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**SWP 29/93 SIMILARITY OR UNDERSTANDING: DIFFERENCES IN
THE COGNITIVE MODELS OF BUYERS AND SELLERS.
A PAPER OUTLINING ISSUES IN MAPPING AND
HOMOGENEITY**

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ABSTRACT

This paper reports on the first stage of research of the ESRC funded project 'Identifying Managers' and Consumers' Perceptions of Competitive Industry Structures'. This work examines the extent to which managers within an industry have similar or different cognitions of competition to each other and to their customers. In the first part of the paper, the theoretical bases of the adopted cognitive mapping methods are explained. Empirical evidence is then presented which supports the use of these methods. Cognitive mapping interviews were conducted with 24 managers from the off-shore pumps industry and 17 managers involved with the purchase of pumps. The data gathered indicate that: a) managers' cognitions of competition are diverse from each other and from customers; b) similarity of cognition reduces as company boundaries, functional boundaries and industry boundaries are crossed; c) managers may have an ability to recognize and understand each others' and customers' cognitions. The implications of these findings for strategy formulation and decision making are discussed.

INTRODUCTION

The dominant approach to the study of competitive strategy has been adopted from industrial/organisational economics. This approach assumes that managers are rational and objective decision makers. Indeed, it is implicit within the economic notion of the firm that managers arrive at coherent competitive strategies by sharing similar, if not the same, rational, analytically based conceptions about whom the competition is, and the strategies that these competitors are following. This has been reflected in the strategic groups literature, in which researchers have sought to map competitive industry structures by categorising firms on the basis of objective economic indicators of their strategies (McGee and Thomas, 1986).

There has been ample evidence to question this assumption of management objectivity and rationality (Mintzberg *et al*, 1976, Fahey, 1981, Johnson, 1988). Therefore, there is a growing interest in how managers make sense of their competitive environment, in order to understand the cognitive processes involved in strategy formulation and implementation (Huff, 1990). However, cognitive studies of competition have tended to represent managers' mental models of competition by aggregation across an industry (Porac and Thomas, 1990), rather than examining individual managers' cognitions. Although it is becoming apparent that managers' mental models of competitive industry structures may be diverse (Easton, *et al*, 1993), it is not entirely clear to what extent managers' mental models of competition are homogeneous or diverse, and what factors affect the homogeneity/diversity of managers' mental models. This paper presents an outline of the first stage of a program of research concerned with mapping individual managers' cognitions of competition which seeks to address some of the influences upon the homogeneity/diversity of managers' mental models of competition.

The aims of this paper are threefold. The first aim is to outline the theoretical and methodological issues concerning mapping managers and buyers cognitions of competition, in order to propose a robust mapping methodology. The second aim is to outline a validation of this methodology. The final aim is to examine empirically the extent to which managers and buyers have homogeneous cognitions of competition and, if they do not, propose ways in which cognitive diversity may be reconciled.

The paper begins with a review of the theory and evidence concerning the psychological process of categorisation, from the areas of cognitive psychology and management science. These areas have been dominated by a model that suggests that managers categorize their competitors in a simple hierarchical manner. Research conducted with managers and experts from other fields suggests that expertise is generally associated with more complex, context-dependent mental models.

The paper reviews methods used to elicit the structure of managerial mental models. The hierarchical sorting technique used by Porac and his associates is predicated upon the hierarchical theory of mental models. Therefore, this technique may be too context insensitive. It is argued that the repertory grid procedure and another recently developed visual card sorting method are suitably flexible to allow context sensitive representations of managerial mental models to be constructed.

In the second part of the paper, a visual card sorting technique used by the authors is evaluated with respect to its psychometric properties. The method is demonstrated to have good validity by comparing it with the previously validated repertory grid technique. Moreover, it is found to be quicker to administer and interpret than the repertory grid procedure.

In the final part of the paper, the degree of homogeneity of managers and buyers cognitions of competition within a one industry study is assessed. The results indicate that cognitions of competition are diverse rather than homogeneous. The results also indicate that this diversity increases as company boundaries are crossed, as functional boundaries are crossed and as industry boundaries are crossed into buyer/supplier relationships. The results also suggested that managers' ability to recognize others' mental models of competition follows a similar pattern, but that recognition of others' mental models may be more widespread than cognitive similarity. It is concluded that future cognitive studies of competitive industry structures assess recognition as well as

similarity, and that recognition of others' mental models may play an important role in strategic decision making and implementation.

The empirical aspects of this paper are drawn from a study of the UK off-shore pumps industry. The sample consisted of 24 managers from the off-shore pumps industry, supplemented with information from 17 managers involved with the purchase of pumps. The cognitive mapping methods used were the visual card sort technique and repertory grid technique, and maps were compared using a self-rating methodology.

PSYCHOLOGICAL THEORIES OF CONCEPT REPRESENTATION

This section is organised in the following manner: General models of memory and models of concept representation are reviewed first. These models are contrasted with evidence from research conducted with managers. To the extent that managers may be considered to be experts within a given field, research conducted with experts from other domains is also reviewed.

Theories of memory and concept organisation.

Memory can be divided into long term and short term memory (Baddeley, 1983). Short term memory processes information for storage and retrieval in long term memory. Therefore, one function of short term memory is to access information for decision making from long term memory (Baddeley, 1983). Since short term memory has a limited capacity (Miller, 1956), the structure of long term memory will influence what information is accessed about a given concept. Hence, managerial decision making will be influenced by the structure of long term memory (Cherniak, 1984, Rips, 1975), and also how information is communicated (Edwards, 1991).

It is generally agreed that information is represented in long term memory by a set of organising principles that group events and concepts together in terms of contiguity (Schank, 1982, Schacter, 1989). This contiguity may refer to two concepts being associated by time, function or attributes shared. These organising principles have been labelled, for instance, schemata (Bartlett, 1932), mental models (Johnson-Laird, 1989), scripts (Schank, 1982) and cognitive models (Lakoff, 1987). According to this view, a manager has a mental model for each of the companies that she sees her firm as being in competition with. Therefore, it is important to determine how these different mental models of individual companies are related in memory to form an overall mental model of the competitive structure of the industry.

The most efficient way to represent information about a concept or object in memory is in a hierarchy (Charniak and McDermott, 1985). Efficiency is maximized when information is represented only once, therefore redundancy of information is eliminated. Collins and Quillian (1969) proposed a model of memory based upon this premise. Their model suggests that a person represents information in a semantic network, arranged in a hierarchy. A semantic network is a network of nodes, connected by arcs (Stubbart, 1989). Nodes represent concepts, objects, ideas, adjectives etc., whilst arcs represent the association between two nodes. The network is arranged such that information about an object is abstracted at higher levels in the network. For instance, a manager may represent abstract information about an industry at a higher level of the hierarchy. At lower levels of the hierarchy, more specific information about particular companies is represented. According to this theory, memory is organised by a hierarchical category structure.

Collins and Quillian's theory suggests that there exist necessary and sufficient attributes for an object to belong to a particular category. Therefore, category membership is either "all or none". This model, along with other similar models, may be called the classical model (Medin, 1989).

Smith *et al* (1974) have criticized Collins and Quillian. They suggest that the Collins and Quillian model cannot handle those circumstances in which a concept can be a member of a category, but not share all the necessary defining features of that category. Moreover, they suggest that the structure of memory does not determine how concepts are retrieved from memory, but retrieval is based upon the salience of the features of the concept to be retrieved. Concepts with salient features are thought to be accessed from memory more readily.

Mervis and Rosch (1981) have proposed one way in which knowledge about objects may be represented in this hierarchy. They suggest that a domain of knowledge can be organised into three levels of a hierarchy, a superordinate level, a basic level and a subordinate level. Information about the concepts of objects within that domain is represented at each level of the hierarchy. For instance, all grocery retailers may represent the superordinate level. Local versus national grocery retailers may represent two basic levels, and specific store names may represent the subordinate level. According to Mervis and Rosch objects are categorised according to similarity at each level of the hierarchy. Each of these categories is assumed to be associated with a set of descriptors for that category (cf. Collins and Quillian, 1969, Collins and Loftus, 1975).

Mervis and Rosch suggest that the basic level is intermediate between the superordinate and subordinate level. However, the basic level is the level at which within-category similarity is maximized with respect to between-category similarity. For instance, many local grocery retailers have much in common relative to national grocery retailers. Thus, Mervis and Rosch predict that information from the basic level should be retrieved more easily than from either the subordinate or superordinate categories. Hence, according to Mervis and Rosch, decisions made by managers should be made more readily on the basis of information from basic level categories of competitors, rather than on the basis of information concerning the whole industry (superordinate level), or individual firms (subordinate level).

Mervis and Rosch (1981) also suggest that objects are categorized according to their overall similarity to a prototypical member of that category. The prototype is thought to be an abstract ideal example of the category. Some members of a category may be closer to this prototype than others. Category members that are similar to the prototype share many features of the prototype. Similarity to the prototype is assessed by the extent to which the prototype and the category member share attributes that define the category. Thus, unlike Collins and Quillian's classical model, the Mervis and Rosch model is probabilistic.

Other theorists have suggested that objects are categorised according to the similarity they share with an exemplar (Smith and Medin, 1981). An exemplar may be defined as a good example of the category. For instance, the category of national grocery retailers may now be represented by either Tesco or Sainsbury, since they are both good examples of this category. This type of theory may be called the exemplar view.

However, both variants (exemplar and prototype) assume categorisation takes place on the basis of comparisons between some referent typical of the category, and that categories are arranged in a hierarchical structure (Medin, 1989).

The Mervis and Rosch theory has received some criticism. The theory makes no predictions regarding in which ways context may alter how objects are categorised (Barsalou, 1982). Also, the theory does not distinguish between the effects of differing types of descriptors upon categorisation (Barr and Caplan, 1985, Barr and Caplan, 1987, Caplan and Barr, 1991). Most importantly, it is not clear whether objects "belong to the same category because they are similar (or whether) they seem similar because they are in the same category" (Medin, 1989, pg 1473).

Nevertheless, the basic tenets of the theory have been supported by experimental and anthropological research (Mervis and Rosch, 1981, D'Andrade, 1989). These are that concepts and objects are categorised, and that these categories are arranged in a semantic network, which may be hierarchical in structure. Moreover, this model has been predominant in both psychology and in management theory over the past 10-15 years.

In the following sections, the adequacy of Mervis and Rosch's theory will be assessed in regard to its application to strategic management science. Insofar that top managers are experts at making strategic decisions, research into expert knowledge is also relevant to this discussion.

Managers' mental models of competitive industry structures.

Mervis and Rosch's theory of categorisation has been advocated for use in strategic management research (Dutton and Jackson, 1987, Porac and Thomas, 1990). The paper written by Porac and Thomas (1990) is of special relevance. In their paper, Porac and Thomas state that an understanding of top managers mental models of the competitive environment will enable a fuller understanding of strategic responses to competitive pressures.

Basing their arguments on Mervis and Rosch's categorisation theory, Porac and Thomas present a number of propositions of how managers organise information concerning their competitors. Three of these are especially relevant to how managers perceive the relationships within competitive industry structures. The first of these is that managers make sense of their competitive environment by developing cognitive hierarchical taxonomies that summarize the similarities and differences between competitors.

Evidence for this proposition has been provided by Porac *et al* (1989) and Hodgkinson and Johnson (forthcoming). Both studies found that managers can represent the structure of an industry by hierarchical taxonomic categories. However, both studies used a methodology that directed managers to organise their cognitions in a hierarchical manner. Thus the evidence for the proposition may be equivocal.

Moreover, Hodgkinson and Johnson (1987) found that managers mental models of the competitive environment may be specific to particular contexts. As noted in the previous section, one criticism of Mervis and Rosch's theory is that it cannot yet account for changing mental models with changing contexts.

The second proposition that is relevant here suggests that managers match an organisation to a category at the basic level in the hierarchy of categories (recall that the basic level is intermediate between the sub-ordinate and super-ordinate categories). Porac and Thomas (1988) asked managers to categorise spontaneously organisations. They found that managers placed organisations in intermediate categories, previously elicited from the managers, suggesting that managers categorise competitors initially at the intermediate basic level. This result would appear to support Porac and Thomas' proposition (1990).

The final proposition that is relevant here suggests that organisations placed within a category are perceived to be in closer competition with each other than other organisations. Gripsrud and Gronhaug (1985) reported that grocery store managers within a small town perceived a small fraction of the total number of grocery stores as competitors. This result would also seem to support Porac and Thomas' proposition. However, that only a small fraction potential competitors were listed as competitors does not necessarily mean that competitors have been categorized.

The evidence from the management literature is equivocal regarding the utility of Mervis and Rosch's theory of categorisation. Although the predictions made by Porac and Thomas (1990) based upon Mervis and Rosch have been supported by the data, methodological artifacts can just as easily account for many of the results. Moreover, the data presented by Hodgkinson and Johnson (1987) indicate that the theory is not sensitive to differing contexts.

Expert knowledge.

Managers may be considered experts in a particular domain of knowledge. Therefore, a review of the literature on expert knowledge is relevant to this discussion. Gilhooly (1990) considers that there are five *maxims* of expert knowledge. These are; experts remember better; experts work forwards to a problem solution; experts have superior understanding of problems; experts are superior in knowledge, not basic capacities; experts become expert through extensive practice. Most of these maxims indicate that experts have a memory for their domain of expertise that is better organised than that of the novice, but also contains richer and more complex information (Gilhooly, 1990).

Three studies are relevant to this discussion, since they have tested aspects of Mervis and Rosch's theory of categorisation in relation to experts, from differing knowledge domains. Gammack (1987) found that a hierarchical taxonomy did not represent an expert's knowledge as efficiently as a non-taxonomic category structure, since the hierarchical structure contained much redundant information. Similarly, Tanaka and Taylor (1991) found that experts categorise just as efficiently at both the subordinate and basic (intermediate) levels of the hierarchy proposed by Mervis and Rosch. Mervis and Rosch (1981) stress that categorisation should be more efficient at the intermediate basic level. Murphy and Wright (1984) found that experts can readily describe categories in terms of overlapping attributes, although novices can not. Mervis and Rosch's theory would predict that attributes should not overlap, since basic level categories minimize between-category similarity.

All these studies suggest that experts categorise at the subordinate level of Mervis and Rosch's hierarchy, rather than the basic level; perhaps indicating greater complexity of expert mental models.

However, some evidence suggests that experts may have more simple mental models than novices. Expert fighter pilots may have less complex mental models of their aeroplane than novice fighter pilots (Schvaneveldt *et al*, 1982). It may be that experts in very complex knowledge domains (such as fighter planes) organise their knowledge on the basis of simplifying heuristics. These heuristics are derived by excluding very unlikely associations.

Taken together, the results of the studies listed suggest, that on the whole, experts do not necessarily have hierarchical taxonomic mental models of their expert knowledge domain, since some experts tend to categorise at the subordinate level. The complexity of the mental model may be contingent upon the complexity of the knowledge domain. Therefore, the research reviewed in this section may indicate that the complexity and structure of the mental models of the environment that are held by managers may be contingent upon the nature of the knowledge being represented.

Porac and Thomas (1988) did find evidence supportive of Mervis and Rosch (1981). It will be recalled that their respondents spontaneously categorized target companies at the basic level of a derived hierarchy. These results may suggest that expert knowledge research is not relevant for managerial research, and that Mervis and Rosch's theory is an adequate model of managerial categorisation processes. Recall however, that Porac and Thomas used a sample of grocery store managers in a small American town. It is doubtful whether grocery store managers have access to the same expert knowledge of an industry as, for example, the chief executive officer of a large multinational company. Thus, the mental models of managers may be dependent upon their expertise in a given industry or market.

The current state of categorisation.

The evidence presented in this paper has indicated that the model of categorisation presented by Mervis and Rosch (1981) may not be wholly appropriate for understanding how managers categorize organisations that are in competition with each other.

Firstly, mental models have been found to be context dependent (Barsalou, 1982). The categorisation theory advanced by Mervis and Rosch cannot easily incorporate these findings (Medin, 1989). Exemplar theory, where instances of a category are dependent upon resemblance to a good example of that category, rather than an ideal prototype, can deal with this context dependency (Medin, 1989). Quite simply, as the context changes, so may the best example of that category.

However, there are two problems with exemplar theory. Firstly, it is subject to many of the same criticisms as prototype theory, since exemplar theory is also based on the premise of hierarchical mental models and feature matching (Medin, 1989, see above).

Secondly, the contingencies of the situation may dictate which type of categorisation theory is the most appropriate model. Cohen and Basu (1987), in an analysis of categorisation theory applied to consumer behaviour, consider that prototype theory may be more appropriate when the consumer has time compare all the attributes of the target instance with the prototype, and is also motivated to do so. In contrast, Cohen and Basu (1987) consider exemplar theory to be more appropriate when

the consumer is constrained by time and complex information. Thus, Cohen and Basu (1987) consider the form of categorisation to be context dependent. It is not clear whether their arguments are relevant to managers.

A review of the relevant literature on expert knowledge has questioned the hierarchical nature of the Mervis and Rosch model. The results of studies conducted in this field suggest that experts may be more likely to use subordinate level categories to classify objects in their field of expertise (Murphy and Wright, 1984, Gammack, 1987, Tanaka and Taylor, 1991). Results also suggest that expert knowledge does not necessarily imply more complex mental models of a domain, especially if that domain is very complex (Schvaneveldt *et al*, 1982).

According to these results, a hierarchical model of categorisation may be appropriate for managers in local and stable environments (cf. Porac and Thomas, 1988), since these types of managers are not required to understand complex industry structures. However, managers in more complex and diverse industries should have mental models of the industry structure that are less hierarchical and more complex. Very complex environments may even lead to managers with simplified mental models of the competitive relations between companies within an industry.

Recent developments have suggested that categorisation, in part, may be made upon the basis of presumed causal relations between objects (Murphy and Medin, 1985, Medin, 1989, Rips, 1989). That is, people categorize on the basis of their knowledge of the world, rather than or as well, as matching features to some referent value represented in memory (Lyon and Chater, 1990, Vandierendonck, 1990). Thus, a manager may place two companies in the same category, not because they share features in common, but because s/he knows that these companies are in close competition.

It is likely that categorisation actually takes place upon the basis of both feature matching and presumed knowledge about the world (Medin, 1989). It is also likely that both exemplars and prototypes may be appropriate mental referents in differing circumstances. Moreover, the structure of mental models may also change with circumstances.

Thus, the structure and form of managers' and mental models of competitive industry structures is dependent upon a large array of contingencies. It is probable that only a few of the very many variables that may affect categorisation have been touched upon here, and possibly in the literature as a whole. Therefore, it would seem that a contextual approach is required to understand mental models of competitive industry structures.

A methodology that makes minimal assumptions concerning the structure of mental models is required to supplement this theoretical approach. In the following section, three methods for representing managers' mental models are described. Their adequacy is assessed by the assumptions they make about mental models.

METHODS FOR REPRESENTING MANAGERS' MENTAL MODELS

With the shift towards a more cognitive analysis of strategy, a concomitant shift in methodology has emerged, such that cognitive mapping techniques are becoming increasingly popular in management research (Huff, 1990). Cognitive mapping techniques are methods used to assess the structure and content of peoples' mental models (Axelrod, 1976), showing how a person integrates information about his/her environment in graphical format (Fiol and Huff, 1992). Many of the techniques have been developed from research conducted in sub-fields of cognitive science, such as cognitive anthropology, artificial intelligence and linguistics (see Huff, 1990).

Two methods have been predominantly used to assess the structure of managers' mental models of competitive industry structures (Huff, 1990). These are complex statistical operations performed with Kelly's repertory grid (Kelly, 1955, Fransella and Bannister, 1977, used by Reger, 1987 and Walton, 1986) and hierarchical taxonomic categorisation techniques (eg. Porac *et al*, 1989). In the following sections, both of these techniques will be reviewed. Another technique, recently developed by the authors will also be reviewed.

In the following sections, each of the mapping techniques applicable to the representation of mental models of competitive industry structures will be described. Also, their theoretical underpinnings will be assessed, along with their practicability and known psychometric properties.

Hierarchical taxonomic sorting techniques.

Porac and his colleagues (eg. Porac and Thomas, 1987) have devised a set of interview procedures based upon Mervis and Rosch's theory of categorisation (outlined above). Variations of the technique can be used to construct individual taxonomies (Hodgkinson and Johnson, forthcoming), or taxonomies representing the collective cognitive structure of the research participants. For the main part, these techniques have been used for the latter purpose.

The technique used for individual taxonomies, asks the participant to identify various sub-categories of businesses which stem from a beginning category. This beginning category, known as the "root beginner", is provided by the researcher. Further sub-categories are elicited by the participant, until no further meaningful sub-categories can be identified.

Aggregate maps are assembled in a similar way. In this case, different individuals' taxonomies are amalgamated by an independent panel of experts. Further samples of participants are then used to identify sub-categories. Again, the process is repeated until no further meaningful sub-categories can be identified. An example of the type of map produced by hierarchical taxonomic sorting techniques is shown in figure I.

INSERT FIGURE I HERE

One of the problems with these techniques is that they assume that mental models follow a hierarchical taxonomic structure. However, as was discussed above, a persons' mental model does not necessarily follow a hierarchical taxonomic structure. In the case of experts, mental models may have a much "flatter" structure. Moreover, these techniques can be context insensitive and do not elicit any reasons for the way in which the taxonomies are derived.

Therefore, methods that do not assume a hierarchical structure of mental models are perhaps more suitable. Also, such methods should elicit reasons for why the participant represents her knowledge in a given way. One such technique is the repertory grid.

Repertory grid technique.

The repertory grid is a flexible technique for eliciting a person's mental model of a given domain. The technique is predicated by Kelly's construct theory (1955). The underpinnings of the theory are well-established, and have been described in detail elsewhere (Kelly, 1955, Bannister and Mair, 1968, Fransella and Bannister, 1977). However, the basic tenet of construct theory is that each individual seeks to predict and control events by forming theories about the way concepts relate to each other. Current work in experimental cognitive psychology, independent of construct theory, has begun to support this basic proposition, suggesting that people can categorise objects on the basis of *naïve* theories (Medin, 1989, Rips, 1989). Moreover, since repertory grid technique represents a person's knowledge in multi-dimensional space (see below), it may be considered to represent knowledge across an array of contexts.

The first stage of the technique involves *eliciting the elements* (eg. asking the respondent to name the companies s/he believes his/her firm is competing with). The next stage involves eliciting the *constructs*. Constructs are the qualities that people use to think about the elements; constructs are the descriptors of the elements. In order to elicit the constructs, the method of triading is used. Triading involves selecting three cards at random. The respondent is asked to identify the two companies that are most similar, and then to state how these two are different from the third. After the interview, the companies and constructs are then arranged into a grid. The respondent then rates each of the companies on each particular element.

A map of the respondents mental model may be produced by subjecting the grid to principal components analysis and/or cluster analysis (Smith and Stewart, 1977). Cluster analysis shows how the elements are grouped together. Principal components analysis produces a map that shows the underlying dimensions that differentiate between the elements. However, these techniques can involve some subjective interpretation on the part of the researcher. Moreover, there exist a wide variety of techniques labelled cluster analysis (Everitt, 1980), thus making it difficult to choose the appropriate technique. Thus the adequacy of any maps constructed from repertory grid is dependent upon the ability of the data to meet the underlying assumptions of the chosen statistical technique of construction. Examples of cluster analysis derived and principal components analysis derived grid maps are shown in figure II.

INSERT FIGURE II HERE

In terms of practicability, grid technique may take some time to complete, since it involves triading and the administration of the grid. This may be a substantial problem if the number of elements is large. Participants may also find the procedure somewhat annoying, because of the process of triading (Brown, 1992). For these reasons, the relative intrusiveness of the technique may create difficulties in obtaining access to some executives, since they may be unwilling to allocate too much time to the researcher.

Despite criticisms concerning the construction of maps, and the practicability of the technique for competitive mapping research, grid technique has a number of advantages. The technique has been shown to be reliable by producing similar representations, over time, of a person's mental model (Bannister and Mair, 1968). Moreover, Bannister and Mair assert that sometimes the very fact that grid structures (and hence mental models) change over time is usually the topic of interest. Similarly, Bannister and Mair cite evidence suggesting that grid technique has acceptable validity when evaluated within the confines of standard psychometric assessment, although grid technique attempts to go beyond the limitations of normative assessment. Another advantage of grid technique is that it rests upon a well established and well articulated theory of psychology (cf. Garg-Janardan and Salvendy, 1988), although flexibility in the assumptions underlying the cognitive structure of the map is retained (Smith and Stewart, 1977).

Producing a visual map of a person's mental model.

The visual card sort technique described here is based on cognitive categorisation theory, given the impetus provided by strategic groups theory and previous cognitive analyses of competitive industry structures (see above).

It is necessary to produce a representation of a person's mental model that is consistent with the complex empirical findings of cognitive categorisation reviewed above (cf. Garg-Janardan and Salvendy, 1988). Therefore, a flexible method is required in order to be consistent with the flexible nature of human categorisation. One method that is consonant with the psychology of categorisation involves a visual card sorting task which shows how people categorize concepts within a particular knowledge domain (Canter, *et al*, 1985, Gammack, 1987).

The method requires the respondent to name all those companies that s/he can think of that compete with his/her own company. This stage is equivalent to the *element eliciting stage* of the repertory grid technique. The names of the elicited companies are written on cards.

The respondent is then asked to sort the cards, such that those companies that compete most closely with each other are placed most closely together. The respondent is then asked why s/he placed the cards in this manner. In this way, the technique provides a quick and face valid way of representing the relationships between companies in an industry. It also provides descriptions of each of the companies or clusters of companies, depending upon how the cards are arranged.

As it stands, the procedure is constrained to show just one picture. Therefore, it may lose some of the context sensitivity of mental models. This is easily overcome if the respondent is asked if s/he would wish to produce other ways of arranging the cards. Thus it is possible to elicit multiple maps

from one respondent (Canter *et al*, 1985), that show how that individual's mental models change with differing contexts. In this way, fuller and more accurate maps of individuals' mental models are obtained.

Each of the maps can be recorded by simply taking a photograph of the map. The labels that the respondent gives to each of the clusters of companies can be tape recorded and written down. From these sources of data, a map may be constructed that shows the way in which the companies were arranged, together with the descriptors used to label those companies. Examples of a visual card sort map is shown in figure III.

INSERT FIGURE III HERE

The procedure is potentially very easy to administer and minimally intrusive. Moreover, the task is compatible with the cognitive psychology of categorisation and does not require the application of statistical procedures to produce the maps. However, although card sorting methods have a long history in the social sciences (Canter *et al*, 1985, McKeown and Thomas, 1988), it is not known whether visual card sorting can be applied to the study of managers' mental models of competitive industry structures. Thus the validity of this technique has not yet been tested in this knowledge domain.

Representing mental models of competitive industry structures: Summary and conclusions.

The paper began with a review of the literature concerned with how managers represent information concerning other companies. Although the dominant model in both cognitive psychology and management science has been a probabilistic hierarchical model of knowledge representation, special considerations indicate that managers do not necessarily represent knowledge in a hierarchy of concepts. Empirical evidence from studies with experts suggests that not all managers represent their knowledge in a hierarchy.

The next section of this paper examined the methods that may be used to uncover the structure of managerial mental models. The taxonomic categorisation technique employed by Porac and his associates may be too inflexible to construct satisfactory cognitive maps.

In contrast, the repertory grid is flexible and can elicit reasons for the structure of the map. However, the map is derived from complex statistical operations on the raw data. Thus, a certain amount of researcher interpretation may be required to construct the map. Moreover, the repertory grid technique can be intrusive and takes considerable time to produce a map.

A simple visual card sorting technique, described here, may offer an alternative to the repertory grid. Like the repertory grid, it elicits reasons for the structure of the map. It is also sensitive to differing contexts. Unlike the grid, the technique requires the participant to categorize and arrange the concepts in the domain investigated.

However, as yet, the blind adoption of the visual card sort technique is not recommended. Although consistent with theory, the empirical validity of the visual card sorting technique needs to be tested. In the following sections, a validation study of the visual card sort technique will be described, which compares this technique to the previously validated repertory grid technique.

VALIDATING THE VISUAL CARD SORT TECHNIQUE

Participants.

Participants in the study were drawn from three industries each concerned with pumps supplied to the North Sea off-shore oil industry. The first industry to be sampled consisted of senior managers from companies that manufacture such pumps. Initially, ten companies were approached at managing director level asking for co-operation. Five companies agreed to co-operate out of these ten, giving access to twenty five managers. Between three and eight managers were interviewed per company from this industry, representing a range of senior managerial functions, such as managing director,

sales and marketing director, manufacturing director and finance director. This sample was contacted again for follow-up interviews, of which 24 managers out of the original 25, were able to participate.

A sample was also drawn from the off-shore contracts engineering industry. Companies operating in this industry build oil rigs for oil companies, and thus have to buy pumps for these rigs. Again, initial contact was made at the level of managing director, but interviews were conducted only with those people with knowledge of the off-shore pump industry. Out of seven firms contacted, four agreed to participate, allowing access to eight managers, who were either purchasing managers or engineering managers. The final sample also consisted of purchasing and engineering managers with knowledge of the off-shore pumps industry, but were drawn from oil companies. Nine companies were contacted at managing director level, of which six agreed to participate, allowing access to nine managers.

Thus a total of 42 managers were interviewed initially (although two managers did not provide full information, and so their data were discarded). Twenty four of these managers were interviewed a second time (of which 22 provided usable data). All the sample were male. They had been working in their present position for an average of 4.27 years (std dev = 5.12), working for their company for an average of 10.44 years (std dev = 6.66) and had been working for their industry for an average of 16.78 years (std dev = 7.93).

Procedure.

Each of the participants was administered a semi-structured interview, that usually lasted less than half an hour. The purpose of this interview was to uncover the participants' mental models of the relationships between competitors in the North Sea off-shore pump industry. During the semi-structured interview, both the visual card sort technique and construct and element elicitation phases on grid technique were implemented. The element elicitation phases of visual card sort mapping and grid technique are identical. It was assumed that constructs elicited by visual card sort mapping would have been supplied by the triading phase of grid technique anyway. Thus these constructs were used in the administration of the repertory grid.

Repertory grids were administered by postal questionnaire a few days after the initial interviews. Out of 40 questionnaires distributed, 35 were returned (a response rate of 87.5%). In addition to the grids, participants were asked to rate the importance of each of their constructs in assessing competition, on a five point, fully anchored Likert type scale (1= Very unimportant, 5= Very important).

In the follow-up interviews, twenty four managers from the pump manufacturing industry were presented with a random sample of maps, of which 23 provided usable data. Participants were asked to rate the similarity of each of the maps to their own mental model of the competitive structure of their industry. That is respondents were asked to compare each of the maps with their *own cognitive structures at that point in time*, rather than a representation of those cognitive structures. Ratings were made on a five point fully anchored Likert type scale (eg. 1= The same as my view of the competitive environment, 5= Not at all similar to my view of the competitive environment).

Asking respondents to rate the similarity of maps to their own cognitions is one way of checking the validity of the mapping technique (Huff and Fletcher, 1990). This technique rests on the basic premise that people can recognize maps of their own mental models. Thus, in this study, people should rate maps elicited from themselves as being more similar to their own mental models than randomly generated maps based on elements supplied by the participant her/himself, if the mapping technique is valid. In this study, this technique has been improved by embedding the target maps and the random maps amongst a random selection of other maps elicited from other people.

The maps were presented in blocks consisting of all the visual card sort maps, all the principal components analysis maps and all the cluster analysis maps. Within these blocks, the respondent was presented a random selection of maps, consisting of their own maps, a selection of other peoples'

maps and maps randomly generated for each respondent from the elements they provided. Maps were presented in random order within blocks, and blocks were also presented in random order.

The follow-up interviews took place between five and seven months after the initial interviews. It is therefore unlikely that respondents remembered the way they arranged the cards in the first interview, thus removing bias due to recall.

Assessing the validity of the technique.

The validity of the technique was assessed in three ways. Firstly, the average importance of the constructs elicited from visual card sort mapping was compared to those elicited from triading. Secondly, numerical comparisons were made between the category structures elicited by visual card sort mapping and those derived by cluster analysis of repertory grids. Finally, participant self-ratings of similarity to one's own cognitive structures were compared.

A related t-test was used to assess any differences in the rated importance of the constructs elicited by visual card sort mapping and by triading. An average for each type of construct was taken for each participant, the means and standard deviations of which are shown in Table I. Only 29 participants, out of 35 who responded to the questionnaires, had provided constructs elicited by triading as well as visual card sort mapping, thus the related t-test was applied to these 29. The result of the test was not significant ($t=1.03$, $df=29$, $p>.10$), indicating that visual card sort mapping produces constructs as least as important as those elicited by triading. Moreover, as can be seen from Table I., the means for both types of construct are high, in relation to the five point scale, indicating importance. Thus the results suggest, within the context of competitive mapping, both techniques are eliciting non-trivial constructs.

INSERT TABLE I HERE

Objective comparisons between the category structures produced by visual card sort mapping and cluster analyses of repertory grids were produced by the application of a formula for comparing categories introduced by McKeithan *et al* (1981). The formula estimates the dissimilarity between two category structures thus:

$$D = 1 - ((\ln(a + 1)) / (\ln(b - 1)))$$

Where D is the dissimilarity, a is the total number of elements that are placed in the same categories in both maps and b is the total number of elements ($\ln$ is the natural logarithm). Thus, according to this formula, two maps are *exactly the same* if D is equal to zero, and are *maximally dissimilar* if D is equal to one.

Category structures were derived from repertory grids by applying the average linkage between groups clustering method using the squared Euclidean distance. The clusters were defined at that level of the agglomeration schedule where the largest difference was observed between two steps (Norusis, 1988). These cluster analysis derived maps were compared with the primary, secondary and lower order maps (if produced) elicited by visual card sort mapping.

It was found, by applying the McKeithan *et al* formula, that the average coefficient of dissimilarity between grid derived maps and visual card sort maps was 0.144 (std dev = 0.141), if the coefficients of dissimilarity are averaged within each participant first (for those with more than one visual map). This value was found to be significantly different from one ($t=35.40$, $df=34$, $p<.001$). Since testing the significance of the difference between one and the average value of the dissimilarity coefficient is analogous to testing the significance of a correlation, it may be assumed that both mapping techniques produce convergent results in terms of category structures at least. This is supported by the very large size for t and the proximity of the average value of the coefficient of dissimilarity to zero.

In order to test differences between self-rating data of similarities between elicited maps and random maps to managers' own mental models, the self-rating data were subjected to a repeated measures

analysis of variance (ANOVA), with two factors, mapping technique (visual card sort map, principal components derived map and cluster analysis derived map) and who the map belonged to (the participant or a random map derived from the elements the respondent himself supplied). In this analysis, for managers that had produced two visual card sort maps, an average rating was taken, otherwise the rating of the primary map was used for those managers who only produced one such map. The means and standard deviations for these analyses are shown in Table II.

INSERT TABLE II HERE

ANOVA revealed a significant main effect for whether the map was a random map or not ($F=11.20$, $df=1/21$, $p<.005$). This indicates that participants were discriminating successfully between their own maps (regardless of how they were produced) and the random maps. An examination of Table II. indicates that participants were consistently rating their own maps to be more similar to their own mental models than the random maps, thus indicating the validity of the visual card sort technique. This overall main effect also indicates the validity of using self-rating data for assessing the veracity of cognitive maps, since repertory grid derived maps have been validated previously (Bannister and Mair, 1968).

The interaction effect between the type of map and who the map belonged to was not significant ($p>.25$). This indicates that although participants can discriminate their own maps from random maps, visual card sort mapping is neither superior nor inferior to repertory grid derived maps. The result also indicates that self-ratings were not influenced by recall of the original interview, since participants' own visual maps were not rated significantly higher than participants' grid derived maps (participants would not have seen their grid derived maps before). The main effect for type of map was also not significant ($p>.10$).

Practical considerations and inter-rater reliability.

It was found that the participants could complete the visual mapping procedure very quickly, typically from start to finish in less than five minutes. Arranging the cards themselves usually took less than thirty seconds per map per respondent.

In contrast, repertory grid technique took much longer to administer, usually between fifteen and twenty minutes. This is in addition to the time it took to elicit elements and constructs from visual card sort mapping. Thus visual card sort mapping, compared to grid technique, is minimally intrusive, quick to administer and potentially less irritating for participants to complete.

Inter-rater reliability was assessed by comparing the maps constructed from the interview data by two coders (two of the authors). In the construction of the visual card sort maps from 42 participants, coders disagreed only on minor aspects of three maps. These disagreements were easily resolved by consulting back to the initial interview tapes and notes. Thus the inter-rater reliability of the technique was found to be very good. This high inter-rater reliability may be attributed to the well-defined structure of the technique and double checking carried out with participants during the interview. Moreover, inter-rater reliability is expected to be high since the technique requires participants to make their cognitive structures explicit, rather than researchers inferring them from secondary sources.

Discussion of results.

The results of the validation study indicate that the new visual card sort technique is at least as valid as the established repertory grid procedure (Bannister and Mair, 1968) in mapping managers' mental models of competition. The results supporting this contention may be summarized as follows: a) Constructs elicited by visual card sort mapping are at least as important for evaluating competitors as those elicited by triading: b) The coefficients of similarity between the cluster analysis derived maps and the visual card sort maps were close to maximal similarity and very different from maximal dissimilarity: c) Participants successfully discriminated between their own maps, regardless of whether they were derived from repertory grids or elicited by visual card sort mapping, and randomly generated maps.

Repertory grid technique and visual card sort technique are two methods of representing a person's knowledge that rely on differing assumptions, although both are theoretically consistent. For instance, repertory grid technique derives maps via statistical analysis of specific comparisons between competitors. Thus repertory grid may be considered an indirect method (Olson and Reuter, 1987). Visual card sort technique derives maps from direct questioning of respondents. Given these differing assumptions, the validity of measurement may be increased by using repertory grid technique and visual card sort technique in conjunction (Cook and Campbell, 1976).

In the next part of the paper, an empirical application of the visual card sort technique and repertory grid technique will be described. This research examines the relationships between managers' and buyers' cognitive maps.

EMPIRICAL WORK: BUYERS AND SELLERS MENTAL MODELS OF COMPETITION

It is implicit within the economic notion of the firm that managers arrive at coherent competitive strategies by sharing similar, if not the same, conceptions about whom the competition is, and the strategies that these competitors are following.

An alternative conception, not yet made in the management literature, is that managers may come to recognize each others' mental models through the processes of discourse (cf. Edwards, 1991). Thus managers may arrive at competitive strategy decisions through a process of understanding and recognition rather than necessarily through cognitive similarity. Similarly, marketing strategies may be implemented through an understanding of buyers' mental models rather than cognitive similarity with buyers.

Therefore, the aims of this part of the paper are a) to examine the extent to which managers' mental models of competition are similar to each other and those of buyers b) to examine the extent to which managers recognize the logic underlying each others' and buyers' mental models.

Homogeneity of mental models of competition ?

Porac *et al* (1989) in an examination of the aggregate mental models of competition of managers in the Scottish knitwear industry asserted that the aggregate cognitive categories they surfaced corresponded to individuals' mental models, and thus that there was homogeneity of cognition in the industry as a whole (pg 405). More recently, in a study of the Chicago banking industry, Reger and Huff (1993) concluded that cognitive categories of competition are widely shared by managers within an industry. However, in an analysis of the same data, Reger (1990) concluded that there are differences in managers' cognitions of competition. Similarly, data gathered by Gripsrud and Gronhaug (1985) suggest there is little agreement about competition within even tight geographically defined markets. Therefore, although suggestive, the evidence is equivocal over homogeneity of managerial cognitions of competition.

Since mental models are determined, at least in part, by experience (eg. Schoenfeld and Herrman, 1982), and each individual's experiences will not be the same as other individuals, it may be expected that there should be divergence between individuals' mental models of competition. Indeed, some studies of managers' mental models of competition and other areas of management have demonstrated individual variability in managers' mental models (eg. Reger, 1990, Day and Lord, 1992, Langfield-Smith, 1992, Hodgkinson and Johnson, forthcoming). Therefore, it is possible to propose that:

Proposition 1) Managers' and consumers' mental models of competition are diverse, rather than homogeneous.

Notwithstanding this, it has been argued that managerial cognitions are influenced by the social and cultural environment in which managers work (Huff, 1982). Indeed, there is mounting evidence that this is the case, at least as far as managers' conceptions of the internal capabilities and strategies of an organisation are concerned. For instance, Spender (1989) considers each industry to have its own

'recipe'; a set of beliefs and assumptions common to most managers within that industry. Similarly to Spender, Johnson (1987) suggested that each organisation has its own set of beliefs and assumptions, to which he gave the name 'paradigm'. At a level even closer to the individual, Bowman (1991) found that the functional area of management that one occupies is a critical determinant of belief structures. Related to these findings, de Chernatony (1989) found divergence between the way marketeers and consumers perceived competing grocery brands.

Therefore, although the available literature does not address the issue directly, it may be proposed that managers' mental models of competition will vary:

Proposition 2) across management functions (cf. Bowman, 1991).

Proposition 3) between companies (cf. Johnson, 1987).

Proposition 4) and between managers within one industry and buyers (cf. Spender, 1989, de Chernatony, 1989).

The bases of understanding others' mental models.

Whilst previous studies may have assumed that cognitive similarity is the basis for strategic action, recent developments in cognitive psychology have begun to highlight the role of mental models in discourse (Edwards and Potter, 1992). Edwards (1991) considers mental models to be influential in conveying meaning during communication. Therefore, through the processes of communication managers may come to recognize, at least partially, the mental models of others, without necessarily exhibiting similarity. Thus, eventually managers may come to understand and recognize the logic underlying others' mental models with whom they regularly exchange information. Therefore, it may be expected that:

Proposition 5) managers within the same company recognize each others' mental models most readily.

Similarly, managers may also receive information from their competitors through trade magazines (cf. Spender, 1989). Thus, through the dissemination of information across an industry, it may be proposed that:

Proposition 6) managers recognize other managers' mental models from the same industry more readily than those of customers.

Managers oriented towards the external market may also receive information about buyers through either direct contact, sales force or market research (Assael, 1987). Therefore, through the dissemination of this information, it may be proposed that:

Proposition 7) Managers oriented towards the external market recognize the mental models of buyers more readily than managers oriented towards the internal organisational environment.

Participants.

The participants used in the study have been described above. The North Sea off-shore pump industry was chosen since it was considered that an industry should be studied in which the managers and buyers had a) common career backgrounds, b) substantial tenure within that industry and c) who worked in strategic business units of approximately the similar size, in order to control for individual difference variables. It was considered that the North Sea off-shore pump industry and their customers met these requirements.

Within the pump manufacturing companies sampled, there existed little overlap in terms of job descriptions. Therefore, it was decided to operationalize management function by a simple dichotomy; whether the job focused upon the competitive environment (eg. tendering, sales and marketing, managing director was also included here) or whether the job was focused internally to the organisation (eg. engineering, finance, general manager).

Rating the similarity and the extent of recognition of the maps.

Each participant was administered the visual card sort technique and the repertory grid technique, as described above. Cluster analysis maps and principal components analysis maps were derived from the repertory grid procedure. However, since the maps were based on differing companies and differing attributes, standard statistical measures of similarity were not readily applicable to the data. Moreover, since a measure of the extent to which managers recognize the logic underlying each others' and buyers' maps was required, it was decided to ask managers to rate the similarity of the maps to their own mental model and the extent to which they recognized the logic underlying others' maps (as described above).

In order to investigate the extent to which similarity and the recognition of others' cognitive maps is dependent upon function, company, and whether the focal cognitive map is from a customer or not, a repeated measures experimental design was used. The twenty four managers were interviewed again, of which 23 provided usable data.

Each of these managers was presented with a booklet containing a selection of maps. None of these maps was identified to the participant. These booklets consisted of the visual card sort maps, the cluster analysis derived repertory grid maps and the principal components derived repertory grid maps from each of the following: a) the individual's own maps; b) a randomly selected member of the same company with the same management function; c) a randomly selected member of the same company with a different management function; d) a randomly selected member of a different pump company with the same management function; e) a randomly selected member of a different pump company with a different management function; f) a randomly selected pump buyer; g) a randomly generated map. Thus, the independent variable in the design is who the target map belongs to. The randomly generated maps were used in the validation of the mapping methodology, as described above.

The maps were presented in blocks consisting of all the visual card sort maps, all the principal components analysis maps and all the cluster analysis maps. These blocks were presented in a random order across participants. Within these blocks, the maps selected were presented in a random order. This randomization procedure circumvents any confounding due to the order of presentation. Ratings for each level of the independent variable were averaged over the three different types of map in the analyses.

The participant was asked to rate each of these maps on two scales. The first scale asked the participant to rate the similarity of each of the maps to the participant's own mental model on a five point fully anchored Likert type scale (1= 'The same as my view of the competitive environment', 5= 'Not at all similar to my view of the competitive environment'). A second scale asked the participant to rate the extent to which the participant could understand the logic of the arrangement of the map on a five point fully anchored Likert type scale (1= 'I can easily understand the logic underlying this map', 5= 'I cannot understand any logic underlying this map').

Obtaining ratings is a common methodology in cognitive science (Bower and Clapper, 1989). By averaging over 24 raters and across three different methods of representing individuals' mental models, the reliability of this self rating methodology may be considered robust (Cook and Campbell, 1976, Hays, 1988). Reliability was estimated by using Cronbach's alpha for managers' ratings of each particular individuals' three maps. Excluding the random maps from the reliability analyses; on average alpha was found to be 0.57 for the similarity ratings and 0.65 for the recognition ratings. Reliabilities of this magnitude may be considered acceptable for three item scales. Moreover, since the managers were able to discriminate their own maps from random maps, as described above, the self rating methodology may be considered to be valid.

Preliminary analyses.

In total, 51 different competitors were named by the sample. However, the mean number of competitors named by each participant was found to be 6.81 (std dev = 3.31). On average, the managers interviewed provided 14.00 constructs to describe the competitive behaviour of these companies (std dev = 7.55).

The frequencies with which the number of managers named each particular competitor are shown in table III. These frequencies are broken down by manager type; a) pump manufacturer, b) oil company, c) contract engineering. It can be seen from table III that no one competitor is named by all managers interviewed, although companies A and B are named by all managers from oil companies. Moreover, companies A and B are named with more frequency than others, across all three manager types. Companies C through to J are also mentioned by a number of managers, although with less overall frequency than companies A and B. Companies K through to AU are mentioned with very little frequency. Therefore, by examining the competitors mentioned, it can be seen there is some agreement across managers and customers about which firms are competing in the industry. Nevertheless, this agreement is not total, and there is considerable diversity amongst the managers concerning companies K through to AU. However, examining table III gives no indication of which factors are associated with the similarity/diversity of managers' mental models of competition.

INSERT TABLE III HERE

Assessing the homogeneity/diversity of, and the influences upon the similarity and recognition of mental models of competition.

Since the study used a repeated measures design over several levels of who the target map belonged to, the appropriate form of analysis is repeated measures analysis of variance (ANOVA, Hays, 1988)¹. Therefore the similarity rating data and the recognition data, averaged across the three different map types, were independently submitted to ANOVA. In order to evaluate the significance of these tests, the degrees of freedom of the tests were adjusted by the Greenhouse-Geisser epsilon (Norusis, 1988, pg 268), in order to accommodate possible violation of statistical assumptions.

The results of both ANOVAs revealed a significant effect for who the map belonged to averaged over the three different types of maps presented (for the similarity ratings, $F=6.44$, $df=3.53/64.65$, $p<.01$, for the recognition ratings, $F=5.37$, $df=3.76/60.21$, $p<.01$). The means and standard deviations for each of these scales are shown diagrammatically in figures V and VI respectively.

INSERT FIGURES IV AND V HERE

On the bases of the significant results shown in figures IV and V, it may be concluded that managers' mental models are diverse, rather than homogeneous, supporting proposition 1. It can be seen from figures IV and V that the general relationship is the same for both scales. That is, as the social distance between the rater and the target individual increases, the degree of similarity/recognition of maps diminishes.

In order to examine differences between who the map belongs to and rated similarity/recognition, Helmert contrasts (Hays, 1988, pg 408-409) were applied to both sets of data. Helmert contrasts compare the mean of one level of a variable against the combined mean of one or more other levels of that variable².

Taking the similarity ratings first, the Helmert contrasts revealed the following significant results (these are marked on figure 1): a) managers' rated their own maps as significantly more similar to their own mental model than maps elicited from managers who share the same function and the same company ($t=3.50$, $p<.01$); b) on average, managers rated maps from within their own company, including their own, as significantly more similar to their own mental model than maps elicited from members of different companies but with similar management functions ($t=3.43$, $p<.01$); c) on average, managers rated their own maps, maps from people within their company or who shared a

similar management function but from a different company as significantly more similar to their own mental model than maps elicited from managers from different companies with different management functions ($t=2.33$, $p<.05$); d) on average, managers rated their own maps and others from within their industry as more similar to their own maps than those elicited from buyers ($t=2.62$, $p<.05$).

These results indicate that within the general context of diversity the similarity between two individuals' mental models of competition is a) greatest within the same company (supporting proposition 3); b) decreases across management functions (supporting proposition 2); c) is least between managers from within the industry and customers (supporting proposition 4). However, that managers were found to rate their own maps are significantly more similar to their own mental models than the maps of others lends more support to proposition 1, namely that managers' mental models of competition are diverse, even within the same management function in the same company.

A similar, but slightly different pattern of significant results emerged for Helmert contrasts with the recognition data (these significant results are marked on figure 2): a) managers' were able to recognize significantly more logic in their own maps than maps elicited from managers who share the same function and the same company ($t=2.87$, $p<.01$); b) on average, managers were able to recognize significantly more logic in maps from within their own company, including their own, than maps elicited from members of different companies but with similar management functions ($t=3.13$, $p<.01$); c) on average, managers were able to recognize significantly more logic in their own maps and others from within their industry than those elicited from buyers ($t=2.72$, $p<.05$).

These latter results indicate that a) managers recognize least logic underlying buyers' maps compared to maps from managers within the same industry (supporting proposition 6); b) managers recognize significantly more logic underlying maps from within their own company than from outside their company (supporting proposition 5); c) there is no influence of function upon recognition (unlike the similarity ratings, there were no differences between functions, either within or from outside the focal company); d) managers recognize significantly less logic underlying others' maps, even in their own company, compared to their own maps (again supporting proposition 1).

Proposition 7 stated that managers oriented towards the external market would recognize the logic underlying customers' mental models more readily than managers oriented towards the internal organisational environment. This proposition was tested by conducting a t-test between externally oriented and internally oriented managers for the recognition scale. A similar test was conducted for the similarity scale. The means and standard deviations for both analyses are shown in table IV. The t-test for the similarity scale indicated no significant differences between the two groups of managers ($t=0.66$, $df=21$, $p>.25$ one tailed). For the recognition data, the result emerged as marginally significant ($t=1.54$, $df=21$, $p<.07$ one tailed). Examining the means in table IV, it can be seen that this result is in the direction expected from proposition 6. The marginal significance of this result may be a function of the small sample size. However, the point biserial correlation for this analysis came to $r = 0.32$, which is a correlation of moderate magnitude (Cohen, 1977). Therefore, it may be tentatively suggested that the results provide support for proposition 7.

INSERT TABLE IV HERE

Summary of results.

The results indicate that there is diversity, rather than homogeneity, of managers' mental models of competition, as rated by the managers themselves. The results also indicate that the similarity of these mental models are influenced by company (cf. Johnson, 1987), the managerial function (cf. Bowman, 1991) and whether the individual is a seller or buyer (cf. de Chernatony, 1989, Spender, 1989).

A similar pattern of results emerged for the recognition data, except that managerial function did not appear to influence these results. Importantly, some tentative evidence was found that suggests managers oriented towards the market recognize the logic underlying buyers' mental models more readily than managers oriented towards the internal company environment, although there is no

difference between these two groups of managers in the similarity of their mental models to buyers' mental models.

Given that the dissimilarity of managers' perceptions of competitive industry structures may vary systematically with the maturity of the industry (Easton *et al*, 1993), and industry expertise (Day and Lord, 1992), there are benefits of replicating and extending this research across other industry contexts and other demographic contingencies (such as industry experience). However, the findings presented in this paper have a number of other implications for research. These will be discussed below.

Implications of the results.

The results indicate that recognition and understanding of others' mental models is different construct to cognitive similarity, a distinction not previously made in the management literature. There are two bases for making this conceptual distinction: a) recognition appears to be influenced by company and industry only, although cognitive similarity appears to be influenced by management function, company and industry; b) externally oriented managers tend to recognize buyers' mental models more readily, rather than having significantly similar mental models to buyers. Thus the different forms of the relationships involving the similarity and the recognition data suggest that recognition is a variable that should be included in future studies of management cognition, rather than just similarity, as has previously been the case.

A dominant assumption in management science is that competitive strategies are formulated on the basis of homogeneous cognitions of competition derived from rational analyses within a team of managers. The results presented here question that assumption and raise issues concerning how managers debate and formulate competitive strategies. It may be argued that individual differences in cognitions are mediated in these debates by social, political and cultural means. Nevertheless, from a cognitive perspective, previous research in operations management, focusing upon the similarity of managers' mental models, has suggested that managers make decisions by sharing some aspects of their mental models in common (Langfield-Smith, 1992). Indeed, it has been suggested that managers share some core concepts of competition, both within companies (Reger and Huff, 1993, Hodgkinson and Johnson, forthcoming). Therefore, according to this argument, teams of managers formulate competitive strategies on the basis of the compatibility of their mental models.

Some support for this argument is provided in this study, in that managers within the same company were demonstrated to have significantly more similar mental models compared to the mental models of managers from outside that company. Also, some core similarities across a majority of managers were seen in the competitors mentioned, as shown in table 3. However, the study provides no support for the contention that marketing strategies are implemented by a process involving similarity of cognition between managers and customers, since managers oriented towards the market do not have significantly more similar mental models to buyers than managers oriented towards the internal organisational environment.

A second way of formulating competitive and marketing strategies is by a shared recognition and understanding of others' mental models, which develops through the processes of discourse, thus allowing negotiation of strategic action. The study provides some support for this argument, in that managers most readily recognize the mental models of managers from the same company. Stronger support for the argument is provided by the results which suggest that managers oriented towards the market place recognize buyers' mental models more readily than managers oriented towards the internal company environment.

Conclusions.

This paper has questioned the role of homogeneity of cognition in the formulation of competitive and marketing strategies, in that the results demonstrate significant differences between managers' ratings of the similarity of their own cognitive maps and those of others. The results show that cognitive similarity is conceptually distinct from recognition of others' cognitions. Two pathways of strategy formulation were proposed; one based on shared similarities between individuals' mental models of

competition and one based on recognition of others' mental models. The results indicate that both pathways may be feasible for strategy formulation within a team of managers but that matching the strategy to the mental models of buyers is most likely to occur through recognition of buyers' mental models.

The research reported here suggests two cognitive pathways through which managers may reconcile diversity in their cognitions of competition during the process of strategy formulation. It is clearly important to explore the impact of these cognitive mechanisms upon the process of strategy debate and formulation within a team of managers. In order to do this, individuals' cognitive maps need to be related to the discourse and behaviours of managers during strategy debates.

SUMMARY OF THE PAPER AND SUGGESTIONS FOR FUTURE RESEARCH

This paper has outlined a piece of research concerned with evaluating differences in managers' and buyers' mental models of competitive industry structures. The paper began with a discussion of the bases upon which people may organise knowledge about the structure of competitive industries. On the basis of this discussion, three cognitive mapping methodologies were reviewed, and their suitability for research assessed. It was concluded that a visual card sort technique and repertory grid technique showed most promise for this purpose. In the second part of the paper, the visual card sort technique was empirically validated as a means for mapping individual's mental models competition by comparing it with the previously validated repertory grid technique. In the final part of the paper, empirical evidence was presented that suggests managers' and buyers' mental models of competition are diverse rather than homogeneous. It was suggested that strategic debate and decision making may be facilitated either by a) managers and customers sharing elements of their mental models in common or b) being able to recognize others' mental models.

The results presented in this paper have a number of implications for future research. Clearly the findings that similarity and recognition of cognitive structures are linked to industry, company and function (in the case of similarity) need to be extended across different industry contexts, and across different contingencies. Huff (1982) suggests that managerial cognitions may be influenced by several factors, beyond those explored in this study. For instance, the level of the organisation that an individual works at, strategic group membership and national culture may all influence the similarity between and the recognition of managerial cognitions. We are currently pursuing research in four industries that addresses these issues.

Most importantly, the links of cognitive similarity and recognition to strategic action need to be explored, and embedded in the social context of the organisation. That is, similarity and recognition need to be assessed concurrently with other socio-cognitive and social processes (such as deference to expert knowledge, Mintzberg *et al*, 1976, and the use of symbolic action, Johnson, 1987), in order to determine the joint impact of all these processes upon strategy debate and strategic action. In this respect, it may be possible to devise an observational methodology, to supplement the mapping and rating methodologies presented in this paper, that explores the impact of cognitive, socio-cognitive and social processes upon strategy debate amongst a team of top managers.

Footnotes.

1. Each manager was asked to assess several maps, across various combinations of management function, company membership and buyer or seller. This introduces a dependency or correlation between each of ratings of a given individual. An analysis technique is required which removes any possible biasing effects due to this dependency when comparing ratings. Repeated measures analysis of variance does this (Hays, 1988).

2. Helmert contrasts have the advantage of being orthogonal to (independent of) each other. This reduces the probability of the type I error; that is accepting a statistically significant difference as reflecting a true difference, when no such difference exists. In this data set, Helmert contrasts compare the following:

- a) Managers' ratings of their own maps against maps from managers in the same function in the same company.
- b) Managers' ratings of their own maps combined with maps from managers in the same function in the same company against managers from a different function in the same company.

- c) Managers' ratings of their own maps combined with maps from managers in the same company regardless of function against managers from the same function but a different company.
- d) Managers' ratings of their own maps combined with maps from managers from the same company and/or the same management function against managers from a different company and a different function.
- e) Managers' ratings of their own combined with maps from other sellers against maps from buyers.

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TABLE I. Means and standard deviations of averaged rated importance for constructs derived from visual card sort mapping and triading. Data are shown for 29 respondents who supplied constructs by triading as well as visual card sort mapping.

Type of construct	Mean	Standard deviation
Visual card sort mapping	3.91	0.565
Triading	3.75	0.715

TABLE II. Means of self-rating data (standard deviations shown in brackets).

	Own maps	Random maps
Mapping technique		
Visual card sort	1.87 (1.01)	3.27 (1.20)
Principal components	2.50 (1.26)	3.50 (0.86)
Cluster analysis	2.50 (1.23)	3.05 (1.43)

Table III. Competitors mentioned by members of the pump industry and customer segments.

	Pump companies	Oil companies	Contracts engineers	Total
Number of managers Competitor	25	9	8	42
A	18	9	6	33
B	22	9	3	34
C	13	7	2	22
D	14	4	2	20
E	9	8	5	22
F	13	3	3	19
G	5	2	2	9
H	13	6	6	25
I	7	4	2	13
J	8	2	2	12
K	1	1	-	2
L	2	-	-	2
M	1	1	-	2
N	2	1	-	3
O	3	2	-	5
P	1	-	-	1
Q	1	2	-	3
R	1	-	-	1
S	1	1	-	2
T	1	1	2	4
U	1	-	-	1
V	1	4	2	7
W	1	-	-	1
X	-	1	1	2
Y	-	1	-	1
Z	-	1	-	1
AA	-	1	-	1
AB	-	2	-	2
AC	-	1	-	1
AD	-	1	-	1
AE	-	-	3	3
AF	-	-	1	1
AG	-	-	1	1
AH	-	1	-	1
AI	-	1	-	1
AJ	-	1	-	1
AK	-	1	-	1
AL	-	1	-	1
AM	-	2	-	2
AN	-	1	-	1
AO	-	1	-	1
AP	-	1	-	1
AQ	-	1	-	1
AR	-	1	-	1
AS	-	1	-	1
AT	-	1	-	1
AU	-	1	-	1
AV	-	1	-	1
AW	-	1	-	1
AX	-	1	-	1
AY	-	1	-	1

TABLE IV. Means and standard deviations for differences in rated similarity and recognition of customers maps for internally and externally oriented managers.

Scale	N	Similarity		Recognition	
		Mean	Std dev	Mean	Std dev
Internal orientation	10	3.57	0.89	3.67	0.83
External orientation	13	3.30	0.96	3.05	1.04

FIGURE I. Example of hierarchical taxonomic sorting map.

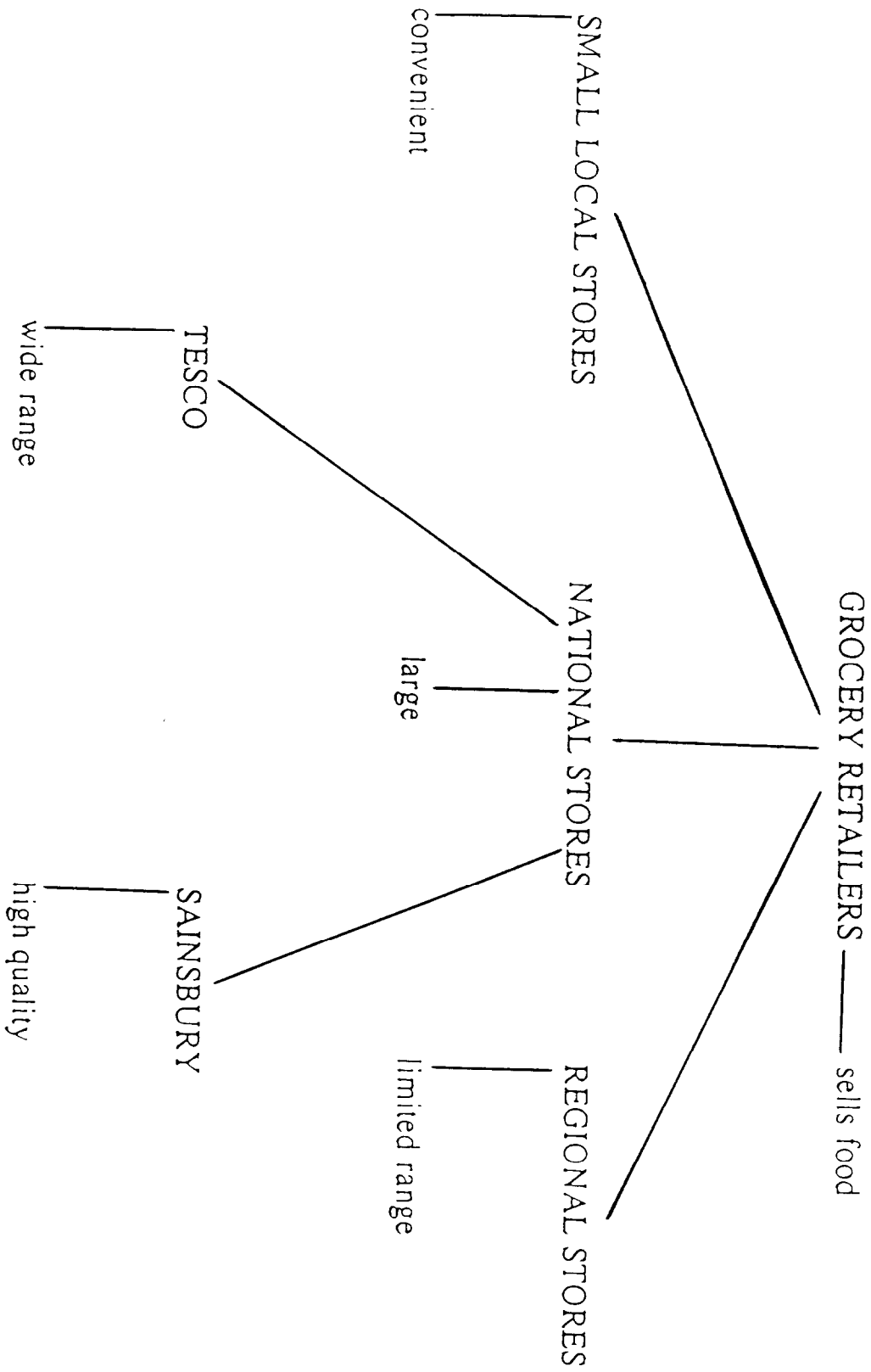
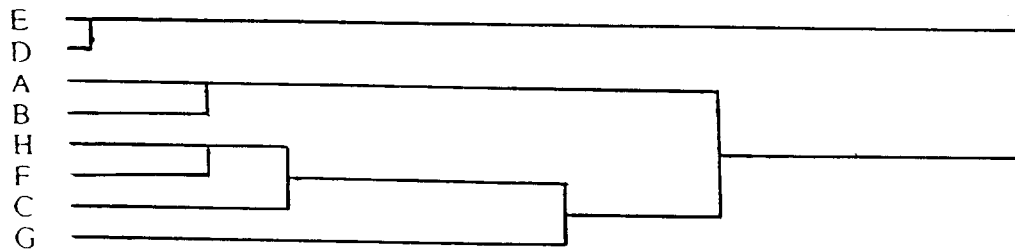


FIGURE II. Examples of cluster analysis derived and principal components analysis derived repertory grid maps (company names have been removed).

a) Cluster analysis map.



b) Principal components analysis map.

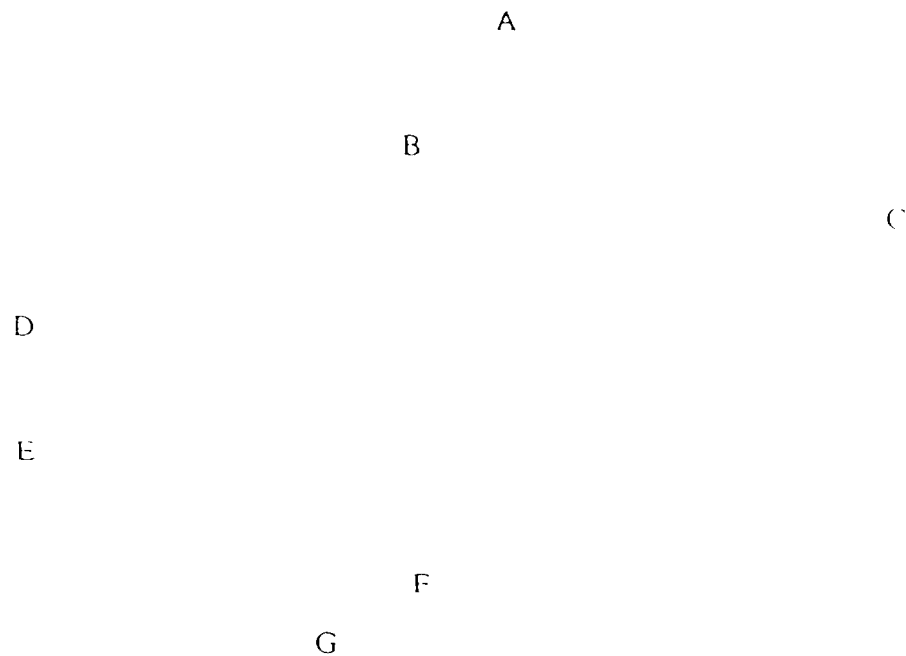


FIGURE III. Examples of visual card sort maps.

Example a)

E		
D		
		B
	F	A
		C
H		
G		

Example b).

E		
D		B
H	A	F
G	C	

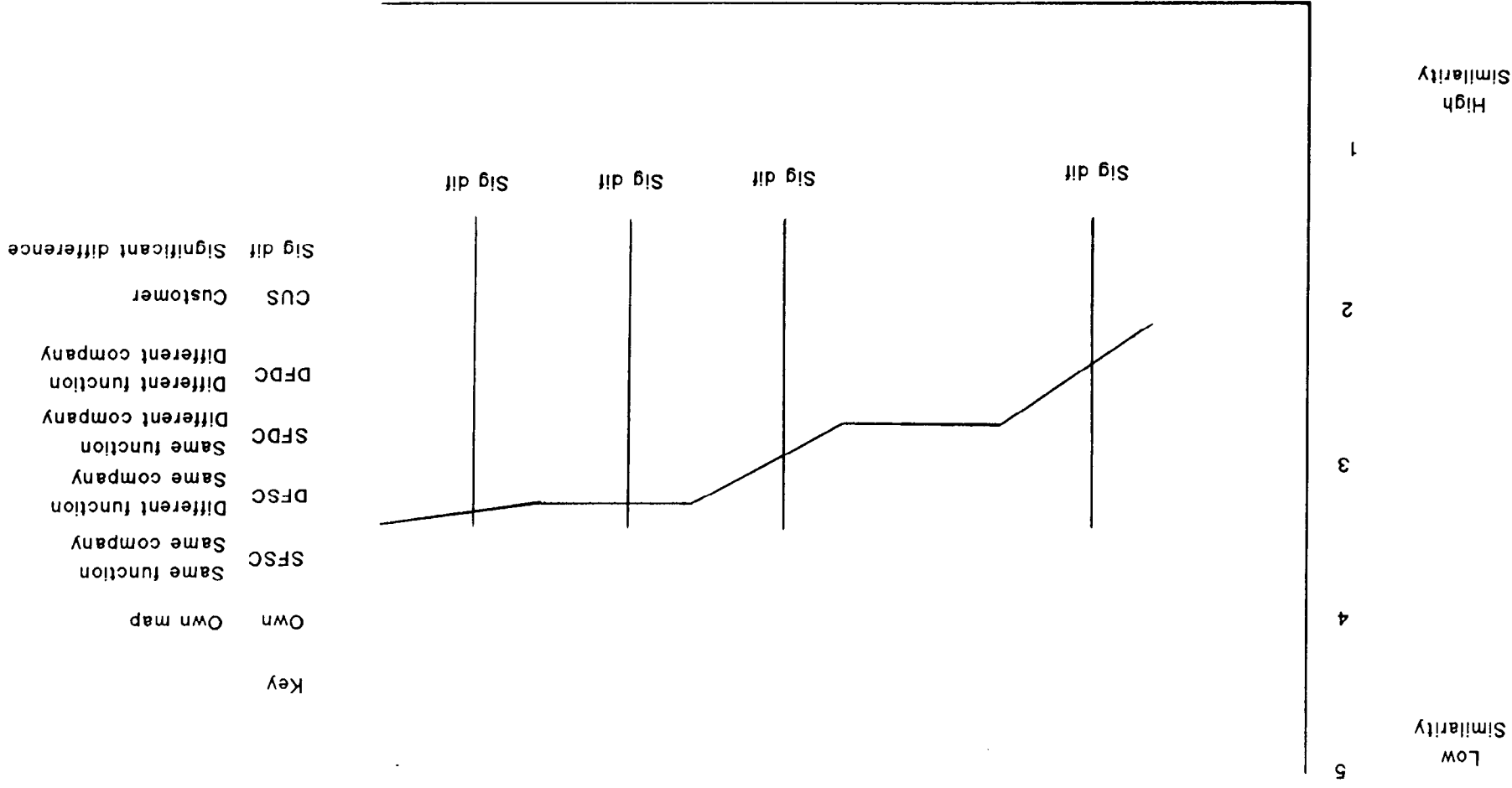
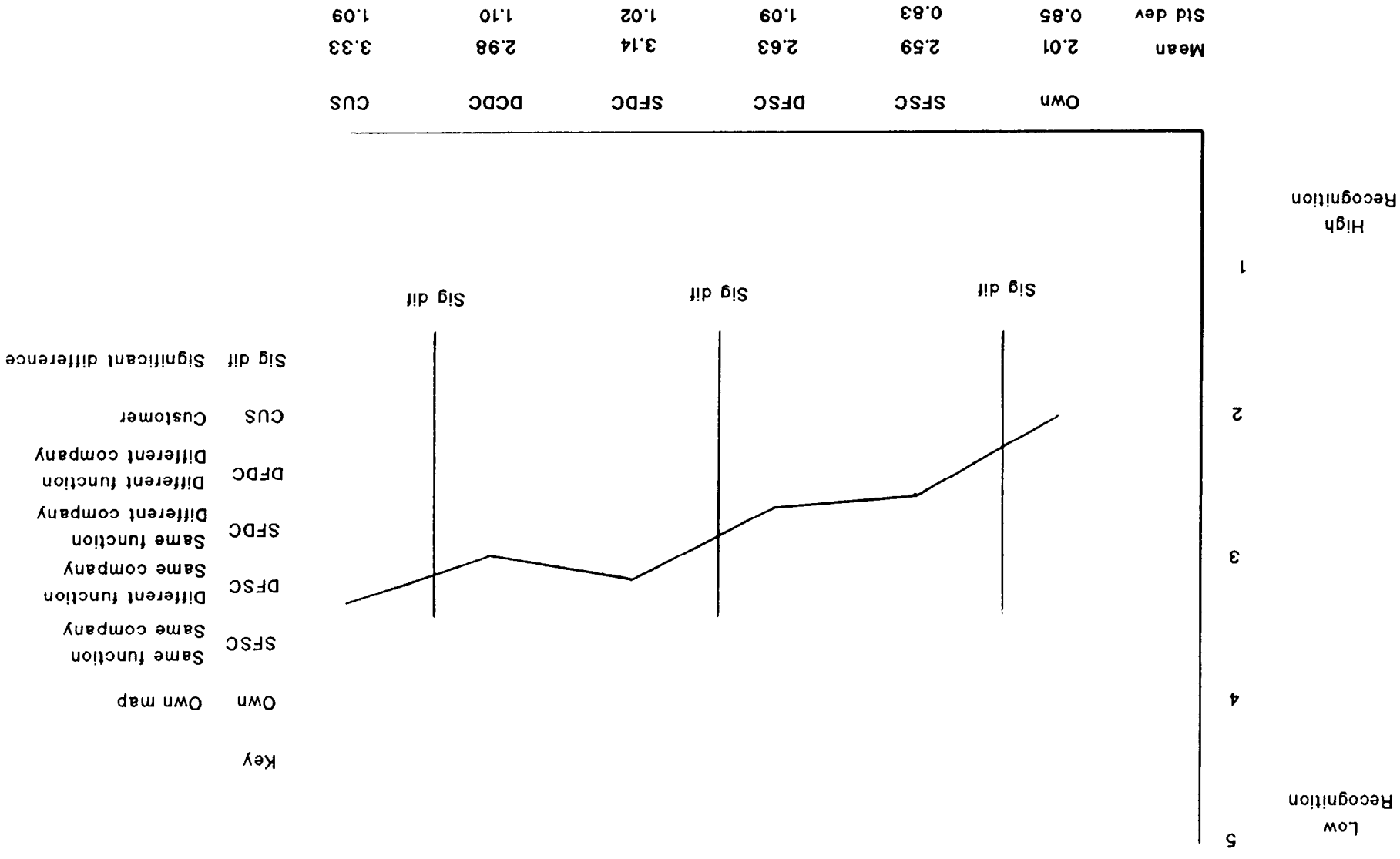


Figure 4. Mean similarity ratings with standard deviations. Significant differences are also shown.



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