictures (ibid. p.239).

The evidence indicates that the written word is processed in the same area of the left cortex as the spoken word; i.e., the Wernicke area. It seems difficult to imagine that any evolution of the central nervous system could have occurred in response to the very recent emergence of writing. It is not difficult to imagine that writing systems evolved to take advantage of the particular set of distinctive characteristics utilized by the Wernicke.

In the traditional paradigm the achievements of Doman and Hughes in teaching preschool children to read and write had to be regarded as freakish and treated with the same sort of reserve as Stern and de Bono. They were, in effect declaiming that `the emperor has no clothes'. In the new paradigm their achievements are only what one would expect.

The achievements in this field need not stop with cessation of the self-defeating educational practices of the old paradigm and the introduction of the simple search and display strategies suggested above. A major task within the new paradigm would be to explore the physiognomic properties of the semantic relation *and* the relations between the written word, the spoken word and the referent, as a set. We know enough to know that this exploration needs to be at the level of distinctive perceptual properties and not at the level of phonemes and graphemes. We know also, from the poets, that some written words have a `fittingness' to their spoken equivalent and to their mutual referent that is not possessed by other words. Such words offer a royal road from one system of symbols to another. Aphorisms and folk-sayings offer frozen capsules of meaning, invariant over time, and to some extent over cultures, that serve similar functions.

These explorations have been deliberately focussed on the primary tasks of education. The thought was that if the new paradigm has substantial consequences for the teaching of the three Rs it could hardly not have a similar magnitude of effect on subsequent learning. I should have learned better. When we engaged in the democratization of work we figured that if we could show a beneficial transformation in such places as coalmines, mills and factories then the possibilities for places of relatively privileged white-collar work would be obvious. We found instead that Weber's theory of bureaucracy created a special form of blindness. Sure enough, we find special reasons for not regarding the transformations at the level of the three Rs as evidence for what could be achieved at the higher levels of education. The three Rs is now seen as `really a training in skills'. `Real learning' is defined at some point beyond where mass learning finishes - somewhere beyond first degree level. This redefinition of learning is very convenient but not sustainable. Pioneering work, such as that done by Stern and Hughes, has already been done at the higher levels of education (Ackoff, de Bono, Emery, Williams). At the higher levels of education there is the same reliance on abstraction, classification and generalisation. Memory has the same central role in learning and examination. What we have had to say in contrasting searching with researching applies with as much force at this level as at the level where children are learning the three Rs. More so. The weight of evidence is that educated; i.e., literate, adults find it particularly difficult to use the evidence of their own perceptions, We have become particularly sensitive to this problem in the past decade or two and come to espouse a `continuing education' that goes beyond normal education and somehow or other comes to be described as *learning to learn'*.

The implications of the new paradigm for this emergent field of continuing education need to be considered because this is par excellence the field that concerns the serious education of adults so that they can better understand and advance their most serious purposes in life.

Continuing education emerged from widespread recognition that social traditions and authority structures were changing at such a rate that:

- the need for education now continues long after formal schooling ends as important social changes occur that were hardly conceivable in the minds of those who designed the old curricula;
- the appropriate aim of such education should be `learning to learn', not just more schooling.

`Learning to learn' was an idea that was not in anyway referring to the traditional concept of study habits. The core referent was to learning for oneself, not teaching oneself from text books.

In my own attempts to dissect this new concept I was much taken with the extent to which it centred around *unlearning* and not just learning of new contexts and new details (Emery, 1975). It did not matter whether the learnings concerned local planning, corporate objectives, work organization or the like: the critical learning problems seemed to lie in unlearning habits of thought and cognitively restructuring or recentering what was already known. This parallels de Bono's experience with trying to teach adult people to think.

When what one has been taught has also been taught as *The Truth* then there are no built-in stop commands, as there has to be on a computer program. In some parts of experimental science there are such signs but this is the exceptional case and not always very effective there. In the traditional paradigm knowledge adds on knowledge and the progress of knowledge is simply assumed to be an inevitable process of accretion. Details will have to be corrected, sometimes a rush of details will have to be added, but the notion of serious restructuring belongs to the prescientific era when people could believe in things like phlogiston and witches. That is, the notion of restructuring or recentering is alien to the traditional paradigm of knowledge and to the people who have absorbed this paradigm as a world view. It is the most difficult of learning tasks.

To enable people to achieve a capability of learning to learn we have had to devise ways in which they can cope with the boot-strap operation of unlearning (for it is that kind of operation in the traditional paradigm).

To this end we gradually evolved the tools that are labelled Search Conferences and Development of Human Resources Workshops. These are tools of the same nature as the tools that de Bono had to devise to help adults learn to think. The effect of these tools was to enable people to achieve in joint activity what they could not achieve alone; i.e., to accept that their pooled perceptions disconfirmed their assumptions and provided alternative conceptions of reality. These practices, which we evolved for adults concerned with their continuing education, do not differ significantly from what Paulo Freire evolved for the same purposes with illiterate peasants of the `Third World'.

The new paradigm allows us to identify the referent for the slogan `learning to learn' (and slogan it was becoming because within the old paradigm it was close to gibberish). The new paradigm gives meaning to the phrase `learning to learn'. In learning to learn we are learning

to learn from our own perceptions; learning to accept our own perceptions is a direct form of knowledge and learning to suspect forms of knowledge that advance themselves by systematically discounting direct knowledge that people have in the life-sized range of things, events and processes. This is hardly a learning activity that is reconcilable with the concept of learning that is embedded in our current institutions of learning. They are committed to the view that learning is an indirect, esoteric and tortuous path of research with a split off element concerned with transmitting the results to students. What is unavoidable in the study of nuclear particles and galaxies has become the prototype of learning, as did the study of unobservable homunculi in the middle ages. I suggest that in these cases the form dictates the content. Real knowledge, and hence real learning, is taken to be that which fits the ruling paradigm. Knowing ourselves and the world we experience and live in takes a poor second place.

There is a certain irony emerging here. In the historical period in which continuing education has been emerging there has also been emerging a massive growth in electronic computerization and communication. The latter has been seen as the inevitable source of an *information revolution*. These new technologies have been designed on the assumptions of the Lockean paradigm and Newtonian Optics. They are providing a paralyzing flood of signals from which human beings are finding they are unequipped to extract information, or in the case of the telephone, unprepared to make use of the information that is transmitted (Emery, 1980). The real information revolution lies in the emergence of the new paradigm.

As everyone with some intact perceptual systems becomes a self confident source of information generation will we be faced with a real information explosion?

There seems little room for doubting that with the emergence of industrial society, the mass society, we offered mass education in the same way as we offered popular democracy - the appearances without the reality.

We have discussed above how this particular feat was accomplished. We also discussed how the new paradigm could transform the learning of the basics, the three Rs. These transformations, and the methods of de Bono for teaching thinking, would all help to restore confidence in the direct access to knowledge that is available to young and old alike. To make only these transformations would be to render obsolete the dichotomies in learning potential that have been enshrined by the old paradigm. We should, however, be thinking beyond this.

If perception is so central to thinking and learning should we not be reconsidering the roles of art and poetry in education? Should we not be giving thought to the education that is to be gained from allowing that we might learn from the other sense, the haptic and those of smell and taste?

One has simply to raise these questions and the direct concerns are expressed about the educational implications of the new paradigm. It is yet another excuse to land us back with the earlier suggestions that the serious business of education be replaced by permissive playfulness? Is it not an education in sensuality?

However, the seriousness with which we proceed to replace the old paradigm will probably be best measured by our answers to those questions. The move from one paradigm to another is literally a figure-ground reversal. We will have to notice that a child trying to capture on

paper an invariant that he perceives is more given to frowning, a puckering of the lips and other signs of intense concentration than a child trying to recall an algebraic formula. More than anything else we will have to notice that humans, regardless of their educational levels, achieve creative thinking by grasping `the universal in the particular'. This they do by perceiving the higher order invariants presented to their own perceptual systems. These higher order invariants are embedded in the total context of objects, events and their environments. They bear no necessary relation to the higher order abstractions that are based on qualities that appear to be very frequently associated with particular classes of objects or events; e.g., that swans are white and all people are selfish.

The figure-ground reversal we are confronting is one in which the education in the three Rs can be safely left to parents and elder siblings. The professional role of teachers will be centred on the complex task of guiding children, and adults who have been blinded in the old paradigm, into the multiplicity of ways in which they can enhance their capabilities for extracting information from their world.

To summarize:

Our perceptual experiences are engagements with an environment that is already informationally structured. They only begin to approximate the traditional notion of sensory impressions when we are engaged in trying to perceive ourselves perceiving (Chein, 1972, pp.136-7).

Our perceptual systems have evolved so that we, and other animals, are, at birth, attuned to detect invariances in the available flow of energy and particles that are ecologically significant sources of information. “Furthermore, there is ample evidence that the senses are not only generally preattuned but *become* more sensitively calibrated to pick up those exigencies of the environment that bear directly on the survival, success and well-being of the perceiver - what has sometimes been called the *education of the senses”* (Shaw and Pittenger, 1977, p.107).

This in-gathering of information takes place in non-Euclidean space. If it was transmitted through media that behaved as Euclidean space most of that information would be garbled beyond retrieval. Admittedly, “There are what might be called `Newtonian oases' in perceptual space. Within a frontal plane, space is approximately Euclidean; and up to a few yards from the observer, shape and size are actually seen as unchangeable” (Arnheim, 1974, p.290). Even within that flat place we cannot always `see straight', as is demonstrated by the well known Muller-Lyer and Ponzo illusions. Viewing beyond the first few yards, it is almost impossible for someone not trained well to `see in perspective' to see things as if they were just a distortion of a Euclidean scene.

Despite the evidence of the senses, schooling, within the old paradigm, appears to move us a long way toward the assumptions of Locke and Herbart. The preschool child's concept of space is topological; by twelve it is Euclidean (Piaget and Inhelder, 1956). Within the new paradigm one would hope that by the age of twelve a child would have as many geometries as his world requires, if it is to speak to him or her.

In the following table (opposite) I have tried to summarize the differences in education practices and experiences that have been or are likely to be observed in the different paradigms.

I have not attempted to contrast the effects on the personal development of those adults whose lives are committed to teaching. This is only because I am not sure that a life-time commitment is necessary or desirable in the new paradigm. In the old paradigm, Charles Dickens' Mr Gradgrind is still very much with us. The poets tell us more about the new `teacher'; and little wonder that Plato would ban the poet from his Republic!

"If he [the teacher] is indeed wise he does not bid you enter the house of his wisdom, but rather leads you to the threshold of your own mind" (Gibran, 1923).

"It must go further still: that soul must become its own betrayer, its own delivered, the one activity, the mirror turn lamp". (W.B. Yeats).

Summary Table		
The Practice		
	Traditional Paradigm	**Ecological Paradigm**
Object of learning	Transmission of existing knowledge, abstraction of generic concepts	Perception of invariants; discovery of serial concepts; discovery of universal in particular
Control of learning	Asymmetrical dependence: teacher-pupil; competition of pupils	Symmetrical dependence: co-learners; cooperation of learners
Coordination of learning (a) behaviour settings (b) timing	School/classrooms, age grading/school calendar, class time table	Community settings synchronized to and negotiated with community settings
Learning materials	Text books, standardized lab, experiments	Reality centred projects
Learning activity	Paying attention, rote practice, memorizing	Discrimination, differentiation, searching, creating
Teaching activity	Lecturing, demonstrating	Creating and re-creating learning settings
System principle (after Abrahms, 1953)	Pedagogy: 'the mirror'	Discovery: 'the lamp'
The Experience		
	Traditional Paradigm	**Ecological Paradigm**
Cultural mode	Work/Religion: 'serious drudgery'	Active leisure: 'exciting, frustrating'
Dominant group emotions (after Bion, 1961)	Dependency; fight/flight	'Work'/Creative working mode
Personal development	Conformity; bullying Divorce of means and ends; cheating; self-centredness; hatred of learning (and swots)	Tolerance of individuality; depth and integration; homonomy; learning as living

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