Gordon Pask's contributions to psychology

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Abstract *This paper reviews the contributions of Gordon Pask, cybernetician, to the discipline of psychology as a methodologist and as a theoretician. Pask was prolific in many fields but especially so in psychology both as an innovative experimenter and an innovative theorist. Over four decades, Pask carried out experimental studies of learning, problem solving and decision making, often using sophisticated computer-based environments. These latter, in turn, inspired the design of teaching machines and learning environments with practical applications in education and training. Pask's theorizing while addressing detailed methodological and conceptual issues was also holistic and unifying in intent, not least in his proposals for rapprochements between process, individual and social psychologies.*

Introduction

Gordon Pask was internationally known as a cybernetician. He was known as one of the founding fathers of the discipline. His commitment and contributions to cybernetics are well documented and well attested (Scott, 1980, 1982, 1993; Glanville, 1993). Indeed, among his peers in cybernetics he was known as the cybernetician's cybernetician (Beer, 1993; von Foerster, 1993). In holding true to the vision of cybernetics as a transdiscipline, one that brings order to and unifies other disciplines, Pask well recognised that the cybernetician should also be a practitioner of significance within at least one other discipline. In other words, the generalist should pursue at least one specialism and should do so successfully. This serves two purposes: the person committed to cybernetics is shown not to be a mere dilettante and, in so far as he applies cybernetic concepts and methods in his work within a specialist discipline (or disciplines), he is providing publicly available evidence of the usefulness of adopting a cybernetic approach within that discipline.

Pask was naturally holistic in his thinking. If you like, he was a "born" cybernetician but he also respected the specialist knowledge and expertise that is required for successful practice within a particular discipline. Pask was an effective and versatile learner. He could readily get to grips with complex bodies of knowledge and associated methodologies. In that respect he was a true polymath. He could interact knowledgeably and constructively with practitioners in many disciplinary areas. He had early interests in geology and mining engineering. His medical studies provided knowledge and expertise in

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biochemistry, physiology and neurology. He made major contributions to psychology, education and educational technology, artificial intelligence and computer design, epistemology, architecture and design. Without claiming specialist knowledge, Pask was also well read and knowledgeable in arts and humanities subjects. He knew what the great philosophers had said, both classic and modern. He knew his Dickens, Shakespeare and Jane Austen. He loved the theatre and contributed to it. When he had the time, he drew and painted with great skill.

Here I wish to discuss Pask's contributions to psychology, the discipline area to which he contributed most substantially. As I understand it, it was during his undergraduate time at Cambridge studying medicine that he first became interested in psychology as a particular disciplinary area. He attended the lectures given by the great Cambridge psychologist, Sir Frederick Bartlett. His friends and peers included Richard Gregory and Donald Broadbent, Cambridge psychologists who went on to gain international recognition. Pask's many contributions are still being assimilated. I am quite convinced that subsequent generations will look back on Pask's generation of psychologists and recognise that, in him, we have been fortunate enough to have a contributor to the field of real genius and originality. I will try to summarise, in outline at least, why I think this is so.

Contributions to methodology and theory

Pask has contributed greatly to the methodology of experimental psychology. These contributions are often overlooked since they are readily overshadowed by his theoretical contributions and by particular empirical studies. As a methodologist he was proficient, thorough and original. He has also made many original theoretical contributions. In this section we consider some specific examples. In the next section we look at his conversation theory (CT) which serves as a useful framework for understanding the range and coherence of his work.

It is well known that Pask pioneered adaptive teaching systems in the 1950s and 1960s. Pask's own early book on cybernetics (Pask, 1961) gives an account of that work. Pask recognised that the systems he was building also served as experimental support in the study of human cognition and learning. He referred to this as a "null-point" or "steady state" methodology (Lewis and Pask, 1965; Pask and Lewis, 1968; Pask, 1972). As noted later, one of his contributions to the theory of human learning was to characterise man as a system with a "need to learn" (Pask, 1968). If we are to study human learning, it is necessary to ensure that learning takes place and that we can, with some confidence, say what it is that the learner is learning. An adaptive teaching system learns about the learner in order to optimise the rate of learning. It does the latter by continually presenting problems whose difficulty is such as to maintain the learner at an optimal rate of learning, that is, at a steady state of learning (see Lewis and Pask, 1965, for a clear statement of principles).

What happens if this steady state is not maintained? Now, as experimenters we cease to know what is happening. If the problems are too easy, the learner becomes bored. He begins to pay attention to other things. He learns other things we do not know about. Similarly, if the problems are too difficult, the learner fails to master the problems and, again, his attention will wander. He will attend to other things. Reference to steady states and rates of learning is an acknowledgment that man is a dynamical, self-organising system. Pask would often refer to this, the dynamical systems aspects of learning theory as his "macro theory of learning". As described below, in later developments of the macro theory of learning systems, Pask studied the dynamics of coming to know in intellectual domains and designed systems to monitor and regulate changes in a learner's level of uncertainty about the subject matter being studied and, also, his strategic uncertainties about what aspects of the subject matter to attend to (Pask and Scott, 1973; Pask, 1975a). Pask also studied the particular mechanisms and content of learning and correspondingly referred to the "micro theory of learning". In the micro theory we are concerned to characterise the particular skills and concepts that are being learned and to describe how the learner directs his attention in order to come to know those skills and concepts in a process of "symbolic evolution" (Pask and Scott, 1971, 1972).

In work carried out with Brian Lewis, Pask had discovered there were limitations to the steady state methodology. Sometimes learners would "play" with the system and attempt to override the adaptive controller. From this discovery, Pask, working with the author, went on to develop the "co-operative externalisation technique" and the first conversational teaching systems (Pask and Scott, 1971). In these systems, as well as there being a level of discourse about problems and possible solutions to problems (or, if you wish, stimuli and responses to them), there is a higher level of discourse about what type of problem should be tackled, in other words, a discussion about strategic aspects of learning and teaching. In return for externalising his preferences about what to learn, what to attend to, the teaching system cooperates with the learner by presenting him with his preferred problem type. This is contingent on the learner making satisfactory progress. If the learner's choice of strategy is not effective, then the teaching system takes over and imposes a strategy, one that is genuinely known to be effective for that type of learner. It was in the course of carrying out this work that Pask and Scott first discovered and characterised two distinctive learning styles, holist (many-at-once) and serialist (one-at-once) (Scott, 1969; Pask and Scott, 1971, 1972).

In order for there to be a discourse about strategic aspects of learning, learner and teacher must share a common description of the domain of knowledge to be learned, requiring still high levels of discourse; these discussions themselves may be up for negotiation at higher levels as learner and teacher share conceptions and misconceptions. In simple signal transformation tasks, where, when presented with a signal, the learner is required to transform a signal into an appropriate response within a short period of time, as for example in a

keyboard skill, the structure of the knowledge domain, that is, the description of classes of problem that are to be posed, may be presented to and shared with the learner in a fairly straightforward manner. For complex bodies of intellectual subject matter, something more sophisticated is required. It was from these requirements that Pask and Scott went on to develop CT and embody it in course assembly system and tutorial environment (CASTE) (Pask and Scott, 1973). CASTE was an effective, adaptive, conversational teaching system, "A vehicle for driving through knowledge". It was also a sophisticated system for observing processes of learning. In association with CASTE, Pask and associates developed a knowledge elicitation methodology for course assembly purposes and methodologies for knowledge and task structure representation (Pask *et al.*, 1975). From the perspective of methodologies for studying learning, Pask liked to characterise CASTE as being analogous to a physicist's cloud chamber. As a cloud chamber allows one to observe particle interactions, so CASTE allowed one to observe the occurrence of "understandings", occasions when learners can be said to know or understand a new skill or concept by being able to "teach it back".

CASTE accommodated both serialist and holist learning styles. A learner working holistically could choose to work on more than one topic at once. A serialist would typically choose to work on one topic at once. This gives rise to fundamental uncertainties for the observer of learning in CASTE (in general, the observer of a conversation), analogous to fundamental uncertainties in physics. He might know a learner's intentions, as when a holist selects a cluster of topics subordinate to his main aimed for topic, but not be sure when a particular topic becomes understood. Alternatively, he may know when a particular topic becomes understood, as when a serialist works on one topic at once, but may not be sure of any more global intentions the learner is entertaining beyond the current "worked on" topic.

Associated with the concepts of learning style and learning strategy are the concepts of comprehension learning and operation learning. These are complementary aspects of the learning process. The former refers to building descriptions of procedures (e.g. knowing that the ingredients of bread include flour, water, yeast . . .); the latter refers to procedure building itself (being able to make a loaf of bread). Empirically it was found that it is often the case that holists are biased towards comprehension learning (globetrotting failing to ground ideas operationally) while serialists tend to be biased towards operation learning (improvidence failing to take advantage of similarities between operations in different domains). Learners who are successful at both kinds of learning are said to be versatile. Much detail is glossed here; see, especially, Pask (1976) and Pask *et al.* (1974-1979). See also the papers by Entwistle, Ford and Tickle (this collection).

Process and person psychologies

CASTE was an embodiment of Pask's CT. The first full statement of the theory was in a paper entitled: "A theory of conversations and individuals exemplified

by the learning process on CASTE" (Pask *et al.*, 1973). What, given the title, was Pask up to? Well, he was being a cybernetician who was employing cybernetic concepts of control, communication, and self-organisation. He was employing them in the domain of psychology. As a transdiscipline, cybernetics also purports to be a unifying discipline. So, with one stroke, Pask was attempting to bring unity to the discipline of psychology. As Wittgenstein (1953) noted: "Psychology has experimental methods but is conceptually confused". As a discipline, it is composed of many competing paradigms or schools of thought. Pask's CT aims to bring unity, understanding and reconciliation to two major divisions of thought within psychology. The first division can be characterised fairly crudely as the person versus the process division. There are some psychologists who emphasise that it is important to study the "person" as an integral whole; sometimes these are known as humanistic approaches within psychology. Approaches that tend to emphasise the whole person include those of Maslow, Kelly, Freud, Jung and Adler. In contrast, the process approach, as the name suggests, is one that studies particular aspects of the whole person as separate domains of study. Examples are studies of perception, of problem solving, of memory, of language processing. Within these domains of study there are further subdivisions, for example, auditory perception, visual perception, olfactory perception. Psychologists studying these domains and subdomains use a broad range of methodologies. However, all of them fall within the traditions of natural science. A range of experimental techniques is deployed. Statistical and other mathematical models are built. Computers are used to carry out computational modelling of various sorts. In neuropsychology, careful study is made of the effects of brain damage.

Pask brings order to the person/process distinction using the classic cybernetic technique of abstracting over sets of special cases. In the process approach what is being studied are particular psychological processes. What they have in common is they are in fact all processes. They can all be understood or modelled as procedures that act on an input and carry out operations to transform it in some way. An image is recognised, an event is remembered, a problem is solved. Pask's general name for all these different sorts of psychological process is "concept". His formal definition is that a concept is a procedure that brings about, or maintains, or recognises a relation. Relation is being used as an empty slot or label for that which is being acted on by the process as input or product. Pask's next step in building a rapprochement between person and process, is to use another classic cybernetic tool, to apply definitions recursively, in this case, to characterise processes that act on processes. That is, we may have concepts whose domain of application, whose input and products, are other concepts. Thus we may have hierarchies of processes, of concepts. For example, we can have problem solvers that can construct problem solvers. This is one of Pask's own very elegant definitions of what learning is (Pask, 1975a).

Now we are very close to the person/process rapprochement as promised. We have to do something that is quite alien in the thinking of classical logic and natural science. This is to allow classes of processes to act on themselves, to be self-producing. Instead of a hierarchy of processes, we now have a heterarchical system of processes that are organisationally closed, that not only are productive but are also incidentally but necessarily self-productive, that act so as to reproduce themselves as a coherent whole. The whole person can then be characterised as an ensemble, or collective of self-reproducing concepts, Pask refers to such totalities as psychological (p-) individuals and, as we shall see below, for very good reason distinguishes them from the mechanical (m-) individuals (biological systems and their augmentations, possibly other kinds of system) that are the processors that embody the p-individuals.

Individual and social psychologies

Let us now look at the other great divide in psychology where Pask provides a rapprochement, some unification. This is the divide between individual and social psychologies. Many psychologists study the individual, often being interested in the difference between individuals, such as differences in the "personality" or intellectual abilities or other skills and abilities. There are psychologists who study processes of individual development, of individual learning, and of individual self-actualisation. There are other psychologists who are profoundly interested in man as a social being. They are interested in how humans behave and interact in social settings. They study the social influences on attitude formation, processes of group formation and of communication within groups. They study behaviour in social institutions such as the family or the workplace. There is an awareness that the individual person is constituted in part by social processes, as there is also an awareness that social processes are constituted by the behaviours and interactions of individuals. These topics have been tackled and elaborated by many classic theorists, for example, Piaget, Mead, Vygotsky and Heidegger. Pask was certainly familiar with the writings of Piaget and Vygotsky (Pask, 1966) but not directly with Mead or Heidegger.

What Pask did that was so innovative was to void the distinction between the psychological individual and the social processes that are constitutive of him and which he or she is constituting. Mead posited that "the self is a social process". Unfortunately, there is an ambiguity here. The word self can be used in at least two distinct ways. It can refer to the totality of a person as a psychological individual, as in Pask's system of self-reproducing concepts, or it can refer to the psychological individual's concept of itself, it is self image or self reflection. Mead sometimes appears to intend the former use of the term; sometimes, following Cooley, the latter. Pask agrees with Mead, Vygotsky, Buber and von Foerster that the psychological individual is dialogical in form, is a social process, is constituted by an inner dialogue, is an inner conversation. As a good cybernetician, Pask abstracts from specific cases and voids the distinctions and thus argues that all conversations, all dialogues, all social

processes are psychological individuals. They are all organisationally closed, self-producing, collectives of concepts.

This is, of course, from the perspective of an external observer. He is the one that distinguishes the self-organising totality that is the conversation. The conversation is of course distinguishing itself but not necessarily reflectively. Neither in conversations with ourselves nor in conversation with others are we necessarily or continuously obliged to construct or refer to reflected images. I and we do not have to expressly refer to the me or us, though we may do, which self-referential property, as von Foerster has so elegantly stressed is what makes human life special (cf. Wittgenstein, 1953, "Languages are forms of life " and von Foerster, 1993, "We need language to talk about language"). Indeed, in the very dialogic processes that constitute I and thou, concepts may arise that not only establish and retain the distinction between I and thou, but actively deny there is any sense of "we". Here is the general form of social conflict the "original sin" or "primary error" that second order cybernetics is concerned to address (von Foerster, 1993; Hyut-Man, this collection). By the same token, there are occasions in the dialogic process when the I and thou distinction is voided. Here is the form of social cooperation, of teamwork, of losing sense of self to be part of a larger whole.

There are those who are not comfortable with Pask's formulation, the psychological individual is a conversation, a conversation is a psychological individual. I suspect this may be because some people have very strongly defended self images, very strong senses of individuality and personhood. They do not resonate with Pask's formulation. They may even – but possibly not admit to doing so – find his formulation threatening. There are others who find the formulation liberating and inspiring, who recognise in it the power and beauty of cybernetic thought and abstraction.

Two kinds of individual

A possible source of confusion in coming to understand Gordon Pask's CT is his distinction between two kinds of individual or unitary entity – psychological individual or p-individual and the mechanical individual or m-individual. Perhaps the first thing to note is that using Pask's own terminology (Pask, 1969), p-individuals are "language oriented systems". They are conversational processes but may themselves be participants in conversation. In contrast, the mechanical individual is a "taciturn system", a system that is observed as an "it". Notice it is we as external observers who are distinguishing the two sorts of system. With respect to human beings, we commonly shift perspectives from one form of individual to the other. A surgeon may talk to Joe Bloggs, the p-individual, before and after his operation, but during the operation, he is interacting with an m-individual an "it". Pask characterised the properties of m-individuals in different ways on different occasions. He would often remark that his chief interest in m-individuals was their potential for embodying and supporting the processes of p-individuation. When pressed, Pask would concede that biological individuals, brains and bodies, are the only

current examples we have of m-individuals that support p-individuation. But, he considered himself wise enough not to deny that status to the planets and the stars. He also took great pains to point out that p-individuation may be distributed as in the conversational processes of social interaction, where the p-individual is a conversation embodied in a collective of m-individuals whose activities, as processors, have for the moment become synchronised. As in so many ways, Pask was well ahead of his time. It is only in recent times that psychologists have come to talk about distributed cognition. In later years, Pask developed interaction of actors (IA) theory as a generalisation of CT, beyond locally observed conversations, as in CASTE, to encompass the full field of action where many conversations may begin and end (see de Zeeuw, this collection). Such general forms were always imminent in his thought (see, for example, the final sections of Pask, 1963, and Pask, 1973, 1979) and he inspired many colleagues and students to apply his ideas to social systems (Navarro, this collection; Scott, 1987, 1997).

Pask also noted that when m-individuals serve as processors for p-individuation, they are very frequently augmented in some way by tools, by artifacts and, not least, by communications media: pencil and paper, computer, mouse and screen. It has now become fashionable in psychology to talk of "situated cognition". Again, Pask was well ahead of his time. He frequently asserted that we store many of our memories in our environment, not only in our notebooks but also in our familiar places and faces, our friends and families.

At first sight, the difference between p-individuals and m-individuals may look like some form of Cartesian dualism of mind and body. But this is not so. Pask believed neither in disembodied minds nor disembodied bodies. With Warren McCullough and the Stoics, he would agree that: "A thought in the head is like a fist in the hand" (McCulloch, 1965).

So, what does the distinction between p-individuals and the m-individuals achieve? The great advantage of making and maintaining the distinction between p-individuals and m-individuals is that the observer is not obliged to maintain a one to one correspondence. An m-individual may embody several p-individuals; several m-individuals may embody one p-individual. The distinction between the two types of system is one that is made by an external observer. However, they are both in their own ways self-distinguishing by dint of organisational closure. As already defined, a p-individual is a self-distinguishing, self-reproducing, organisationally closed collective of concepts. M-individuals, as typified by biological systems, are also organisationally closed, self-distinguishing and self-producing. They are the classic autopoietic systems of Humberto Maturana (Maturana and Varela, 1980). Here it is perhaps worth making a note about terminology. Pask, who was a close friend of Maturana's, was happy to follow Maturana's usage and apply the term autopoiesis to biological individuals but refrained from using the term as a way of describing the organisation of psychological systems, preferring his own term of p-individuation.

Concluding comments: awareness and consciousness

In his later years, Pask developed and refined conversation theory into a formal, axiomatic theory. As well as providing static images of conceptual structures, he also developed ways of imaging the dynamics of the processes of conceptualisation, the processes of concept production and reproduction which go on continuously (or as Pask might say, "Conceptualisation is conserved"; see Green, this collection, and Pask, 1996) and of imaging and describing the particular activities within that dynamic which we experience as directed thought and perception. These latter are processes of which we are usually to some extent aware and may experience with ourselves or with others as conscious events (L. *conscio*, "know with" as in "know with another person"; McCulloch, 1965; Lewis, 1967). Pask considered this, his development of a formal theory of the form of consciousness, to be perhaps his greatest achievement.

As with much if not all of Pask's work, his key ideas about consciousness appeared in early writings in embryonic form, and were reworked in some cases over a period of decades. Pask's master works are perhaps his two volumes on CT (Pask, 1975b, 1976) which have detailed accounts of learning and teaching using CASTE and accompanying theoretical development of conversational theory and its ramifications into a technology of knowledge elicitation and representation. In it there are also many other gems dealing directly with topics in psychology, the philosophy of science and cybernetics.

Chapter 11 of Pask (1975b) gives an account of the dynamics of consciousness and explains why it is that there are shifts of attention. Essentially the argument is that events about which we are uncertain make it into our awareness. As the events that we are attending to cease to be uncertain, they are dealt with automatically, non-consciously in more procedurally proficient and efficient ways. As this happens, some novel event about which there is uncertainty will come to occupy our attention. Notice how this account adumbrates (to use another favourite Pask term) or includes within it both goal setting as a purposeful and directed behaviour and problem solution emergence as "creativity" or "intuition".

Pask presents this account of the dynamics of awareness as part of a comparative discussion of other psychological theories of creativity (he was not professing to be wholly original). In the introduction to the same book, by way of an aside, he comments on the then current (and indeed still current) Broadbent type models of "working memory" (v. Baddeley, 1990). It is generally agreed by experimental cognitive psychologists that there are limits as to what may be held in working memory. Essentially, in this type of model working memory is that part of the overall cognitive system that contains those items of information of which we are currently aware. For example, when we are doing mental arithmetic, we hold in mind the numbers to be operated on and we also hold in mind the operations to be carried out and results and part results as the computation takes place. It is usually agreed that we can hold in mind some five or seven "chunks" of information at any one time.

There has been debate about the precise form of these limitations. Is there a channel down which a limited amount of information may flow? Are there only a fixed number of slots into which chunks of information may be placed? Is there only a certain amount of "attentional energy" to be disposed of?

Pask's comments on these models are, for me, typically Pask! It is brilliant! It is true lateral thinking. In fact, rather than being a piece of "sideways" thinking, it is a piece of "inside out" thinking. He does not ask "What is the form of these limits?" Rather, he asks, "Why are there limits?" and prompts us by further asking, "What would happen if there were no limits on our 'working memories', no limits on what we could consciously be aware of?"

There is an aphorism ascribed to Confucius: "If there were no limits, man would disappear into the boundless" (Wilhelm, 1951). Essentially, Pask provides the same insight. It is precisely because we are "here", experiencing a world of time and space, that there are limits and that there is such a thing as "working memory".

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