Farmers as scientists: A personal construct theory interpretation of hierarchical decision models

Roy Murray-Prior[1]

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[1]Work undertaken while PhD student at Department of Agricultural Economics and Business Management, University of New England, Armidale, NSW, Australia. Current location, Muresk Institute of Agriculture, Curtin University of Technology, Northam, WA.

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Abstract

Hierarchical decision models based on a two-stage decision process (Gladwin 1977, 1989) have proved useful for describing and predicting individual decisions with a minimum of theoretical bias. A major weakness has been that the process did not incorporate an explanation of the underlying motivation for behaviour or for selection of aspects. In this paper it is shown personal construct psychology (Kelly 1955), which assumes people behave as 'scientists', can overcome this weakness. The combination provides a theory and an empirical model of behaviour that explains the motivation and reasons for behaviour, allows for learning, and describes and predicts individual decisions.

1. Introduction

Decisions studied with hierarchical decision models include: choice of marketplace by fish sellers in Ghana (Gladwin C. 1975); choice of crops and adoption of new technology by farmers in Guatemala (Gladwin 1976); decisions by farmers in Alabama about the type and kind of chemical fertilisers to apply (Gladwin 1980); adjustment decisions by tobacco producers in Florida following the collapse of their industry (Zabawa 1984); and production and marketing decisions of wool producers (Murray-Prior and Wright 1994). Although the hierarchical decision models in these studies were general models which were tested on groups of people, they could predict consistently 85 to 95 percent of the choices made by individuals. The models also proved useful in identifying the important reasons for particular decisions where expected utility and regression models were not successful.

A key assumption of the hierarchical decision model is that each alternative consists of a set of aspects (Gladwin 1980). Decisions are made in a decomposed manner

involving the sequential comparison of the various alternatives on the basis of a number of characteristics or aspects.

An important issue for a model that eliminates alternatives by aspects is the psychological mechanism used by decision makers for selecting aspects and for deciding their order. In his elimination by aspects model, Tversky (1972) follows the lead of Lancaster (1966) and assumes that an individual derives utility from aspects of goods rather than the goods themselves. Gladwin (1977) proposed three mechanisms by which a decision maker might select aspects without the need for rank ordering. These mechanisms are discussed briefly in this paper, but are found to be unsatisfactory. It is proposed that personal construct theory (Kelly 1955) provides a more appropriate explanation for the selection of aspects. It also provides a useful explanation of the motivation for behaviour and for learning.

2. Outline of the hierarchical decision model

The hierarchical decision model postulates a two-stage decision process. The first stage (which generally occurs fairly quickly), assumes decision makers narrow down the set of alternatives to a small subset by ensuring the options meet a set of criteria or aspects; a form of Tversky's (1972) elimination by aspects theory. Once the problem has been reduced to a choice between two or three alternatives, the 'hard-core' decision process of the second stage occurs. This stage is 'essentially an algebraic version of "maximization subject to constraints" ' (Gladwin 1976, p. 882).

Following the approach outlined by Lancaster (1966) and Tversky (1972), Gladwin (1977, p. 20) defines an aspect as 'a dimension or factor or feature of an alternative'. She also incorporates the definition of Tversky (1972, p. 285) who considers aspects:

> can represent values along some fixed quantitative or qualitative dimensions (e.g., price, quality, comfort) or they can be arbitrary features of the alternatives that do not fit into any simple dimensional structure

In other words, when a farmer considers whether to increase his livestock numbers various aspects of this alternative will be considered; for example, relative expected

future profitability, predictions of future carrying capacity, impact on cash flow, implications for labour requirements, and implications of worst case drought or price scenarios.

Gladwin further assumes all aspects are divided by the decision maker into a few discrete categories. A continuous aspect such as riskiness of a crop may be treated as a constraint (e.g., a farmer may say a particular crop is too risky to grow in his environmental conditions), or be used to establish an ordering (or a partial ordering) of the alternatives on the aspect (e.g., crop A less risky than crop B).

No unreasonable assumptions are made with hierarchical decision models about the computational abilities of the decision makers involved since the models contained criteria identified by them. Perhaps their biggest weakness has been associated with problems of aggregation. While they were quite good at predicting individual and group decisions to change behaviour (especially to adopt), they were not so effective at predicting group decisions of the 'how much' type; for example, the quantity of fertiliser used, area of crop planted, or change in livestock numbers (Gladwin 1977; Murray-Prior and Wright 1994).

The two stages of the hierarchical decision model are discussed briefly below.

2.1 Stage 1 - Pre-attentive or unconscious processing

In many situations decision makers are faced with choosing from a range of alternatives. An assumption of the hierarchical decision model is that their first step is to simplify the problem by rapidly, and often unconsciously, eliminating all alternatives that fail to pass a series of aspects. This stage is also referred to by Gladwin (1980) and Gladwin and Murtaugh (1980) as a pre-attentive process. By this they mean it refers to information processing which is 'outside of a decision maker's ordinary attention and awareness' (Gladwin and Murtaugh 1980, p. 117).

Pre-attentive processing involves the type of information filtering which we undertake almost unconsciously. For instance, when reading a list of papers to be presented at a conference, economists might scan the titles (and authors) looking for particular

'buzz' words that suggest the paper may be within their area of interest and mark these for further consideration.

This type of processing is illustrated in Figure 1. An initial set of alternatives is simplified by comparing them with a series of aspects. Stage 1 is assumed to continue until three or fewer alternatives remain; the number remaining depending on the type of decision. Three alternatives were chosen by Gladwin based on empirical observation rather than for any theoretical reason. The remaining alternatives are then compared in more detail in stage 2 of the decision process. For some decisions only one alternative may be left after the first stage and no further action is required. For other decisions none of the alternatives might pass, in which case the aspects may need to be reconsidered, or other actions considered.

2.2 *Stage 2 - Maximisation subject to constraints*

After setting up the problem in the first stage, decision makers are then assumed to enter the conscious or 'hard core' phase of the decision process (Gladwin 1977). It involves ordering the remaining alternatives on one aspect and then passing the alternatives in order through a remaining set of constraints or aspects. If the alternative ranked highest on the ordering aspect passes through all the constraints, it is accepted. If it isn't, the 'second-best' alternative gets a chance. If none of the remaining alternatives passes the constraints, the decision maker uses another strategy. Stage 2 is divided into six steps (see Gladwin (1977) and Gladwin (1980) for a comprehensive discussion of the steps).

2.3 *The decision process as a decision tree*

A decision tree can be used to represent the decision process. The decision-tree structure will depend upon the number of alternatives and constraints (see Gladwin (1977) for illustrations of many of these). In the decision-tree representation of the decision process, the aspects are formulated as criteria or constraints that are used to asses the alternatives.

Figure 1

Stage 1 processing in a hierarchical decision model

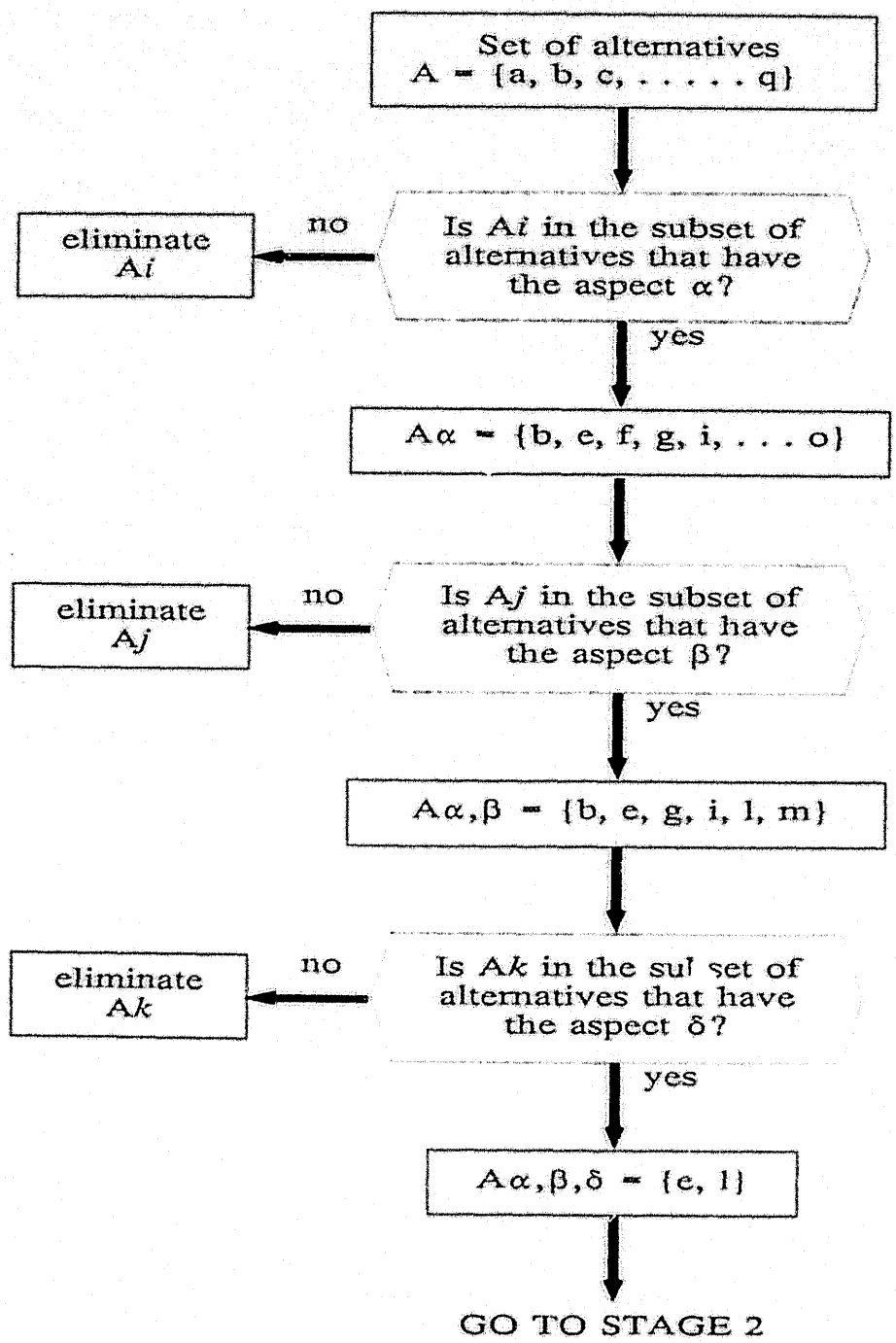


Figure 2 illustrates the formulation of a decision process as a decision tree. Apart from the first criterion, it also illustrates Stage 2 of this process. The figure illustrates one decision (choice of micron type of merino sheep), which is part of a series of decisions of a model to begin merino breeding. The criterion about climatic and pasture conditions is Stage 1 of the micron decision. Following this is the ordering aspect which is the criterion used to decide the top ranked type of merino. The remaining criteria are the constraints that the top ranked type is required to meet before it is accepted. Note, in one case the top ranked type was not accepted because suitable quality sheep of this type were not available. In this case the next ranked type was bought.

An important difference occurs between the use of criteria in stage 1 (elimination by aspects) and stage 2 (maximisation subject to constraints). In stage 1 a criterion is used to eliminate an alternative from further consideration. Conversely, the ordering criterion in stage 2 is used to compare the alternatives, but not to eliminate them (Gladwin 1977). The alternatives with a lower ordering on a criterion still have a chance to be chosen if the higher ranked alternatives do not pass their constraints. In addition, if none of the alternatives passes their constraints, they may get another chance in the final step of stage 2.

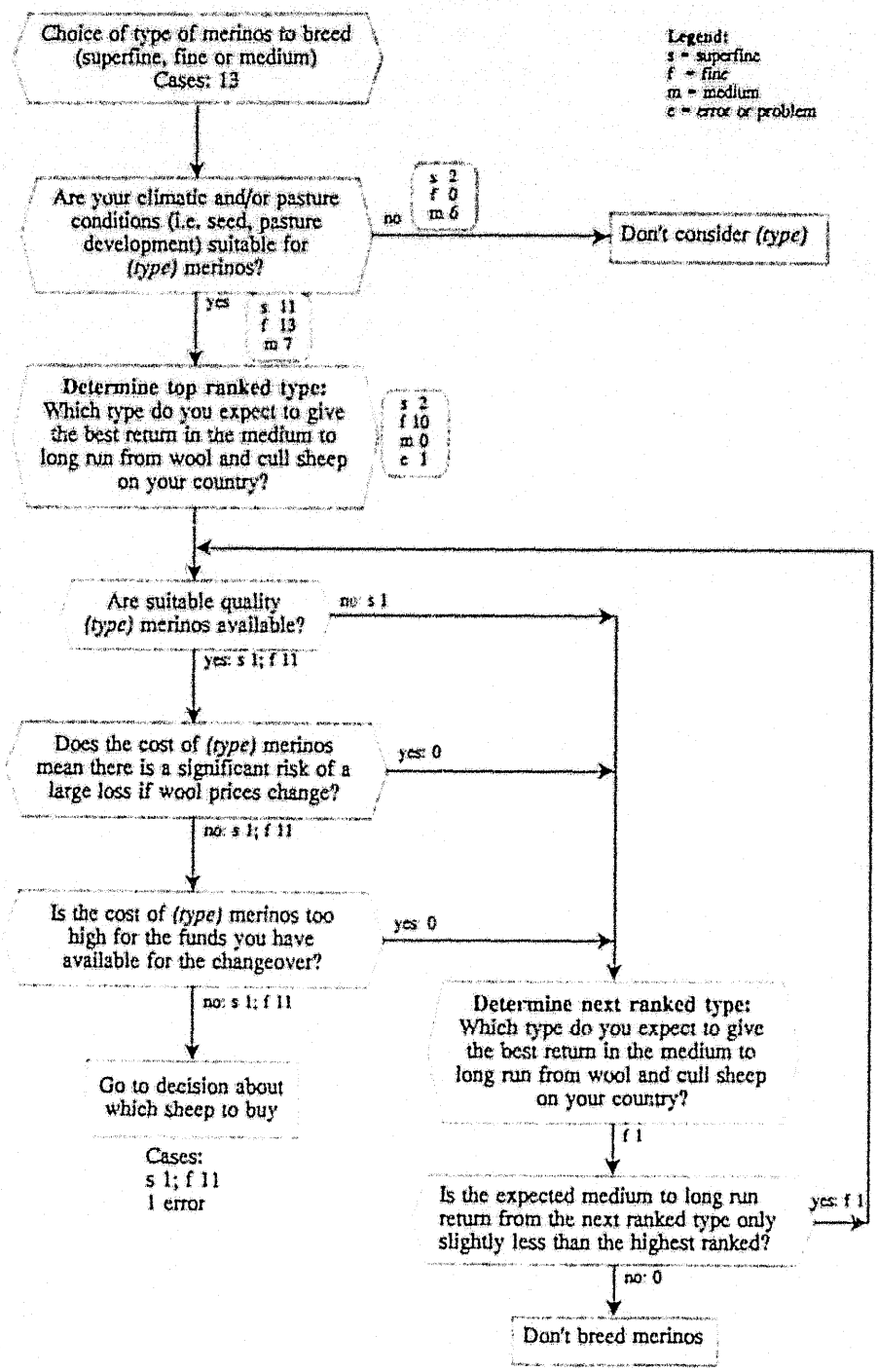
3. Utility functions and the hierarchical decision model

While the decision trees of the hierarchical decision model represent decision rules that can be written in terms of preference relations, they do not represent a preference order. There is, therefore, no ordinal utility function of the alternatives (Gladwin C. 1975, 1977) because not all alternatives are compared and the ordering is not complete. This means it is also not transitive.

An outcome of this, which also applies to the elimination by aspects theory (Tversky 1972), is that the model may lead to violations of dominance. While this may create problems for a normative model of decision making, it does not create any particular problems for descriptive or predictive models provided they are consistent with the violations of dominance for the decisions being modelled. As noted by Tversky and

Figure 2

Decision about micron type of merino to breed



Kahneman (1986), who provide evidence of such violations, a descriptive model needs to be able to provide an explanation for such phenomena.

Gladwin (1977) also examines the question of deriving a utility function of the alternatives based on the utility of an alternative being the sum of the utility of its aspects as assumed by Tversky (1972) for the elimination by aspects theory. She argues this implies a cardinal utility. This is not consistent with the rank ordering of aspects which implies an ordinal measure of utility. Since the additivity of utility assumption can't be used, a utility function of alternatives can't be derived in this way.

4. Selection of aspects in the hierarchical decision model

A key issue for a model that eliminates alternatives by aspects is the psychological mechanism used by decision makers for selecting aspects and for deciding their order. In his elimination by aspects model, Tversky (1972) follows the lead of Lancaster (1966) and assumes that an individual derives utility from aspects of goods rather than the goods themselves. Therefore, each aspect can be assigned a number representing its utility or value.

In the elimination by aspects model the utility of a particular aspect α determi.. the probability of it being selected. The probability of aspect α being selected is given by:

$$P(\alpha \text{ is selected}) = \frac{u(\alpha)}{\sum_{\beta \in (A'-A^\circ)} u(\beta)}, \qquad 1$$

where $u(\ )$ is the utility assigned to aspect $(\ )$ and aspects α and β belong to at least one alternative in A but not to all the alternatives (Gladwin 1980, p. 54). Here $\beta \in (A'-A^\circ)$, where $A'-A^\circ = \{\alpha \mid \alpha \in x' \text{ for some but not all } x \in A\}$.

The aspects chosen and their order is therefore determined probabilistically. For a particular decision at time t the order of aspects is fixed. For repeat decisions over time the probabilistic process results in different states of mind, different orders of aspects and therefore different choices (Tversky 1972).

While Gladwin (1977) has argued that the hierarchical decision trees of stage 2 do not generate a utility function of aspects, it is also debatable whether people select aspects probabilistically. Gladwin C. (1975, 1977), Zabawa (1984) and Murray-Prior and Wright (1994) provide evidence against this by obtaining different results in repeated decisions from a deterministic choice procedure. The differences occurred because in repeated decisions the alternatives received different assessments on the aspects. Many of these differences were due to changes in context rather than inconsistent behaviour.

Gladwin (1977) proposed three mechanisms by which a decision maker might select aspects without the need for rank ordering. They can be summarised as: subjective choice of the most important aspect without rank ordering the rest; some aspects may be constraints imposed from outside; and use decision rules to select the aspects. None of these imply a utility function over aspects.

The first mechanism, selection of aspects by subjective choice of the most important, is considered to result in a preference ordering for stage 1, but not stage 2. Gladwin (1977) argues that in stage 1 aspects will be picked in succession based on importance and this will result in an order of aspects. This seems inconsistent with her arguments that stage one is a pre-attentive or unconscious process. If an alternative is required to pass a series of aspects that are processed almost unconsciously there would be no requirement for any order of aspects to be made. In fact parallel processing could occur. Consider a wool producer on the New England tableland examining various enterprise options. Alternatives such as cotton, vegetables, wheat, and goats might be eliminated from further consideration because of a few aspects, without it being necessary to rank order the aspects. In stage 2, selection of the ordering aspect from the remaining set of aspects is required, but rank ordering of the others is not necessary since the alternatives have to pass all the aspects to be chosen.

The second mechanism is based on the idea that the decision maker has no choice with some constraints and therefore has no reason to rank order them. Constraints imposed by weather, capital and soil type may impose themselves without giving the decision maker any opportunity of avoiding them. Then the most that will occur is a partial ordering of the aspects.

It appears the choice mechanism considered most appropriate by Gladwin is the third which posits 'decision rules ... to select *aspects*, which then are used in other decision rules to select the alternatives.... rules behind the rules, or reasons behind the reasons' (Gladwin 1980, p. 55). The decision rules to select aspects may require aspects that are used to choose between the various aspects used to choose between the alternatives of the decision process and so on.

This approach leads to the question of where the first set of rules comes from; the infinite regress problem. Gladwin (1977) suggests the rules arise from the schema a person has of the situation in which the choice arises. A schema is regarded as a mental image, internal representation or model of the universe (Gladwin 1977) which comes about because of experience (Gladwin 1979a).

In answering the inevitable question about where the schema comes from, Gladwin (1977) is less sure. She even goes as far as to suggest 'the way in which the decision criteria are selected is unimportant, as a test of the model will show incorrectly specified criteria' (Gladwin 1979b, p. 659) - shades of the Friedman defence. Schema are regarded as acquired along the lines suggested by Piaget (1970), but less concrete is the discussion of the motivation behind the use of schema. The latter is considered to be provided by a person's schema of themselves, their social identity (Gladwin 1977).

To answer the question of the source of self schema or social identity Gladwin (1977) toys with two ideas: a) personal motivation or 'utility'; and b) the Marxian concept of 'the superstructure of the social formation or system existing at a given time, ... the remnants of the superstructure of former social formations, and ... nuclei of superstructure of the future social system' (Gladwin 1977, p. 79). The first explanation is agreed to be circular. The second views all behaviour to have the mode of production as its basic explanation. No evidence is presented to support either of these explanations. Elsewhere she admits the decision criteria found from farmers in Mexico appear 'more amenable to a neoclassical-economic than a Marxist interpretation' (Gladwin 1979b, p. 659) which suggests using such a framework as the basis for explaining behaviour may not be appropriate either.

It is not the intention to debate Gladwin's explanations for the formation and motivation for use of schemata, since she does not appear to place great faith in them herself. In any case the hierarchical decision model does not provide an adequate explanation for: why people might behave in the way suggested by the model, of the motivation for people's decisions, of how the aspects are selected, or of how learning might take place. In the next section a psychological theory known as personal construct theory (Kelly 1955) is introduced which can be used to overcome this weakness and to round out the theory.

5. Personal construct theory - the farmer as a scientist

The most common analogy used to explain, in simple terms, the philosophical position taken by Kelly (1955) and personal construct theorists is that people can be likened to scientists. They attempt to make sense of the world by developing hypotheses, or constructs, about how they expect the world can be anticipated to behave and continually test these constructs against what they construe has occurred. They are trying to make sense, discern patterns and establish order in the complexity of the world in which they find themselves. This approach puts the emphasis for the explanation of behaviour with the person. Although the environment influences behaviour, its effects are determined by the construction system of the individual.

To continue with the scientist analogy - scientists develop theories based on their existing belief structure, the patterns of evidence they see (which is viewed through their belief structure), and their perception of the environment in which they are operating. As mentioned by Quiggin (1986), when discussing expected utility theory, economic theories have a hard core of hypotheses that believers are very reluctant to abandon, but there are more loosely-held hypotheses which may be enhanced, adapted, or abandoned depending upon how the believers perceive the evidence for or against these hypotheses.

6. Structure of personal construct theory

Personal construct theory, unlike the utility theories, is not derived from axioms from which a mathematical model of behaviour is developed. Instead it is based on a fundamental postulate and 11 associated corollaries that are stated in abstract terms and give the theory a wide range of convenience (Bannister and Fransella 1971). It is not just a theory of risk, or a theory of choice, but depends upon the context to which it is applied to determine the content of the theory.

A complete listing of the postulate and corollaries of personal construct theory, along with a precise definition of the terms, can be found in Kelly (1955). For reasons of brevity those considered relevant to this paper are outlined here with a brief interpretation of their meaning. The fundamental postulate (Kelly 1955, p. 46) states that:

> A person's processes are psychologically channelized by the ways in which he anticipates events.

This statement is saying that people's motivation and subsequent behaviour are directed by their expectations of the future and the manner in which their behaviours will interact with events in that future. It does not imply that what they do is in any sense completely decided, but it is structured in certain directions that affect the actions that will be undertaken. The emphasis on the future implies that what people are about is making sense out of their world and testing their view of it by how well it predicts (Bannister and Fransella 1971).

The 11 corollaries are added to this postulate to clarify and extend its interpretation. The construction corollary says:

> A person anticipates events by construing their replications.

People attempt to detect patterns or order in the surrounding chaos and interpretations are placed on the perceived patterns. The corollary also implies a person's interpretation of events will depend upon the construction they placed upon them, or on the nature of the pattern they perceive. In this sense a construct is taken to be a 'way

in which at least two elements are similar and contrast with a third' (Kelly 1955, p. 61) and covers concepts such as attitudes, beliefs, opinions and values (Bock 1976).

This leads to the individuality corollary which is:

> Persons differ from each other in their construction of events.

Peoples' construct systems will differ because they start out with different abilities and experiences. As a result they may interpret new events in different ways. This may sound entirely obvious, but it has an important associated implication for theories that interpret people's motives from behaviour that occurs under seemingly similar situations. Although two people may behave in the same manner in a particular situation, they may do so for different reasons. Conversely, people with different experiences may still place the same construction on events.

Several authors have argued that people suffer from information processing limitations and therefore use simplifying heuristics that sometimes include hierarchical or sequential processing methods to handle complex decisions (e.g., Simon 1955; Payne 1976; Janis and Mann 1977; Schoemaker 1982; Larichev, Moshkovich and Rebrik 1988; Heath and Tversky 1990; Grether 1992). A related idea can be found in personal construct theory with the organisation corollary:

> Each person characteristically evolves, for his convenience in anticipating events, a construction system embracing ordinal relationships between constructs.

The system of constructs is in the nature of a complex tree-like structure with some constructs subsuming others but bearing little relationship to still other constructs. In other words it is not a strict hierarchical arrangement of constructs (Earl 1983). Some constructs such as *buildings* have a higher level in the structure and a wider range of convenience than others such as *house* or *shed*. In this way events can be constructed at different levels allowing for differing interpretations depending upon the level of construction utilised.

Kelly (1955) expands the definition of constructs with the dichotomy corollary:

A person's construction system is composed of a finite series of dichotomous constructs.

In other words constructs can be considered as if they were bipolar (Bannister and Fransella 1971). Alternatives can be compared using these constructs based on whether they are similar or contrasting on each construct. Kelly (1955) also suggests some constructs allow gradations between the two extremes of similarity and contrast. A person uses a finite number of constructs, but the number and type will vary with factors such as their level of ability and intelligence, the type of decision and the decision-making environment.

The manner in which people make choices with their construct system is clarified by the choice corollary:

> A person chooses for himself that alternative in a dichotomised construct through which he anticipates the greater possibility for extension and definition of his system.

People choose alternatives that they expect will enable them to make sense of the world and cope with its complexities. This may range from choosing adventurous alternatives that provide new experiences and excitement, to opting out completely by committing suicide. Nothing in the above suggests the decision chosen is the best in retrospect, only that it seemed the best at the time the decision was taken. Nor does it imply that the person will be optimising in any rational sense according to the normal economic meanings for 'rational'. To some observers the behaviour may appear totally bizarre. The position of a person making a choice is described by Earl (1983, p. 126) when he says:

> The inquiring person also needs to bear in mind that the consequences of certain choices may put her in situations where she is forced to form theories about events which she is poorly equipped to analyse. She will avoid making such choices unless they seem to be necessary in order that she may obtain answers to questions that she finds particularly fascinating, or in order to keep still more incomprehensible situations and events at bay.

Kelly's theory is therefore a theory of motivation as well as a theory of behaviour. A person's motivation comes from the desire to be able to predict and control their interaction with the world around them. The actions they choose are directed by the way their construction system expects events to occur in the future.

Personal construct theory can also provide an explanation for learning with the addition of the experience corollary:

> A person's construction system varies as he successively construes the replications of events.

The 'process of construing is a process of learning' (Salmon 1981a, p. 30). The continual comparison by a person of their construction of events with the subsequent results allows for an evaluation of the appropriateness of the system. Dunnett (1988) implies that this is a continuous process. Unless a person totally ignores hypotheses that are obviously incorrect, this process of anticipation and comparison will lead to changes in the construct system in an endeavour to improve the accuracy of the anticipations. The reason for calling it the theory of 'man as a scientist' is now obvious.

Kelly (1955) notes changes that occur in the construction system may not necessarily be good or stabilising. Some may lead to greater accuracy, in which case the system will be more resistant to change. Earl (1983) suggests learning or changes in a person's construction system occur in three main ways: the positioning of a particular event may be changed with respect to the construct axes; the hierarchical position of constructs may be changed; and new constructs may be added.

A key assumption of personal construct theory is that people's behaviour may not always appear logical or rational to an outside observer (according to normal economic definitions of these terms), although it will be consistent with the constructs being applied by the person involved. The fragmentation corollary provides some reasoning behind this:

> A person may successively employ a variety of construction subsystems which are inferentially incompatible with each other.

Here Kelly (1955) is saying people may apply different construction subsystems to seemingly similar situations. The constructs contained within these subsystems do not necessarily have to be logically related to each other. Constructs at separate levels of the system and along different branches may be used. These may result in disparate behaviours.

While Kelly recognised people would be individuals in the sense that their construct systems would differ, to be consistent with his dichotomous construct system he was also aware that various groups of people would construe events in similar ways, implying similar construct systems. This is outlined in the commonality corollary:

> To the extent that one person employs a construction of experience which is similar to that employed by another, his psychological processes are similar to those of the other person.

This has the interesting implication that in situations in which a group of people have similar construct systems they may behave in similar ways. It is not assumed that individuals have to have the same experience to develop similar construct systems, only that, because of their various experiences, they have come to the same hypotheses about the results of various actions. It is therefore consistent for people with different experiences to act alike because they construe the situation in the same way.

7. Eliciting construct systems

To use personal construct theory to model behaviour, the constructs that guide particular behaviours need to be elicited. Constructs can be obtained by many means ranging from informal conversation to formal computerised techniques. Dunnett (1988) divides the more formal techniques into two main types, those that compile a system of constructs and those based on starting with an individual construct. These techniques will be introduced briefly here since they can help obtain the aspects for a hierarchical decision model.

7.1 Methods for eliciting constructs

Dunnett (1988) discusses three methods for eliciting systems of constructs that are based on techniques originally outlined by Kelly (1955). These methods elicit many of the main constructs associated with the person's construction of the particular area of study. Two of these, self-characterisation and enactment are most suited to clinical psychology and will not be discussed here. The third is the repertory grid which is the technique used most widely for agricultural research.

The repertory grid technique

This technique (in its many forms) is based on the repertory test as outlined by Kelly (1955). It should be noted at the outset that the grid is not used exclusively by advocates of personal construct theory (Salmon 1981b), although they have used it extensively. Simply put, the repertory grid involves defining the particular area by means of various elements. In the original grids (Kelly 1955) the elements were different people, but researchers have used many types of elements including farm types (Ilbery and Hornby 1983) and crops (Briggs 1985). Subjects are then asked to specify various ways in which some elements are alike and some are different; this provides the constructs. Each element is rated or ranked on each construct. The result is a matrix that traditionally has the elements listed along the top and the constructs down the side.

A repertory grid matrix is a simplified portrayal of a person's construction of the particular area of interest being considered in the grid. The elements are the important options or alternatives within the particular area of interest, while the constructs are the main aspects used by the person when they compare and contrast the elements. The matrix can be analysed in various ways (e.g., factor analysis or cluster analysis) to provide alternative 'pictures' about the importance of the elicited constructs and the relationships between the elements.

7.2 *Exploring individual constructs*

Dunnett (1988) suggests that three main methods have been developed in this approach which start with an individual construct and explore its relationship with associated constructs. These are laddering (Hinkle 1965), pyramiding (Landfield 1971) and the ABC approach (Tschudi 1977).

Laddering

As already suggested, personal construct theory envisages a hierarchical ordering of constructs from concrete (subordinate) constructs to more abstract (superordinate) constructs. Laddering is a method of eliciting more superordinate constructs from constructs already obtained. It can help elaborate a person's construct system, especially the abstract higher-order constructs.

Pyramiding

Pyramiding involves exploring a person's construct system in the opposite direction to laddering. More concrete constructs are obtained by inquiring about either or both of the poles of the original construct and establishing subordinate constructs that explain the original construct in more detail.

ABC approach

The aim of the ABC approach is to investigate the obstacles associated with a person moving from one pole of a construct to a seemingly more desirable pole (e.g., from smoking to not smoking). It explores the construction of the advantages and disadvantages of each pole of the original construct to improve understanding of why a change in behaviour may not be occurring.

8. Some criticisms of personal construct theory

It can be argued that SEU theory (at least in its multi-attribute form) can be redefined to cover the 'utility' to be gained from prediction and validation (Earl 1983). The utility or satisfaction we derive from our actions depends upon our expectations about what we expect will happen in interaction with what we perceive as happening. Therefore the constructs we apply to a particular situation are more important and useful in understanding and predicting behaviour than the utility or satisfaction we derive from the behaviour, since the latter will ultimately depend upon these constructs.

From a Kellian viewpoint, a concept of people deriving utility from actions does not add any significant benefits to the perspective of people as mainly concerned with making sense of the world in which they live. Multi-attribute utility is potentially hideously complex and difficult to measure, not to mention the questions already raised in earlier chapters about the descriptive validity of utility functions. As well, it does not have the same facility to explain changes in behaviour and learning. Personal construct theory also has an advantage as a descriptive theory over EU theories in that its assumptions and implied information processing requirements appear closer to reality.

An implication that might be drawn is that Kellian theory needs a separate concept of needs or drives to explain people's desire to predict and validate their world view. Why do they do anything? Consider, for example, the sex drive, or the desire to eat, as primitives that motivate behaviour and therefore are selected for and transmitted from one generation to the next through genes. If it is valid to consider these as motivating needs then it is also possible to argue that a drive to explore, predict and validate hypotheses about the environment is also an important survival mechanism which will be selected for, and transmitted between, generations. After all, an animal (or a society) which has superior drive and ability to predict the results of their behaviours is more likely to survive and therefore reproduce and expand its population.

Another view is that it is unnecessary to include an explanation 'for movement in a theory which makes movement its central assumption.' (Bannister and Fransella 1971, p. 19). This approach assumes life continues. Based on this assumption, the explanations derived from the theory provide an alternative construction of behaviour from other theories that postulate a 'force' compelling movement without necessarily denying the perspective provided by these theories.

Earl (1983) has also raised the question of whether personal construct theory is unscientific because it is possible to rationalise all types of behaviour in terms of constructs inside people's heads. It is true that people may individually rationalise their own behaviour by using particular construct systems, looking for confirming information and ignoring inconsistencies. From a research point of view, however, it is normally possible to discover the constructs people are using and hence external rationalisations for behaviour are not required. This compares favourably with the tendency for deviations from utility theory to be justified by post hoc explanations such as failure to take account of: attitude to risk; attitude to ambiguity; problems with the independence axiom; or the third moment of the subjective probability distribution of prices.

A further criticism has been that it is not possible to elicit all constructs. This fact was recognised by Kelly (1955, p. 51) who noted:

> A person's behavior may be based upon many interlocking equivalence-difference patterns which are never communicated in symbolic speech. Many of these preverbal or nonverbal governing constructs are embraced in the realm of physiology.

Other possible reasons for difficulty in eliciting the relevant constructs include: people may have difficulty in formulating priorities particularly in unfamiliar situations; and a person may not be willing to admit (even to themselves) the constructs they are using, because they may appear to conflict with higher level images they like to present of themselves (Earl 1983). A related issue is that it may be extremely difficult to capture the complex nature of a person's construction of particular events w'.i a few verbal constructs. Many conflicting issues and emotions that are difficult to verbalise may be generated by the events. This is more likely to occur when using the repertory grid technique since it constrains the expression of constructs.

Kelly (1955) was aware of these problems when expounding his theory, but saw them more as a problem of measurement and understanding for the interviewer than as a theoretical problem. From this viewpoint, its range of convenience is limited by our abilities, at present, to construe another person's system of constructs. This will introduce error in the system, with the importance of the error being determined by its effect on the descriptive and predictive ability of the theory in each particular case.

9. Personal construct theory and the hierarchical decision model

Gladwin (1977) saw a need to explain both how schemata were acquired and the motivation to use them when she attempted to explain the selection of aspects in terms of schemata. Since personal construct theory is a theory of motivation, a theory of learning and a theory of behaviour, it provides a coherent explanation for the selection of aspects in the hierarchical decision model.

9.1 Personal construct theory and the selection of aspects

From the viewpoint of a personal construct theorist, people construe the replication of events (construction corollary) using a hierarchical system (organisation corollary) of bipolar constructs (dichotomy corollary). Such a belief is consistent with the

hierarchical decision model where aspects are viewed as bipolar in nature and arranged in a hierarchical system.

Aspects can be regarded as constructs, or a combination of constructs, and people, acting as scientists, choose those aspects (constructs) which they believe will give them the best chance of predicting and controlling the environment in which they live. Since constructs do not have to be considered consciously (Kelly 1955), the theory is also consistent with selection of aspects in both the pre-attentive and conscious stages of Gladwin's model.

In this framework, constructs or aspects used in making decisions are chosen so that the alternative selected will allow the person to further extend and define their system (choice corollary). More significantly, the experience corollary implies the choice of constructs depends upon a person's perception of their experiences. In other words, the constructs a person uses to help in making a particular decision will be influenced by their perception of the current situation and experience with similar situations in the past. The context in which a person makes the decision is therefore important, as is their (not necessarily immediate) experience.

Tversky (1972) developed elimination by aspects theory in an attempt to explain behaviour that is often 'inconsistent, hierarchical and context dependent' (Tversky and Sattath 1979, p. 542). He explained the 'inconsistency' in terms of probabilistic choice of aspects. On the other hand, Gladwin (1979b) explained 'inconsistency' as the effect of different contexts on the relationship of alternatives to a set of aspects that remain constant. Personal construct theory explains apparent 'inconsistency' in terms of the latter reason plus two others: change in the hierarchical position of constructs; and the addition of new constructs (Earl 1983). Apparently 'inconsistent' behaviour may be explained by a person's use of a variety of construct systems that do not have to be logically related to each other (fragmentation corollary).

9.2 Assumptions of a personal-construct hierarchical decision model

Personal construct theory has generally been used to infer reasons for behaviour rather than to predict particular decisions. No particular method of processing is assumed to

be used by people when applying their construct systems to making decisions. Indeed, a variety of processing methods are consistent with personal construct theory (see the choice corollary and the fragmentation corollary).

Gladwin C. (1975, 1977) and Zabawa (1984) used deterministic tree models based on the hierarchical decision model to predict the decisions of groups of people. On the other hand, personal construct theory was developed to explain individual behaviour. To apply it to groups of people in the manner prescribed by the hierarchical decision model requires a few assumptions to be made.

First, members of the group are assumed to use similar constructs when making the particular decisions being studied; what Gladwin (1980) refers to as group-specific decision criteria. This implies a weaker version of the commonality corollary applies to all members of the group. Members would have to use essentially the same constructs to make the decisions but they would not have to reach the same conclusions or behave in the same way. In other words, the alternatives would be compared using the same group of aspects or constructs but the ratings of alternatives on each aspect could vary between people. For example, all members of a group of wool producers might compare fine wool sheep with prime lambs using a construct such as 'suitability of country for the enterprise', ' might reach different conclusions, either because they have different country, or because they perceive their country to be different.

The validity of such an assumption is likely to increase the longer the group of decision makers being studied has experienced a stable environment. By this it is meant that the underlying climatic and institutional causes of variation in decision variables have remained the same. Such conditions are likely to allow the decision makers to have developed a stable set of constructs that their experience has shown enables them to cope with the variation. Decisions in such situations are guided by routines or scripts (Zabawa 1984). Dramatic changes in the environment, such as the collapse of the Reserve Price Scheme for wool, would require farmers to rethink their decision strategies and it might take some time for them to settle into a consistent pattern again. Meanwhile, wool producers might need to 'try out' a few systems before they could settle on a construction that provides satisfactory predictions of future events.

Second, certain assumptions are required about the hierarchical relationships between constructs of members of a group. The constructs used in stage 1 of the hierarchical decision model would need to be the same for all members of the group, but their order would not be important for the deterministic form of the model since alternatives that do not meet these aspects are eliminated. Similarly, in stage 2, all members of the group would be expected to order the remaining alternatives using the same aspect, but the other aspects or constraints would not have to be in any particular order.

This assumption is an extension of the first assumption, but together assumptions one and two are not particularly heroic. They are certainly entitled to be regarded as less heroic than assuming, for instance, that all farmers are utility maximisers (usually measured in monetary terms) and that they make calculations of the utility of each alternative when making their decisions. The constructs and their position in the model are elicited from the decision makers and are tested on their decisions, and therefore have the comforting advantage of being at least based in reality rather than being an imposed reality.

The third assumption is that for the decisions studied using a particular model, the order established by assumptions one and two remains constant. In other words, constructs used in the decision process are not added or deleted from the system and their ordering, so far as it is required by assumption two, is not changed. It still allows the same alternatives to receive different ratings on particular constructs at different times. This is analogous to assuming there has been no structural change in an econometric model.

An assumption of no substantial change in the system is most likely to be valid when decision makers have been faced with a relatively stable environment as discussed for assumption one. Anyhow, if the assumption is violated, it will rapidly become obvious when the predictive capacity of the model begins to decline. An advantage of the hierarchical decision model is that most of it is likely to remain relatively robust to changes in the environment. Only some constructs used and the relative position of some others will change, leaving large sections of the model largely unaffected. This

occurs because people generally resist changes to their core constructs and make most changes at the margin (Kelly 1955).

10. Advantages and criticisms of a personal-construct hierarchical decision model

Perhaps one of the most important advantages of combining personal construct theory and the hierarchical decision model is that it results in a descriptive model that is operational and which can predict and analyse individual decisions. Although the theoretical underpinnings of the personal-construct hierarchical decision model involve a fairly radical departure from elimination by aspects, at a functional level the two models are very similar. Anderson (1979) considered Gladwin C.'s (1975) study of fish sellers to be an 'exemplary' example of the application of elimination by aspects to agriculture. In comparing various models of decision making under uncertainty, Anderson (1979) gives the elimination by aspects theory, and by implication the hierarchical decision model, a high ranking of appropriateness for most of the predictive and analytical purposes he defined.

Gladwin (1977, 1979b, 1980) discuss several other advantages of the hierarchical decision model. First, in most studies the model has proved remarkably accurate in predicting individual decisions, achieving rates of 85 to 95 per cent. The model can also be used to predict future decisions provided major changes do not occur in the conditions under which the decision makers operate. Second, because it explicitly examines the aspects and constraints considered by decision makers, it is extremely useful for differentiating the main factors influencing their choices. This may be important input for formulation of policy, research and extension priorities.

As a descriptive and predictive model, another important advantage is that its psychological assumptions are much closer to the compartmentalised, heuristic processes people appear to use in making decisions. It contains a theory that opens the 'black box' and describes how decision makers construct their decision-making environment. This construction is used to build a model of their decision processes that can explain their behaviour. The model allows the use of both qualitative and quantitative decision

criteria and does not require decision makers to make calculations or use information beyond the bounds of their abilities. A further advantage is it can allow and explain decisions that depart from 'economically rational' behaviour.

Since decision trees are made up of sections based upon a person's construction of different facets of a particular decision (or series of decisions), they are easy to modify to account for errors in the model or for changes in a person's construction of a particular facet. In these instances, errors can easily be pinpointed and most of the model will remain the same with only the appropriate part being altered. The models can therefore be adapted relatively easily to account for learning. Reasons for changes in behaviour which result from learning are apparent from the differences between the before and after models.

If a model is to be useful to policy makers and others who are concerned about the behaviour of groups of people rather than individuals, it must be able to be applied either to a group of people and the results aggregated, or be applicable, with accuracy, to aggregated data. Success with the hierarchical decision model has been patchy when applied to supply/demand type decisions. Gladwin C. (1975) successfully aggregated individual decisions of fish sellers to model the supply of fish to the marketplace. On the other hand, in her study of fertiliser decisions by farmers in Mexico she found 'the size of the increase seemed impossible to model' (Gladwin 1977, p. 179). The excuse in this situation was data and time limitations. Murray-Prior and Wright (1994) found the prediction of numbers of livestock too difficult to model because the decisions were situation-specific.

The personal-construct hierarchical decision model can be criticised on grounds relating to the selection of aspects and the effect of their position in the model on its accuracy and implications. Gladwin (1977, 1979a) suggested that delineating between norms or beliefs and decision criteria can prove difficult. When this occurs the criteria will not predict behaviour. To overcome this she suggested finding people who had contrasting behaviour (i.e., used different behaviour for say different paddocks) despite holding a particular belief. Eliciting decision criteria is a case of attempting to 'walk in another person's moccasins' and requires the interviewer to have a thorough understanding of

the decision maker's construction of events. Another possibility is to use the laddering and ABC techniques of personal construct psychology to explore statements that have failed to predict behaviour when tested (Murray-Prior and Wright 1994). These techniques increase understanding of superordinate, subordinate and associated constructs and can help the interviewer ask the questions required to elicit the appropriate aspects.

One problem with splitting the decision process into two stages, with different decision strategies in each stage, is to define the boundary between the stages. Gladwin (1980) recognises this problem by following the suggestion of Gladwin and Murtaugh (1980) to define the boundary at the point where the decision passes from pre-attentive to conscious thought. In reality this is not completely satisfactory since, for some decisions (probably less important ones), an elimination by aspects process will be used for the entire process. The decision maker may not be particularly conscious of the aspects used in the first part of the process but will be aware of those used in the last part. To account for this, stage 2 of the hierarchical decision model can be considered as beginning when a decision maker is aware of making a conscious effort to choose among a few alternatives. In fact, Gladwin C. (1975, 1977) implicitly uses this idea when she justifies the addition of the second stage by rejecting the elimination by aspects model because it is incomplete when people are making difficult decisions that require consideration of competing aspects.

A criticism often made of decision-tree models is that they can lead to the selection of options that are inferior to alternatives that are eliminated. For a descriptive and predictive model, however, this is not a problem if these 'irrational' events are explained and predicted by the model. Rather, it is a requirement of a valid model.

A more relevant criticism is that the position of an aspect or criterion in the decision tree may influence the answer or, more importantly, may affect the perceived importance of the aspect as a limiting factor. Some aspects logically precede others and so do not create a problem. For others it is more problematic since they may not be ranked by importance either. If the model predicts behaviour accurately then the former criticism is not relevant. However, it is still possible that the order of aspects

in the model may not reflect their relative importance in the decision. In the case where there is one new alternative that may be adopted or rejected the order of aspects does not affect the outcome (Gladwin 1977). However, it may influence the perceived importance of an aspect. This can be tested by changing the position of aspects and examining its effect on adoption. It requires a response from each decision maker, on all aspects in the tree, to be carried out.

From a neoclassical economist's viewpoint, perhaps the most important weakness of the model is that it does not allow for trade-offs between aspects. They would argue that if aspects are considered by decision makers then a model of the form:

$$P(choosing\ A) = \sum_{i=1}^{n} \alpha_i \left(\begin{matrix} evaluation\ of \\ A\ on\ aspect\ i \end{matrix} \right), \qquad 2$$

is appropriate. Here α_i represents the importance attached to aspect i of A. Such a model could then be estimated using regression analysis. It is an empirical question whether decision makers trade-off between aspects when making particular decisions or whether they follow the non-compensatory approach of the hierarchical model. Both have some intuitive appeal, with trade-offs being possible for the comparison of a couple of alternatives on two or three aspects, but being unlikely for more alternatives and aspects because of intellectual limitations.

In her study of fish sellers (Gladwin C. 1975) compared a trade-off model with the decision-tree model using their decisions to go to a particular market. The result was 'that the tree model, ... predicts more decisions with more confidence than does a trade-off model' (Gladwin C. 1975, p. 111).

An interesting aside to this is a study by Gladwin H. (1975) which illustrates that regression models estimated using a linear additive decision model may appear to behave 'as if' they are describing and predicting the decision process. In the study the decision process was a hierarchical decision model simulated on a computer. However, despite sometimes highly 'significant' coefficients, the results of the regression distorted the importance of the contributing aspects. More seriously, the distortion increased with aggregated data. Statistical significance or size of coefficients in regression

equations do not necessarily show economic significance of the associated aspects, nor do they necessarily show relative economic importance of the aspects.

11. Conclusions

In this paper a model of behaviour has been outlined which has two main features: a theory of man as a scientist that explains the motivation and reasons for behaviour; and a hierarchical model of decision processes that provides a practical method by which individual decisions can be predicted and explained. The personal-construct hierarchical decision model is a descriptive and predictive model of behaviour that allows for the simplifying procedures people use in making their decisions. Personal construct psychology provides an explanation for the selection of aspects in the hierarchical decision models. It also provides an explanation for learning and therefore for changes in behaviour.

12. References

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