CHAPTER FIVE

EXPERIMENT THREE

5.00 CHAPTER OVERVIEW

Section 5.01 sets out the main aim of Experiment 3 and how it is to be achieved. The theoretical issue being investigated by the experiment is debated. In other words, what is the nature of the conceptual core, and does it consist of similarity information or of explanatory knowledge. Factors which might influence answers to these questions include the naturalness of the category concept (that is, animal or artifact); and the ease-of-accessibility of the information required to carry out a task, such as in judgments of typicality, similarity and categorization.

Section 5.02 concerns the content of the core, such as, what knowledge people hold to be most important. Six different models of category representation are described, in relation to the nature of the information/ knowledge each model claims is the basis for the conceptual core.

Section 5.03 describes issues surrounding the inherent nature of the entity as belonging to an animal or artifact object. Various articles concerning research on the effects (or not) of environmental structure upon animal and artifact concepts are reviewed. Section 5.04 raises the issue of whether differences in task performance should be attributed to differences in cognitive functions. Section 5.05 describes the hypothesis and predictions for each of the three factors.

Section 5.06 describes the method and procedures used for Experiment 3, and section 5.07 sets out the results of data-analyses and post-hoc tests of comparison. Section 5.08 is a discussion of the various findings and whether they support the original hypotheses; and section 5.09 discusses the implications of the results for the original question posed by the experiment.

5.01 ISSUES AND AIM OF EXPERIMENT 3

Briefly, Experiment 2 tested and supported the notion that different category-types have different representations. The results also implied that

subjects were probably using background knowledge of the category whilst performing tasks which measured category representation. Experiment 3 in this chapter goes on to test the possibility that people have different representations for the same category. For example, people's understanding of what constitutes a typical *Bird* might not be the same as their representation of what defines a *magpie* as such, and differentiates it from a *barramundi.* Experiment 3 tests the psychological reality of the theory-based view of concepts, which advocates dual representations, and compares it with other approaches such as the classical and the prototype views.

Similarity-based models and explanation-based models are compared to determine which of these (as a potential core) has the greatest influence upon people's revised judgments of their concepts. Two possible approaches can be adopted to investigate what constitutes stable conceptual knowledge (that is, the conceptual core). The traditional approach views concepts as being similarity-based, assuming that objects, events and entities coalesce to form categories because they are similar to one another. Similarity relations among objects in the real world are reflected in the structure of concepts, so that similar objects are placed in the same category, and dissimilar objects belong to a different category. People's formation of any category becomes a process of internalizing these natural discontinuities in the environment (Rosch, 1978; Rosch, Mervis, Gray, Johnson, & Boyes-Braem, 1976). Thus, the concept's stability is grounded in the structure of the environment.

On the other hand, the theory- or explanation-based approach does not view concepts as being governed by environmental constraints alone, but as deriving from the individual's naive beliefs and knowledge about the world. Murphy and Medin (1985) claim that human interests, needs, goals and theories play a crucial role in determining the concept formation, and that the sole notion of physical similarity relationships cannot be sufficiently constraining to determine which concepts will have a stable meaning and flexible structure. Background knowledge of the world (such as how we relate to objects and the relations between objects or creatures) is said to provide the necessary stability (or embeddedness) for concepts constructed from such theories.

The empirical issue tested by Experiment 3 concerns the nature of the conceptual core, and the various factors to which it must be sensitive. This is an important question, since a category's conceptual core is said to be the ultimate

arbiter of an object's membership in that category (Smith, 1989). As was described in chapter 1, concept models give differing accounts as to what constitutes our core knowledge of a category of objects or creatures. The models also differ in the extent to which they allow factors outside of the structure of physical appearance to influence people's use of the core.

The aim of the experiment is to investigate what people's core knowledge of a category might be, together with the various factors which might influence the use of that core. The experiment aims to do this by observing the degree (if any) to which subjects might revise their judgment of an object or creature's identity, its similarity and its typicality. For example, a person begins the task with a description of some animal which identifies it as belonging to a certain category. During the task, the subject reads a story which narrates how some of the creature's original properties (physical, essential, functional) have been altered. The subject might decide that these alterations are of sufficient importance as to make him or her change judgment of the creature's original identity (say, a woolly dog) to such an extent that they now conceive of it as being another creature altogether (say, a woolly lamb). All the experimental stories involve "transformation" themes, and are based on the rationale developed in papers by Keil (1989) and Carey (1985), and described in Chapter 2. It is assumed that, by the use of narrative, people's use of causal (van den Broek, 1990) and state (Long, Golding, Graesser, & Clark, 1990) inferences during categorization can be examined.

Beside the actual content of the stories used as stimuli in the experiment, two other factors may have a role to play in determining which is the best concept model. The second factor is the inherent nature of the entity as belonging to an artifact or animal class. A person's perception of an entity's membership in a category might be constrained by its natural environmental structure, or by its functionality. The inherent nature of an object (in which the property is found) as a member of an ontological category (artifact or animal) might influence the structure of the concept model. In turn, the third factor examines whether subject performance on judgment tasks of similarity, typicality and category membership is influenced by the ease of carrying out the task. For example, information about essential features might not be accessed so easily as when a similarity judgment is being made.

The degree of revision (measured by comparison with a control condition) elicited by the information given in each experimental story condition will be a measure of how important (or close to the core) that manipulated information might be. People's readiness to revise their judgments of an object must be constrained by some predictable factors, otherwise chaos would ensue. The factors investigated in Experiment 3 have been suggested by earlier research (Gati & Tversky, 1984; Tversky, 1977; Tversky & Gati, 1978) which indicates that the flexibility of people's perceptions of similarity can be influenced by factors other than the structure of physical appearance, including the entity in which they occur, the stimulus context, and experimental task. These three factors (story-context, task-demands, and animal/artifact nature of the entity) are described in turn below, as well as the reasons why they are relevant to the main issue.

5.02 STIMULUS CONTEXT: THE STORY CONTENT

The various models of how people represent their understanding of categories are tested here through the use of narrative. Story-content is varied according to the information which each model claims is the stable core of a category-concept. The stories form the basis for the control and six experimental conditions. For example, for stories in the family resemblance condition, the transformation concerns the physical features of some object or creature, since it is features of similarity which are considered by this model to be the most crucial during categorization, similarity and typicality judgments. On the other hand, the stories in the psychological essentialism condition add an explanation for the physical alteration. In this knowledge-based approach, it is explanatory beliefs/theories which are considered to be "the glue" cohering an item with its category identity.

Theories such as the classical view of defining features (Bruner, Goodnow, & Austin, 1956), Rosch's prototypes (1973; 1975a), and Tversky and Hemenway's (1984) theory of function-parts, all share, directly or indirectly, the same underlying assumption that similarity is "the glue that makes a category learnable and useful" (Murphy & Medin, 1985, p. 291). At first glance, it would seem that physical appearance might be claimed as a powerful determinant of which features are perceived as being salient and important for a categorization

task. But can physical appearance really be such an infallible guide to what criteria constitute the conceptual core?

Most current theories view conceptual cores differently. Some propose that conceptual cores are definitional (e.g., Armstrong et al, 1983; Osherson & Smith, 1981, 1982; Smith & Medin, 1981). Others propose that conceptual cores contain intuitive theories and idealized cognitive models (e.g., Lakoff, 1987; Medin & Ortony, 1989; Michalski, 1989, 1993; Miller and Johnson-Laird, 1976 (pages 280-301); Murphy & Medin, 1985; Nelson, 1974; Rips, 1988; 1989; 1990). Whereas these latter views can be construed as stressing the importance of category competence, the definitional views stress performance, focusing on those properties most frequently central to category use (Barsalou, 1989). The models of temporary representations (Barsalou 1987; 1989) or of multiple representations and ideal prototypes (Lakoff, 1987) are more radical. They ignore basic principles of cognitive economy of storage and processing, and are generated to account for research findings which show the unreliability of subjects' typicality ratings over time, and the instability of internal gradient structure (Barsalou, 1987; Roth & Shoben, 1983). The control condition, and six of these concept models are described in more detail below.

5.02.1 Control (story condition 1)

Each of the stories had a control condition, where no alteration took place. The theme of this control story was description of an artifact or animal's characteristics, which made it whatever it was. The characteristics in all control conditions included one unseen essence attribute; two independent physical features; one object-part; the function of the object-part.

5.02.2 Family Resemblance (story condition 2)

The family resemblance theory describes a prototype concept based upon a list of independent and characteristic features (Rosch & Mervis, 1975). Potential members should share some (not necessarily all) of these characteristic features with the prototype. A family resemblance theory would propose a fuzzy prototype for both artifact and animal categories consisting of bundles of both physical and functional features. Rosch's (1978) view of what constituted a "natural" category included both artifact and animal objects, using both as examples to argue some point or as word materials in her studies. She

emphasized the importance of functional features when using artifact objects as examples, although she mentioned physical features also. The constraints upon Rosch's theory were environmental in nature, including both the cultural and the physical aspects of the environment. Her theory would propose a world structure of "natural" discontinuities forming artifact and animal categories, and human beings who would be innately sensitive to such discontinuities and form prototypes of artifact and animal category-types.

The general consensus was that objects in categories cohered due to their "naturalness", which was expressed as a shared similarity of appearance. Natural concepts are said to be those formed out of basic ontological categories, such as *living thing* or *intelligent being*. For example, a category that included only thoughts and fish would violate ontological boundaries, and would therefore be an unnatural concept.

5.02.3 Classical essentialism (story condition 3)

The classical view of concepts describes their criteria for membership as consisting of certain defining features, all of which are necessary and sufficient for categorization to occur. The defining features could be physical features, essential properties, or abstract attributes, depending upon the philosophical theory being adopted. One such view is Putnam's early metaphysical essentialism, which claims that things are what they are by virtue of possessing some internal essence. Rocks, for example, are identifiable as such because they have an inner, unseen "rock essence" (Putnam, 1975a, 1975b).

The classical approach argues that "essential" features do not underlie the form and function of artifact objects, because these do not have an inherent nature. Aristotle distinguished between the two category-types by arguing that a natural object has in itself a source of change and staying unchanged; whilst an artifact can change its material. For example, a bed rots because its material is wood, not because of some unseen essence. Thus, a natural object will undergo changes that are due to its form or nature, whereas no changes an artifact undergoes are due to its form or nature. On the issue of whether artifact and animal category-types are inherently different, then, a classical theory would have to give a positive answer (Losonsky, 1990).

5.02.4 Function-part relations (story condition 4)

Cores may be constituted of a variety of kinds of knowledge, and several researchers had suggested that for artifacts, function might serve as the concept's core (Schwartz, 1978; Rosch et al, 1976). Rips (1989) had found that, if something umbrella-like in appearance was described as designed to serve as a lampshade, subjects tended to classify the object in accordance with its *lampshade function*, not its *umbrella appearance*. Related research includes Schyns and Murphy (1994), Landau (1994) and Ward (1993).

Tversky and Hemenway (1984) have presented evidence that object parts proliferate at the basic level, and conclude that object parts link the appearance of category members with their function. These researchers are really positing a *definitional* model of the conceptual core, and claim that the function-part of an object (or of a creature) is the criterion for category membership for basic level objects, whilst the object part itself is the basis for similarity and typicality judgments. Tversky and Hemenway (1984) claim that the functional features of object parts determine category membership in "natural" categories, whether they be artifact or animal objects. Thus, there is a functional relation between an entity's object-part and its function.

The model is similar to the psychological essentialism model (see below) in that it proposes a dual representation, but it differs from psychological essentialism in consisting of definitional criteria, especially with natural categories. Also, this model does not propose an explanatory relationship between the similarity components of the prototype and the diagnostic components of the conceptual core. The core is not described as a theory-like structure, but is said to consist of rules about concrete, functional relations.

Briefly, the conditions described above are all similarity-based. That is, coherence of category-members is said to be based upon a sharing of features, whether these be physical features, essential, or definitions of function. A more recent research area which has consistently produced evidence against a similarity-based approach to categorization began with Rosch herself (1983) and gathered strength with Barsalou (1983, 1987, 1989 and 1991) and especially Murphy and Medin's (1985) argument for beliefs as a basis for coherence. The general consensus was that a concept can be represented in more than one way,

with separate representations of a basic core and a prototype being suggested to account for research findings.

Smith (1989) in his article on "Concepts and induction" outlined the dual representation approach, claiming a concept can be represented in either of two ways: by criterial information or by similarity prototype structure. These two components serve category behaviour as did Putnam's "division of linguistic labour" of essential concepts and stereotypes. One component of the concept (the prototype) is very accessible for rapid identification, or "quick and easy" as Medin and Ortony (1989) describe it. The other component of the concept (the core) is less accessible, consisting of deeper diagnostic information which is the source of conceptual stability, and the ultimate arbiter of categorization.

5.02.5 Two-tier representation (story condition 5)

Michalski (1989; 1993) incorporates information such as needs, intentions, desires into his two-tier model. He argues that understanding of a concept in a particular context occurs on two levels of meaning and is the result of an interaction between two components. The first component is the base concept representation (BCR) and the second is the inferential concept interpretation (ICR). The BCR includes both specific and general information, including examples, counterexamples, and exceptions to the rule. More relevant to the structure of this experiment's stories, the ICR is said to incorporate metaknowledge about the concept, implicit or unaware knowledge, but which is used nevertheless. The ICR applies inferential methods to the BCR, making use of background knowledge to generate an interpretation appropriate to the context. The ICR plays the role of cohering the concept through its use of inferences, relating it to conscious background knowledge or implicit knowledge, so that this model takes intuitive inferences into account. The stories in condition 5 in this experiment include implicit inferences that it can be an entity's needs or intentions which lead to its transformation, and Michalski's two-tier, single representational model of concepts would seem to capture such reasoning.

The base concept is not fuzzy, and the property of stability is derived from this clear-cut certainty. On the other hand, the Interpretation rules constrain the degree of distortion which is allowed to the base concept, and judge the effects of contextual information upon it. Thus, flexibility also is incorporated into

Michalski's concept model, as well as stability. One tier deals with the instances in the world with which we are familiar, perhaps through direct experience. The second tier (ICR) deals with novel situations or atypical instances (e.g., such as occur in the stories) (Hampton & Dubois, 1993; Michalski, 1993).

5.02.6 Psychological essentialism (story condition 6)

This model is derived from the core-plus-identification function model (Rey, 1983, 1985; Smith, Medin & Rips, 1984). Medin and Ortony's (1989) psychological essentialism differs from metaphysical essentialism, in that the emphasis is upon people's beliefs *about* the nature of an object or creature's unseen "essence". This model does not claim that objects or creatures actually possess an internal essence, but that people mentally act *as if* they do. The researchers described such a mind as operating as "the naive theorist" (Medin & Ortony, 1989).

If people do have representations based upon naive beliefs about underlying essences, that would explain the intuitive feeling that an object's membership must be determined by certain "defining features", even if it is difficult to specify what exactly such features are. One of the features shared by this model and that of Tversky and Hemenway's (1984) model is the use of a "division of linguistic labour" to differentiate the roles of the two representations. They also share the notion of accessibility of information, or depth-of-processing. In this model, it is said that people's beliefs about attributes have a continuum of accessibility, with the more accessible attributes tending to be perceptual in nature, such as colour dimensions or physically similar features. Similarity and typicality judgments are based on this "shallow" information and are "quick and easy" (Medin & Ortony, 1989). The less accessible attributes are more abstract and unseen, such as the genetic structure of an animal or the operating principle underlying the functioning of an artifact.

Such explanatory beliefs arise from (and are embedded in) background, general knowledge, such as how people might interact with the object member or instances of the concept. For an example of how beliefs and background knowledge interact, see examples of contagion reasoning and homeopathic explanations, in section 1.02.4, chapter 1.

5.02.7 Ideal prototypes (story condition 7)

Lakoff (1987) has proposed an idealized prototype model which emphasizes the influence of context more than Medin and Ortony's (1989) cognitive model of psychological essentialism. In the idealized prototype model, a distinction is made between general background knowledge (encyclopaedic knowledge) and specific, definitional knowledge about a concept (dictionary knowledge). He emphasized that these cognitive models are idealized: they are built on background circumstances or assumptions that may not hold in the real world. Idealized prototypes may specify either necessary and sufficient criteria for inclusion in a category, or may be a kind of theory about the instances of the category (Komatsu, 1992).

In summary, the above six concept models can be said to be roughly differentiated according to what answer they give to the question: do we identify and categorize the objects in the world around us simply on the basis of similarity of unseen features (essence), physical appearance (family resemblance or object-part functional relations), or according to the explanatory concepts we have constructed explaining that physical appearance (Lakoff, 1987; Medin & Ortony, 1989; Michalski, 1989; 1993; Smith, 1989; 1990)?

5.03 INHERENT NATURE OF THE ENTITY: ANIMAL OR ARTIFACT?

A second factor which might influence people's judgments of some animal or artifact in the outside world is the inherent nature of the entity as a member of that category. The issue being tested concerns whether the inherent nature of animals is essentially different from that of artifact objects.

A natural category such as *Animal* would be defined by unseen essence, which makes the animal whatever it is. The problem lies with artifact concepts and the source of their structure. Do artifact objects have an essence? Barton and Komatsu (1989), Losonsky (1990), and Malt (1993), Malt and Johnson (1992), have all suggested that artifact kinds are inherently different to animal kinds, and that consequently, people will conceptualise the two kinds differently.

Both Schwartz (1978) and Wiggins (1980) argue that artifacts derive their defining features from their names, because they do not share a common, hidden

nature. Function has been put forward as a possible defining feature in the past, but they argue that the notion is not fine-grained or structured enough to have any kind of scientific or nomological influence. Losonsky (1990) himself takes the stance that artifacts do have an inherent nature, and suggests that this consists of the abstract principle by which an artifact operates, as distinct from its actual physical operating mechanism. Thus, for a physicist, any stable oscillating phenomenon is a clock. Losonsky (1990) explains that, to define an artifact's nature, not only is it important to discover knowledge of its mechanical regularities and operating principles, but also its purpose and function.

It could be argued that artifact types will take functional features as defining and animal types will take biological features as defining. Support for this hypothesis comes from Barton and Komatsu (1989) who tested the notion that natural kinds have defining features which involve a shared chromosomal or molecular structure whose possession is critical for membership, whilst artifact kinds share an intended *function*. These researchers found that changes in chromosomal/molecular structure were found to lead to changes in an object's identity significantly more often with natural categories than with artifacts. With artifacts, the critical features leading to changes in identity were changes of function or physical characteristics. Summarizing, their results showed that having a particular molecular structure is necessary for membership in a particular natural kind category, whilst having a particular function is necessary for membership in a particular artifact category.

Malt and Johnson (1992) investigated the hypothesis that artifact categories have conceptual cores of definitive essential attributes, which specify the criteria for an item to be included in the category. Whilst atypical members of natural categories still seem to belong to their categories, some atypical members of artifact categories seem to be only distantly related to their category. For example, *lamp* might not be considered to be, even marginally, a piece of *Furniture* (Barr & Caplan, 1987; Lakoff, 1987; Malt, 1985, 1990, 1993). Artifacts like *pencil, cups, chairs* do not have complex internal structures that are unfamiliar to the average person (such as the internal biology of *Living things*).

Malt and Johnson (1992) reasoned that artifact concepts need to be investigated in order to test the appropriateness of dual representations as a general view of concept structure. In their study, some of the subjects' membership decisions were more influenced by physical features of the artifacts

than by their functions, so that their results cast doubt on the appropriateness of a conceptual core based on function for artifacts. They conclude that it is unlikely that people hold beliefs about some unknown, hidden features that are the key to category membership for artifacts. Thus, taking into consideration Barton and Komatsu's results (1989), the question remains open as to whether the inherent nature of the entity might be an influencing factor in subjects' construal of it as an animal or as an artifact.

A significant main effect for an animal versus artifact difference would be support for the view that the inherent structure of animals is different to that of artifacts. Perhaps the question stated at the beginning of this section should be re-phrased, to focus upon whether our background knowledge influences subject performance with the two concept structures.

5.04 TASKS AND THEIR INFORMATIONAL DEMANDS

The third factor which might influence people's judgments is the nature of the task itself. The issue being tested asks whether differences in task performance should be attributed to differences in cognitive functions, or to levels of meaning.

A family resemblance theory would predict that similarity judgments and categorization judgments of an everyday object involve the same process. From her research results, Rosch (1973,1975a) inferred that the coherent representation of an ordinary category, and the membership criteria of its items, are based upon the typicality and similarity of its item members. In other words, categorization and similarity judgment tasks are carrying out the same cognitive process, that is, categorization based upon similarity comparison of physical attributes.

In their paper on dual representation models, Medin and Ortony (1989) described similarity acting "as a guide" to categorization decisions. People are said to have beliefs about why objects or creatures appear the way they do, and this information is on a continuum of accessibility. Medin and Ortony (1989) claim that the easiest information to access involves surface appearance and physical features, so that similarity judgments based on this information can be a sort of "quick and easy" heuristic for deciding inclusion in a category. A more

diagnostic categorization involves access to deeper and more meaningful explanations and beliefs, and when this process is employed, people's perceptions of similarity are influenced by their beliefs. Medin and Ortony's (1989) psychological essentialism model seems to formalize Quine's (1977) views on subjective and objective similarities, equating subjective similarity with a judgment of "pure" similarity whilst objective similarity involves explanatory concepts about that physical appearance.

Medin and Ortony's (1989) model claims that the tasks differ only insofar as the ease-of-accessibility to the information, with diagnostic core knowledge being deeper in meaning and so more difficult to access, whilst surface information like similarity of appearance is easier. On the other hand, Rips (1986; 1989) claims that the two tasks differ because they are carrying out different cognitive functions, and his results show dissociation effects (between the two tasks) which support this claim.

In an experiment similar to the "transformation" studies carried out by Carey (1985) and Keil (1989), Rips (1989) used the same underlying logic as Keil (1989), in that he also used transformations to investigate the extent to which people used similarity as a basis for categorization. Unlike Keil, Rips (1989) used adults as subjects. His stimuli were stories of accidental events which happened either to animals or artifacts. Firstly, he presented subjects with stories about imaginary animals which were easily identifiable (as insects, birds, fish); and each of which had undergone either a catastrophe (accidental condition) or a normal maturation-change (essence condition). Either way, there was a change from the animal's original appearance to that of another animal. Subjects were then asked to make three judgments:

(a) whether the animal was more likely to be categorized as a bird (pre-catastrophe or pre-maturation) or as an insect (post-transformation);
(b) whether it was more typical of a bird or an insect; and
(c) whether it was more similar to a bird or an insect.

When the changes were due to an accidental catastrophe, the subjects were likely to agree in their choice of *Bird* (the original concept) for all three judgments. However, when the changes were due to maturational changes, the subjects were likely to make different choices, showing the *dissociation effects* between categorization and typicality/similarity decisions which are indicative

of dual representation models. They said the animal belonged to its original category of *Bird*, but judged it to be more typical and more similar to the *Insect* category. Once again, changing similarity structure did not automatically result in a revision of category identity.

The study shows that the kind of information used for categorization (unseen essential features) can be very different to that used in similarity assessment (overt physical appearance). The attributes or attribute weights which are considered to be *relevant* or *appropriate* in one task (similarity assessment) might be *ir*relevant when another assessment task is being carried out (categorization) (Komatsu, 1992). The dissociation effects found in all three "transformation" studies suggest that, even in natural categories, naturalness and similarity might not be the "glue" which makes items cohere as categories. Core and identification theories (Smith, 1989) explain such dissociation effects as a "division of labour", where the tasks are said to reflect separate cognitive functions, and the ease of doing so depends on the appropriateness or relevance of the information available.

Rips' dissociation effects have been found elsewhere in the research (Armstrong, Gleitman & Gleitman, 1983) and were interpreted by Smith (1989) as evidence for the presence of dual representation in a model. Rips (1989) argued that his results were support for an explanation-based account of conceptual structure, and that, although similarity of appearance may provide some cues to an object's category identity, it fails to provide an adequate explanation for people's perception of what constitutes that object's category identity.

These demonstrations (Carey, 1985; Keil, 1989; Rips, 1989) suggest that categorization is not a function of objective similarity, as described by Quine (1977). Whilst similar entities might be clustered into the same category as a general rule, a context-free, goal-free judgment of similarity does not always predict categorization decisions (Medin, Goldstone, & Gentner, 1993; Ortony, Vondruska, Foss, & Jones, 1985). One main reason for the difference between the two tasks is apparently that pure similarity judgments do not take into account the most *relevant* aspects of a given categorization decision. So, to categorize something as a kind of animal, one must attend to the features that are biologically most important, but to categorize something into a functional category or an event category requires one to emphasize quite different features

which are more appropriate (Barton & Komatsu, 1989). Barsalou (1983; 1987) has shown this repeatedly with his ad hoc categories, where his goal-driven categorization of dissimilar objects can form coherent, comprehensible categories, but only if the relevant attributes can be identified. The studies of Carey (1985), Keil (1989), and Rips (1989), extend this phenomenon to more common, everyday concepts, like *Insect* or *Coffee-Pot.*

The issue tested here, then, is whether the judgment tasks will differ according to the ease-of-accessibility of the information, so that results should show similarity judgments as ranking significantly higher than categorization judgments, because they require deeper access to more meaningful information. The alternative possibility is that performance in the judgment tasks mirrors cognitive functions directly, with different information driving subject performance in the different tasks. In this latter case, dissociation effects would be found, with the similarity assessment task being significantly different from the categorization task.

5.05 HYPOTHESES AND PREDICTIONS

Results from Experiment 2 would suggest that category representation involves meaningful knowledge, as well as structural information. The general hypothesis being tested in Experiment 3 is that similarity-based models do not capture *all* of people's knowledge about categories, that the conceptual core also includes people's beliefs about the unseen reality of an object or creature's appearance. It is also hypothesised that it is this conceptual core of knowledge which will influence people's task performance to the greatest degree, and their performance with animal concepts as compared with artifact concepts. To sum up, the experiment is looking at the nature of the conceptual core of a category. It does this by looking at 3 factors (discussed more fully below) which may play a role in the representation and function of a core.

5.05.1 Story content and the conceptual core

Similarity-based models, as they stand, cannot contain information about operations, transformations and relations amongst properties (Komatsu, 1992). It is argued that, in order to categorize, the core should include *informational content* because it is this which captures people's knowledge about *relations*

between features (Murphy, 1993b; Wattenmaker, Nakamura and Medin, 1988). A list of properties can only partially describe most concepts, which require particular relationships among their attributes to be specified. As Murphy (1993a) argues, a concept is more than the sum of its parts: for example, a car is not the same as a pile of car parts - the relationships among the components are crucial.

It is argued that people are capable of making a number of inferences and causal attributions based upon general knowledge. One example is the puzzle of how to categorize someone who jumps into a swimming pool, in formal evening dress. If the context of this event is set at an evening party, the person is likely to be identified as an *intoxicated person.* In order to do this, the categorizer has to have more than an awareness of physical similarity, and draw upon some knowledge of the world as well, inferring possible explanations for such an action (Murphy & Medin, 1985).

Experiment 3 will test six models of concept representation employing experimental story conditions. The empirical aim is to discover which of the six story conditions will be most effective (as measured by comparison with a control story condition) in persuading a subject to revise his/her original judgment of some object or creature. The dependent variables are subject judgments of typicality, similarity and categorization.

The common theme of the experimental story conditions is transformations. An artifact object or a living creature, as a consequence of some event, becomes so altered as to become very like another object or creature. The nature of the alteration in each experimental condition depends upon the category-model being tested, and what properties of the artifact/animal that model describes as the most important and salient.

It is predicted that if the similarity-based theories are supported, then the experimental story conditions 2 (family resemblance), 3 (core essential features) and 4 (function-part relations) should effect the greatest degree of revision from the original concept across tasks. However, if the explanation-based theories of categorization are supported, then conditions 5 (two tier representations), 6 (core and prototype) and 7 (ideal prototype) should effect the greatest degrees of change in subjects' judgments.

5.05.2 The structure of artifact and animal concepts

Do we use only the external environment as a source of meaning, passively accepting the constraints imposed by the ontological categories in the world? The hypothesis being tested here is that our perceived naturalness of artifact and animal categories is subject to intellectual (as well as ecological) factors. It is hypothesized that people's conceptual core involves more than a representation of the object/animal's metaphysical or environmental structure.

It is predicted that if no significant differences in conceptual revision are found between category-types, that would be support for an explanation-based model, which assumes that it is people's naive beliefs about artifacts and animals which influence their perceptions of similarity between features. Thus, this view's prediction of no significant differences between category-types is based on the assumption that both types derive their information from the knowledge-based content of the conceptual core.

Evidence for differences between people's basic concepts of animals and artifacts has been found by Rosch, Mervis, Gray, Johnson, & Boyes-Braem, (1976), and these are set out in section 2.03.4 in chapter 2. A family resemblance model would predict differences between artifact and animal concepts, because of differences in *perceived* environmental structure (Rosch, 1978).

The classical approach would claim that the defining features which classify a creature are unseen and consist of identifying essences; whilst the defining features which classify an artifact are seen, being either functional, physical or nominal (Schwartz, 1977). The prediction would be for significant differences between the two category-types, because animal concept structure is assumed to use unseen features whilst the artifact concept structure is said to be based upon physical or functional features.

5.05.3 Tasks and information processing

It is argued that people's perceptions of the similarity of objects in a category can be influenced by intellectual factors such as degree-of-knowledge about the category. If such is the case, then task performance cannot be a direct reflection of our cognitive functions, as Rips (1989) might claim. Medin,

Goldstone, and Gentner (1993) have listed a number of studies to this effect, describing how experts' perceptions of similarity (where their particular field of knowledge is concerned) are different from those of novices. For example, novices in the subject of physics tended to classify physics problems on the basis of superficial or surface features, whereas experts will classify on the basis of deeper underlying principles. This difference between novice and expert in *perceived* similarity extends to many areas of expertise, including chess, problem-solving, chemistry, statistics (Chi, Feltovich, and Glaser, 1981). Another study by Murphy and Wright (1984), demonstrated that people with different levels of theoretical sophistication in some area of expertise show related differences in their patterns of similarity judgments. These studies are support for the Medin and Ortony (1989) claim that similarity and categorization tasks differ because of their ease (or not) in accessing the required information. Where Medin and Ortony's (1989) theory implies that intellectual factors influence both perceptions of similarity and categorization decisions, Rips (1989) would claim that intellectual factors influence only the categorization judgments.

But how can we account for the differential weightings (importance) given to the various features of an object during task performance? Rips (1989) might argue that the feature weighting is determined by the task demands, that is, a similarity judgment gives importance to features of similarity, whilst a categorization judgment gives importance to defining features. Thus, if the salience of features in an object is determined by task demands, it is predicted that similarity judgment tasks should be highest in the similarity-based conditions, because that is when information about physical appearance is most relevant and important. Also, it is predicted that categorization judgment tasks should be highest in the explanation-based conditions, because the latter provide diagnostic information which is important for the task of membership decision.

Alternatively, it is possible that, as Medin, Goldstone, and Gentner (1993) claim, both judgment tasks are subject to intellectual factors such as naive beliefs about why certain artifact objects or creatures should be similar to one another. In such case, the similarity judgment rankings can no longer be taken as measures of "pure" physical similarity. In such case, it is predicted that similarity judgments will be high in the explanation-based conditions also.

5.06 METHOD

Participants

Seventy university college residents chose to participate in the experiment, with subjects' age ranging from eighteen to fifty-five years. All had a competent knowledge of the English language. Data from all 70 participants was used in the analysis. People were divided randomly into seven groups of ten each, arranged in a Latin-squares design.

Design:

The independent variable consisted of 14 stories, that were divided into two category-types: 7 were concerned with some artifact object and 7 involved a living being. Each story had seven conditions, which consisted of one control and six experimental. The control condition simply described the original artifact object or living entity. The six experimental conditions were variations upon a basic theme which was that of change: the original artifact object or living entity undergoes a transformation of some sort. As a result, the stories vary as to the descriptions of the change, the explanations for it, and its consequences. Apart from the baseline (control) condition, each of these six experimental conditions is meant to test a different model of category representation. A description of the seven conditions, together with example stories, are placed in Appendix G. Examples of the instructions and practice booklets provided for participants are attached in Appendix H. All the stories used in the task booklets of Experiment 3 are attached in Appendix I.

The dependent variable consisted of judgment rankings of similarity, categorization and typicality. The experimental conditions consisted of story narratives, whose common theme was one of transformation in either an animal or an artifact object, and which the animal or artifact had undergone *as a consequence of* the events described in a story. The manipulated information in the story-text consisted mainly of changes in the creature/object's description (e.g., physical features, functional features, essential features). Each person performed three tasks: similarity, categorization and typicality judgments. For example, upon reading a story, persons were required to assess whether an artifact object or the animal in the story, was now more similar to its original category identity or to a new category identity. The task consisted of selecting a value from 1 to 6. 1 signified no change at all from the original identity, and 6

signified complete transformation into the new identity. The artifact/animal's original category was set under 1, and the artifact/animal's new identity was set out under 6. A scale was provided under each ranking continuum, and varied according to task. An example of a story in the control condition 1, and in the family resemblance experimental condition 2, and the scales used for the three tasks related to it, is listed hereunder:

> Story Item Two: Swan to Bat (Condition One):
> The Tarp is a warm-blooded creature. It has snowy white feathers on its wings, and a graceful head. The Tarp likes to paddle in rivers and lakes with webbed feet.
>
> Story Item Two: Swan to Bat (Condition Two):
> The Tarp is a warm-blooded creature. It has snowy white feathers on its wings, and a graceful head. The Tarp likes to paddle in rivers and lakes with webbed feet.
>
> One day, a Tarp called Henty was caught in a trap. Some time later,
> Henty grew large flappy ears.
> His wing surfaces became rough and brown.
> His feet now resembled strong, clawlike fingers.

(a) Typicality assessment task:
1 Good example of a Swan; 2 Fair example of a Swan; 3 Poor example of a Swan; 4 Poor example of a Bat; 5 Fair example of a Bat; 6 Good example of a Bat.

(b) Similarity assessment task:
1 Very similar to a Swan; 2 Rather similar to a Swan; 3 Barely similar to a Swan; 4 Barely similar to a Bat; 5 Rather similar to a Bat; 6 Very similar to a Bat.

(c) Categorization task:
1 Certainly a Swan; 2 Probably a Swan; 3 Possibly a Swan; 4 Possibly a Bat; 5 Probably a Bat; 6 Certainly a Bat.

If a participant were exposed to the same story in each of its seven conditions, the ease or difficulty of assessment might bias the data. Consequently, it was necessary to vary across participants the actual stories testing a condition. For this reason, a latin squares design was used to allocate people to story items. Thus, instead of giving everyone only the one story varied seven times, there were 7 stories about animals plus 7 stories about artifact objects, making a total of 98 story items in all.

The Latin squares design consisted of 7 groups of 10 people each. In each group, the story item conditions were printed in the same sequence for all three tasks, so it was necessary to avoid practice effects or the possibility of some meaningful continuity between one story item and the next. To avoid this, participants in the same group were given randomly one of ten possible sheets on which was printed a sequence of conditions (for example, artifact story condition 7; then natural story condition two, then artifact story condition 4, et cetera), and requested to follow this sequence in completing their tasks. The sheets were allocated to persons within groups on a random basis. Consequently, each person in a group fulfilled the same story item conditions, but did so in a different sequence of conditions.

Materials:

A participant received the same stories for all three tasks. Stories and questions were divided up into booklets according to task-type, and the whole of a person's material was not stapled together until the end of the experimental session. Otherwise, it would have been difficult to randomly vary the sequence within groups, both of tasks performance and the sequence of fulfilling the conditions. Practice booklets were different to the experimental booklets in that they consisted of a mixture of artifact and natural entities based stories, while the objects and entities undergoing transformations were different to those mentioned in the experimental booklets. All 70 participants received the same practice booklets. See Appendix H for a description of these booklets.

The experimental manipulations in the various stories each tested a different model of category coherence. The stories (apart from those in the control condition) had a basic theme: they all described something happening to an animal or an artifact object, which resulted in a change in its appearance, essence or function. In some conditions, the story included an explanation for the occurrence. The stories were constructed to test each of the seven concept models described in section 6.02. A description of how the stories were constructed is included in Appendix G, and the actual stories are in Appendix I.

Procedure:

Participants were tested three or four at a time in a large room, sitting alone so that answers could not be compared or influenced. They completed the three judgment tasks at their own speed, in the one session, with the experimental session generally lasting no longer than 75 minutes. Upon arrival,

participants were given the practice sheets and a brief introduction by the experimenter, to the effect that this was *not* an intelligence test, there were no right or wrong answers, but was rather a collection of people's opinions. Then the practice sheets for the particular task were handed out, which had the instructions printed at the top of the page. Participants were encouraged to ask any questions about the instructions or how to answer the practice questions, but were informed that advice on *what* to answer could not be given. Participants were also requested to express any hesitation about doing the task now that they saw what it entailed, but no one refused to carry on.

Upon completion of the practice booklet, and after any questions were discussed, participants were given the experimental booklet for whichever task was being completed first of the three (for example, the similarity judgment task). Each person in the group was given a sheet with a list of different sequences for fulfilment of the seven condition questions. Upon completion of the task, the experimenter put this booklet aside and handed out the second practice booklet for the second task (for example, typicality judgment task). After the second experimental booklet had been completed and put aside by the experimenter, the same procedure was followed for the third task (say, categorization decision).

The order in which the three tasks were completed was varied across the seven groups of participants. Upon final completion, each person's data were stapled into the one booklet. Any comments and impressions about the stories were encouraged and discussed, and if the participant found a particular story item to be absurd, a brief note of the experimental condition was made on the individual's booklet.

5.07 RESULTS

The data-analysis considered three questions concerning factors which influence people's judgments. As well as the factor of story content, the analysis is carried out on data from task-types (typicality, similarity and categorization judgments) and concept-types (artifact or animal).

(1) Which one of the six experimental story-conditions (and thus which concept model) best reflects the criterial information or knowledge which

constitutes a conceptual core, whether it be explanatory beliefs, essential features, functional relations, details of physically similar features, et cetera? It is hypothesized that the judgment means, when compared, will be a measure of how close to the conceptual core, how deep, that concept model is.

(2) The structure described in the different concept models might favour an animal or artifact concept. For example, the information contained in stories consisting of family resemblance information might favour an animal concept because they are based on physical features. It is hypothesized that the conceptual core might influence a person's perceived "naturalness" (or lack of it) in the artifact/animal concept structure.

(3) The information required to process a task, if it is not present or less accessible in some models, may result in lower judgment ratings in that story condition. Can task-demands influence subject performance? Secondly, which of the six concept models have a dual representation?

Rips (1989) found dissociation effects between judgments of category membership and similarity to another animal, which he interpreted as evidence for a division in cognitive labour, with similarity judgments requiring physical appearance information from a concept and membership decisions requiring diagnostic criteria. If such dissociation effects are found here, they would indicate that categorization is a totally different process (using different information) from that of similarity or typicality assessment. It is also hypothesized that the degree of change might be influenced by task-demands, so that similarity tasks achieve higher revision in similarity-based conditions such as family resemblance, and categorization tasks achieve higher revision in explanation-based experimental story conditions.

To assess these three questions, a 2 (category-type) x 3 (task-type) x 7 (story-type) Manova (repeated measures) was used to analyze the data. The mean rating scores for the control condition (C1) and each of the experimental conditions (C2 - C7) are presented in Table 15.

Grouping variable

A grouping variable of seven groups, with ten participants each, was introduced to control for order effects in the presentation of the various story conditions, and incorporated in a Latin squares experimental design. This

participants-groups category variable was found to have no significant effect, where F (6,63) = 0.405; $p > 0.05$. Since no significant differences were found between these groups, they were not taken into further consideration.

Table 15: Mean rating scores from Manova in seven conditions

	Animal categories.			Artifact categories.		
Cond**	Typic*	Simil*	Categor*	Typic*	Simil*	Categor*
C1	1.371	1.429	1.471	1.286	1.186	1.229
C2	4.414	4.757	4.486	4.357	4.543	4.400
C3	3.100	2.900	3.043	3.500	3.129	3.243
C4	3.800	3.814	3.643	3.643	3.686	3.329
C5	4.829	5.000	4.757	4.743	4.814	4.747
C6	4.429	4.657	4.457	4.286	4.600	4.300
C7	3.229	3.157	3.200	3.571	3.643	3.571

* Tasks: Typic=Typicality; Simil=Similarity; Categor=Categorization
** Story conditions and their concept models:

C1	control condition
C2	family resemblance
C3	essence
C4	functional relations
C5	two-tier representation
C6	explanatory core + prototype
C7	ideal prototype

Category by Task by Story Interaction

Within subjects, the three-way interaction was found to be not significant, with F (12,756) = 0.670, $p > 0.05$.

Category by Task Interaction

Within subjects, a significant interaction between category and task was not found, with F (2,126) = 0.354, $p > 0.05$.

Category by Story Interaction

Within subjects, the interaction between category and story was significant, with F (6,378) = 3.002, p=0.007. This result indicates that at least some of the means in the seven story conditions differed from each other on the basis of whether the story-context concerned an animal or an artifact. The mean rating scores from the Category x Story interaction are set out in Table 16.

Overall, the lack of a significant main effect in the Category factor indicates that the structure of animal concepts is not based on some inherent or essential "naturalness" which automatically differentiates it from the structure of an artifact concept. On the contrary, the significant interaction between the Category and Story factor indicates that subjects construe an animal or artifact concept on the basis of the information or knowledge contained in the story-context.

Table 16: Mean ratings as a function of Category and Story, across judgment tasks, and arranged in order of increased mean.

Condit*	Concept-Model	Animal	Artifact	Total
C1	control	1.42	1.23	1.32
C3	essence	3.01	3.29	3.15
C7	ideal prototype	3.20	3.60	3.40
C4	functional relations	3.75	3.35	3.55
C6	explanatory core, prototype	4.51	4.40	4.45
C2	family resemblance	4.55	4.43	4.49
C5	two-tier representation	4.56	4.77	4.66

* Story conditions

Task by Story Interaction

Within subjects, the interaction between these two factors was significant, with F (12,756) = 3.384, p=0.000. This indicates that the story-effect across the seven conditions differed greatly depending upon which task was being performed. The mean rating scores from the interaction are set out in Table 17, where it can be seen that, with one exception (in condition 3), the similarity judgment task showed a trend towards the highest means of all three judgment tasks. Newman-Keuls post-hoc comparisons between the task means were carried out, and this trend was found to be not significant overall. One exception was the case of condition 4 (functional relations), where a significant difference was found between the similarity and categorization task means (mean difference = .28, Wr = 279).

Figures 3 and 4 give a visual representation of the variables included in Table 17, with the means divided into the animal (Figure 3) and the artifact (Figure 4) stories respectively. Figures 3 (animal concepts) and 4 (artifact concepts) show subject performance in the three tasks in all 7 conditions. As can be seen in both figures, there is little difference between condition 2 and condition 6. Both

figures suggest the presence of a possible dissociation between tasks in conditions 4 and 6, and this was confirmed by the post hoc tests.

Table 17: Mean rating scores as a function of Task and Story with six conditions (C2 to C7) arranged in order of increasing importance of the information contained in their conceptual core. Importance is measured by the mean score elicited by each judgment task.

Con**	Concept-Model	Typic*	Simil*	Categ*	Total
C1	control	1.33	1.31	1.35	1.33
C3	essence	3.30	3.01	3.14	3.15
C7	ideal prototype	3.40	3.40	3.38	3.40
C4	functional relations	3.72	3.75	3.49	3.55
C6	core and prototype	4.36	4.63	4.38	4.45
C2	family resemblance	4.38	4.65	4.44	4.49
C5	two-tier representation	4.79	4.91	4.76	4.66

* Tasks: Typic=Typicality; Simil=Similarity; Categ=Categorization
** Story conditions

Factor A: Category-Type

Within subjects, differences between animal and artifact categories were not significant at F (1, 63) = 0.008, $p > 0.05$. As can be seen in Figures 3 and 4, there is little difference between the two variables of artifact and animal.

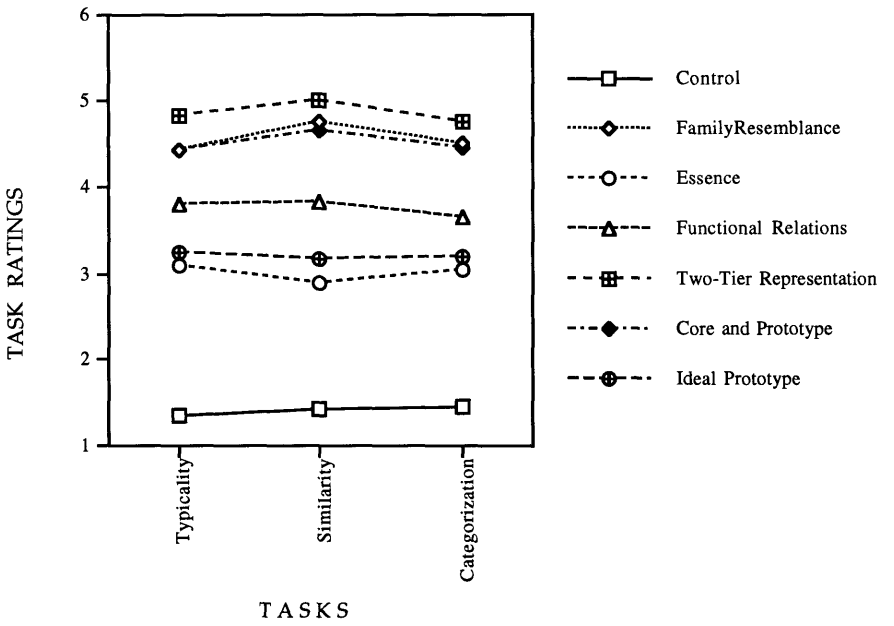
Factor B: Task-Type

Differences between the three judgment tasks (typicality, similarity and categorization) were not significant at F (2,126) = 2.142, $p > 0.05$.

Factor C: Story-Type

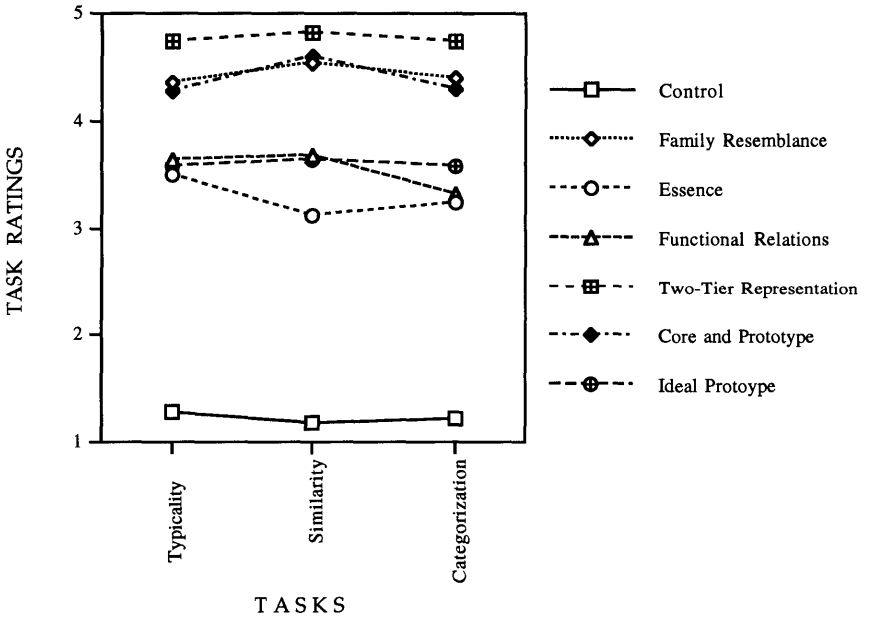
The seven story conditions differed significantly in their mean rating scores, with F (6,378) = 215.311, $p = 0.000$. A very strong main effect was found for the story type, indicating that certain details or information (as contained in the six experimental story conditions) are more relevant to the concept core than others. Figures 3 and 4 illustrate the various experimental story conditions in relation to one another, and in relation to the control condition.

Figure 3



Animal Concepts: Mean Rating Scores
for three tasks in seven conditions

Figure 4



Artifact Concepts: Mean Rating Scores
for three tasks in seven conditions.

To answer the first question asked at the beginning of the Results section - which of the six concept models best portrays the criterial information contained in the conceptual core - the concept models are ordered according to ranking in the Total column of Tables 2 and 3, beginning with the smallest mean ranking, as expected, in the control condition (C1) whose story portrayed a description of the original concept, but no alterations occurring to it. The same order of concept models (based on importance of criterial information as measured by high to low rankings) was found in each of the three judgment tasks and in each of the two category-types. Post hoc comparisons conducted between the control and each experimental condition showed that each concept model effected a significant change in subject performance across all three judgment tasks. Condition 1 (control) was found to differ significantly from condition 3 (mean difference = 1.825, Wr = .547), from condition 7 (mean difference 2.075, Wr = .654), from condition 4 (mean difference = 2.225, Wr = .717), from condition 6 (mean difference = 3.13, Wr = .763), from condition 2 (mean difference = 3.16, Wr =.796), and from condition 5 (mean difference = 3.34, Wr = .824).

Explanation-based models (conditions 5, 6 and 7) had been predicted to elicit higher judgment ratings than the others (conditions 2, 3 and 4) but this prediction was not supported in such a clear-cut fashion. A post-hoc comparison of means was carried out, using a Newman-Keuls criterion of critical differences. This particular post-hoc test was chosen because it gives indications of sub-sets of conditions (Howell, 1987). The post-hoc comparisons were conducted on the means from the six experimental conditions, where two main sub-sets were found. Story conditions 3, 4 and 7 formed one sub-set where results did not differ significantly from each other, but they did differ significantly from story conditions 2, 5 and 6, which constituted the second sub-set. More specifically, condition 3 was found to differ significantly from condition 2 (mean difference = 1.34, Wr = .763), from condition 6 (mean difference 1.305, Wr = .717), and from condition 5 (mean difference = 1.515, Wr = .796). Also, condition 4 was found to differ significantly from condition 6 (mean difference = .905), from condition 2 (mean difference = .94, Wr = .654), and from condition 5 (mean difference = 1.115, Wr = .717). Finally, condition 7 differed significantly from condition 6 (mean difference = 1.055, Wr = .654), from condition 2 (mean difference = 1.09, Wr = .717), and from condition 5 (mean difference = 1.265, Wr = .763).

To answer the second question, Newman-Keuls post hoc comparisons of means showed that the animal and artifact means in all six experimental story

conditions were significantly different from the control condition, suggesting that participants revised their judgments to a significant degree in each concept model. However, no significant differences were found between the animal/artifact variables, though a trend was revealed in all experimental conditions for the artifact concepts to elicit a greater revision in judgment (as compared with the control) than the animal concepts elicited. The only exception to the trend was condition 4, where the greatest revision occurred with the animal stories. Post-hoc tests also revealed that the six experimental story conditions divided into two sub-sets, with the story conditions in each sub-set not differing significantly from one another. The first sub-set consisted of conditions 3, 7 and 4 (artifact stories); whilst the second sub-set consisted of conditions 2, 5, 6, 4 (animal stories). Newman-Keuls post hoc tests revealed significant differences between the two sub-sets.

From the presence of the two sub-sets, it would seem that participants did not construe their animal concepts differently from their artifact concepts, but they used the information contained in the story conditions in at least two main ways, although exactly what aspect of the stories it is which influences their perceptions remains unclear. All the stories in Conditions 3 (essence) and 7 (ideal prototypes) seem to be similar in that they deal with unseen properties, that is, abstract ideas. Even in the artifact stories of Condition 4 (functional relations), whilst they involve physical object parts, the focus is on the functional relations between them rather than their physical appearance. It is concluded that the models in this first sub-set were construed by participants as abstract concept structures.

This did not seem to be the case from the second sub-set which included condition 2 (family resemblance), condition 5 (two tier representation) and condition 6 (explanatory core and prototype). It also included the animal stories of condition 4 (functional relations). All the stories in these conditions involved physical appearance to a greater or lesser degree. It is concluded that the models in this second sub-set were perceived by participants as having conceptual structures which were more concrete, that is, derived from the outside environment.

To answer the third question, Newman-Keuls post hoc comparisons were run on the means from the three judgment tasks, in all seven conditions. These revealed that, when compared with the control condition, all tasks in each

experimental condition increased significantly. To look at the second part of the question, which asked about possible dissociation effects between similarity and categorization (which would indicate dual representation), post-hoc tests were carried out in each of the six experimental conditions separately, comparing performance in the three tasks of the control condition and the three tasks in the experimental condition. If any relevant sub-sets amongst the means for the tasks were found in an experimental condition, this would be taken as evidence for the presence of dissociation effects between tasks.

Newman-Keuls post-hoc tests revealed that judgments by participants in each task of each experimental condition significantly increased in rankings, as compared to the control condition. When possible sub-sets among the tasks were searched for, it was discovered that the three judgment tasks did not significantly differ from one another in most experimental conditions, *with the exception* of story conditions 4 and 6. In story condition 4, categorization differed significantly from typicality judgment (mean difference = .25, Wr = .234), and from similarity judgment (mean difference = .28, Wr = .279), with typicality and similarity forming a sub-set. In story condition 6, categorization was found to differ significantly from similarity judgments (mean difference = .25, Wr = .234).

To summarise the findings from this section, it would seem that explanation-based concepts are the most powerful in influencing participants' judgment tasks, as story condition 5 (two-tier representation) achieved the greatest degree of change when compared with its control condition. Since condition 2 (family resemblance) came a close second with condition 6 (explanatory core and prototype), however, it would seem that the importance of physical appearance is not to be discounted as a large part of the content of conceptual cores.

Although no significant main effects were found for either task-type or category-type, both interacted significantly with the story factor, suggesting they were subject to the informational content of the stories (in the case of tasks) or subject to the structure of the model (in the case of animal/artifact concepts). Dissociation effects between tasks were found in two of the concept models, condition 4 (functional core and prototype) and condition 6 (explanatory core and prototype), suggesting that participants were employing dual representations when dealing with these two story conditions.

5.08 DISCUSSION: INTERPRETATION OF RESULTS

Experiment 3 concerned the examination of variables that have been involved in the similarity-based versus knowledge-based issues of coherence. It compared the animal and artifact variables; the means from three judgment tasks; and six experimental story conditions with a control condition. The results provide converging evidence against similarity of appearance as a *complete* account for the coherence of a concept, but it does exert a very strong influence. The various factors and their evidence will be considered separately hereunder.

The first question, stated at the beginning of the Results section, asked what kind of information constitutes the conceptual core. The Totals columns in Tables 16 and 17 both show the order of importance of the criterial information contained in the six concept models. The hypothesis predicted that conceptual knowledge consists of more than similarity-based representativeness. Also, the explanation-based story conditions were expected to elicit a higher degree of revision of the original concept (than the stories in the classical condition or the similarity-based condition). This prediction was partially fulfilled, with story condition 5 (two-tier representation) resulting in the greatest change in the concept, whether the task consisted of typicality, similarity assessment or categorization decision.

It could be argued that the explanation-based story conditions achieve stronger results because they are providing more information upon which persons can base their judgments. Logically, a prediction could be made that the degree of judgment change increases as a function of the quantity of information provided in the story condition. Since condition 5 provided the longest text in its story conditions, this interpretation could be a possibility. This was not the case (as the order of conditions listed in the Results section showed), with condition 2 (family resemblance) describing only a few physical details, yet achieving as large a change in judgment as did condition 6, which involved explanatory core and prototype representation.

Also, not all the explanation-based story-conditions elicited such a high degree of revision, with condition seven (ideal prototypes) achieving a lower degree of revision after the two similarity-based models (family resemblance; function-part relations). The answer to the first question stated at the beginning of the Results section, then, could not simply be that the criteria described by

explanation-based models were more important than the criteria proposed by similarity-based or classical models.

The post hoc tests run on the means of the six experimental story conditions revealed that they formed two sub-sets, with conditions 3, 4, and 7 forming one sub-set; and conditions 2, 5 and 6 forming another sub-set. These sub-sets of concept models do not match the hypothesized ones, so it cannot be concluded that people's conceptual cores are a simple dichotomy of either similarity comparisons or explanatory constructs. In order to draw some conclusions about how people prefer to construe their concepts, and which models provide a better account of what the conceptual core might be, the story conditions in one sub-set are compared with those of the second sub-set.

5.08.1 Two-tier representation versus ideal prototype

Condition 5 (two-tier representation) achieved the greatest degree of change in people's judgments, as compared to their original judgments of the animal or artifact described in the control condition. The stories are modelled on Michalski's (1989; 1993) account of a BCR (basic concept representation) which is processed intuitively according to an ICR (inferential concept representation). The stories give an implicit explanation (consisting of implied intentions or needs of the animal or artifact) for the alteration which occurs to a physical function-part of the entity, and transforms its functions. It would seem from the results analysis that the most important knowledge in a conceptual core consists of information (BCR) which allows implicit inferences to be drawn (ICR) which will explain a transformation of function in an animal or artifact.

Since Michalski (1989; 1993) claims that the BCR consists of both general and specific information, including constraints such as examples, counterexamples and exceptions to the rule, this account of a conceptual core seems to be far too general to be of much use. The strength of the concept model seems to lie in its incorporation of implicit knowledge and people's use of implicit inferences. The stories in this condition did not involve overt explanation, as they do in condition 6. When this story condition 5 is compared with story condition 7 (ideal prototypes), it can be seen that implicit knowledge, which elicits the strongest revision in participants' judgment, is most effective when it involves other people's goals or intentions, or the mechanical needs or potential of artifacts.

The stories in condition 7 are also based upon unstated knowledge, so that to complete the animal judgment tasks here, the participant would have to make use of the lay knowledge that parents and their offspring share a common genetic structure or essence. In the case of the artifact stories, participants would have had to make use of the notion that marketing of goods is driven by the laws of supply and demand. This is common, lay knowledge, but it was unstated in the stories of condition 7, and consequently, participants' revisions of their original judgments in the control condition were not great. Participants found the stories too inferential to understand easily, and a number of them, when asked if any of the stories were difficult, invariably replied that they were rather puzzled by the stories in this condition.

Generally, then, people seem to find it easiest to draw upon implicit knowledge concerned with goals, desires, intentions, needs, when they need to understand and judge a concept. They find it more difficult to make use of unstated knowledge which, even though it might be commonly known, involves abstract ideals such as the one that parents and offspring should resemble one another.

5.08.2 Physical appearance versus unseen essence

The stories of condition 2 achieved the second highest revision of their original judgment as elicited by the control condition, yet the stories involved the transformation of only a few physical features. The stories of condition 3 also involved very little detail, that is, they concerned transformations to unseen, essential features (for animals) or to abstract operating principles (for artifacts). These stories achieved the lowest revision of judgments across all the experimental story conditions. Consequently, it must be concluded that the conceptual core which is proposed by classical essentialism models does not come even close to a psychologically real account of how people understand the world around them. Apparently, physical appearance alone can have a strong effect, but not unseen details such as essence or abstract operating principles.

5.08.3 Functional relations core versus explanatory core

The stories in condition 4 (function-part relations) were modelled on Tversky and Hemenway's (1984) theory of function-part relations, which

proposes a prototype consisting of physical parts and a core consisting of information on the functions of those parts. The stories described an alteration to a physical part, then stated an alteration to a function related to that part. The conceptual core of this model does not involve explanations based on beliefs about the world, but rather it consists of functions which define an artifact or an animal. This kind of conceptual knowledge, when altered, did not achieve as high a revision of original judgment as did the stories in condition 6, which was also a core and prototype model.

In the case of condition 6, the core involved explanatory concepts and beliefs. The stories which modeled this conceptual core were based in situational contexts which might elicit from participants the kind of contagion reasoning and homeopathic solutions described in chapter 1. For example, an animal (through standing too close to another animal) might catch a virus which transformed its genetic structure. Results showed that these kinds of stories elicited a high revision in the original judgments, who found it easy to assess the creature or object as having been transformed into another creature, et cetera.

From this comparison of story conditions 4 and 6, it is concluded that, whilst people find a functional, defining core to be important when assessing an object or creature, they find the kinds of explanations involving beliefs and the use of common background knowledge to be much more compelling when revising a judgment. This evidence supports explanatory concepts and background knowledge as being central to people's conceptual cores.

To summarise the main findings concerning the story factor, then, it is concluded that the *quantity* of information contained in the stories was not the all-important determinant of judgment revision. Instead, three models seem to come closest to what knowledge might constitute a psychologically real conceptual core. First, people seem to easily draw inferences about new functions from their implicit knowledge about people's desires and goals; or of an object's mechanical requirements. They find this kind of information-change so important that they revise to a significant extent their original assessments of the creature/object's category identity, its typicality and similarity. Secondly, the results support the hypotheses that conceptual cores consisting of explanatory beliefs are also important, with participants easily inferring explanations based on the kind of contagion reasoning and homeopathic solutions depicted in the stories of this condition. Thirdly, whilst condition 4 did not involve

explanations, the informational content in these stories allowed relations to be drawn between object-parts and their functions. Finally, results from the story factor provide support for the claim that the most important role of a conceptual core is to enable this drawing of relations, inferences, and explanations (Komatsu, 1992; Murphy, 1993a; 1993b). In order to do this, the core should have *informational* content as well as *structural* content (Wattenmaker, Nakamura and Medin, 1988).

The second question posed at the beginning of the Results section concerned the category-type factor, and asked if participants' performance might not be influenced by the structure of the concept, being that of an animal or an artifact. In other words, participants' perceptions of the stories, and as a result, their assessment of change from the original concept, might be influenced by whether an animal or an artifact object is involved. The prediction stated by structural theories of concepts, such as classical essentialism or family resemblance, was that significant differences would be found between the animal and artifact variables. The data analysis results did not support this, since no significant main effects for the category factor were found. On the other hand, the hypothesis proposed by models of explanation-based concepts was supported. A significant interaction was found between the category and story factors, indicating that it was participants' perceptions of the animals or artifacts which were influenced by the story conditions.

If significant differences had been found between animal and artifact types, that would be support for the argument that biological categories draw their coherence from the "natural discontinuities" inherent in the environment (Rosch, 1978). These results indicate that the external environment and its structure is not the only source of meaning, and that participants did not passively accept the constraints imposed by its "natural discontinuities". The finding has implications for a problem discussed by more recent researchers like Wattenmaker, Nakamura and Medin (1988): where do the *relevant* features come from, if choice of features is not constrained solely by the natural environment? It would seem that our beliefs determine our choices of what features to consider relevant during similarity comparisons, or membership decisions, and this was investigated further by the task-type factor, and its results are discussed below.

The third question, stated at the beginning of the Results section, asked whether people's performance in tasks would be influenced by task demands (for example, similarity comparison is best carried out when similarity information is available) or by intellectual factors (for example, explanatory beliefs influence our perceptions of what is/is not similar). Figures 3 (animal) and 4 (artifact) both show the degree of revision in participants' judgments, as measured by comparison with the control condition. As can be seen, participants significantly revised their original judgments in all three tasks carried out in the experimental conditions. The hypothesis predicted that, if task demands was the answer, then significant differences would be found between the tasks carried out within the same experimental story condition, with similarity assessment tasks ranking particularly high in concept models which involve details of physical appearance.

This hypothesis was not supported, as the data analysis did not result in a significant main effect for the task factor. Also, similarity judgment tasks invariably scored the highest revision means in all of the concept models, with the one exception of story condition 3 (unseen features). The results supported the hypothesis derived from Medin and Ortony's (1989) view of similarity, that is, that it is our beliefs and background knowledge which influence our perceptions of what is similar, and that similarity need not always involve similarity of physical features. A significant interaction between the task and story factors was found, suggesting that the depth of meaning contained in the information of the conceptual core influenced subject performance in the tasks.

A related question involves the presence of dissociation effects, which Rips (1989) suggested were a sign of dual representation in how people understand the world around them. Although condition 5 reflects an explanation-based concept model, Michalski (1989; 1993) described his model as a single representation consisting of two tiers, rather than a dual representation. The fact that the post hoc tests failed to find dissociation effects between the tasks in this experimental condition would support Michalski's description of a single representation. On the other hand, post hoc tests revealed two concept models which did have dissociation effects between tasks, condition 4 (functional core and prototype) and condition 6 (explanatory core and prototype). In both conditions, the categorization task and the similarity task were found to belong to separate sub-sets of means, and it is concluded that this indicates that the two tasks were accessing separate knowledge representations.

To summarise the main findings concerning the task factor, the results support the hypothesis of Medin and Ortony (1989) and of Medin, Goldstone and Gentner (1993), and rejects the notion that participants carrying out their judgments are constrained by task demands. In other words, the nature of the task did not decide how it was cognitively processed. For example, such a claim would mean that similarity judgment tasks involve data-driven processing where perceptual input is the only information taken into consideration; whilst categorization tasks involve theory or concept-driven processing where intellectual factors only are considered. The presence of the significant interaction between task and story indicates that the similarity judgment tasks were subject to intellectual influences also, such as would be found in the explanation-based conditions. The latest research seems to be describing similarity as something which is *constructed* by a particular person with particular goals in a given context, rather than something which is given by the perceptual stimuli from the environment (Hampton & Dubois, 1993). That is what seems to have happened in condition 6, where information other than purely physical appearance was provided. In condition 4, similarity might have been construed according to the defining features of the functional context.

5.09 IMPLICATIONS FOR THESIS QUESTIONS

The question asked in this experiment is: if people's perceptions of similarity are so flexible, how do items cohere as a category, and where does stability of the conceptual core come from? The similarity-based models have looked to world structure and its ontological categories as the source of stability, but the newer explanation-based models do not depend wholly upon environmental constraints for conceptual stability but include intellectual factors also (Neisser, 1987; Murphy, 1993a, 1993b; Wattenmaker, Nakamura & Medin, 1988). It has been suggested that both environmental and cognitive constraints may be present, with similarity-driven induction being subject to environmental constraints and explanation-driven induction being subject to cognitive constraints (Murphy, 1993b; Wattenmaker, Nakamura, & Medin, 1988). The results of experiment 3 do not support this, although they do not entirely reject it either, since dissociation effects between tasks were found in two of the story conditions.

Medin and Ortony (1989) have answered the question by suggesting that it is the role of the core representation to provide an "anchoring" function during diagnostic categorization tasks; whilst the prototype representation of the concept serves for similarity judgments and as a heuristic whenever a speedy categorization is required. Stability of structure, then, would also rest upon this "ultimate arbiter" core, because the core is separate from perceived similarity with its concomitant flexibility and instability. By suggesting a core composed of an individual's naive beliefs about the world, the advocates of the explanation-based approach ensure that the relevance of membership criteria is constrained by something more flexible than purely environmental, structural constraints.

In conclusion, it would seem from these results that how we believe the world to be (in other words, our reality) does not necessarily have to be determined by its physical appearance. On the contrary, our perceptions of similarity can be influenced by what we know about that object and its relations with the rest of its environment, because we use our beliefs to interpret appearance. However, the nature of beliefs and other knowledge structures which influence concepts still lacks explicit specification, especially in the matter of mental representation. The term *theory* or *explanation* used in this experiment could equally apply to scripts, frames, mental models, schemata and goals, and some of these were used in the experimental conditions. However, theories as a basis for conceptual stability have been criticized because of this lack of specificity. The proposal that ordinary, everyday concepts might be represented as beliefs (as for scientific theories) and embedded in theories needs to be more explicit to avoid circularity of theoretical explanation (Komatsu, 1992).

CHAPTER SIX

CONCLUSION

6.00 CHAPTER OVERVIEW

The aim of this chapter is to present answers to the two questions posed by the thesis, and from them draw some conclusion about how people organize and comprehend their world. Section 6.01 summarizes the main findings of the thesis.

Section 6.02 describes the main findings of the thesis with regard to the first question (why do concepts arise), and describes the main conclusions that follow. The section discusses the results from the empirical studies of the thesis with respect to whether or not our concepts arise as a result of the already-existing categories in the environment. The possibility that our conceptual representations reflect the metaphysical structure of the environment was not supported by the results of Experiment 1, and the possibility that they arise from its physical structure was only partially supported by the results of Experiment 2. These experiments eliminated the structure of the environment (be it metaphysical or physical) as the sole basis for concepts. However, in Experiment 2, the small size of the semi-partial correlations between predictors and criterion for representation, would indicate that a third factor was at work during categorization, and the possibility that it was theoretical knowledge was tested in Experiment 3.

Section 6.03 describes the main findings of the thesis with regard to the second question (why do we have the categories we do, and not others). It is concluded that we have the categories we have because our theories of the world dictate what *appears* similar to us. In short, we have certain categories (and not others) as a result of the concepts we construct about the objects and creatures in our world. Based on the results of Experiment 3, it is concluded that a person's concept of a category arises through his or her beliefs and theories which explain the outside world, such as the creatures and objects in it. More specifically, it is pointed out that, as the stories based on the two-tier representation model showed, people can draw inferences about an object's or creature's category identity on the basis of their background knowledge of functions, needs, and appearance.

Section 6.04 argues that the general purpose of concepts is to intentionally understand the world around us, using concepts to build up our knowledge. More specifically, by incorporating the properties of stability, coherence and flexibility into their theories, explanation-based views of concepts and categories can provide an account of a concept's functions. This section looks at some of the unexpected findings of the empirical studies, and attempts to draw conclusions about them by using an explanatory-based account of concepts. The main conclusion is that, in order to attain some degree of plausibility, concepts need to include some subjective knowledge (as well as normative) into their content.

The section also looks at some of the drawbacks (subjectivism and relativism) inherent in a "constructivist" theory of concepts which sees their main function as one of serving to actively construct reality. Theoretical resolutions suggested by Goodman (1984) are discussed.

6.01 SUMMARY OF THE MAIN FINDINGS

The results of Experiment 1 showed that all three category-types had graded structure, with differing degrees of gradience across their levels of production frequency. The superordinate types had the steeper gradience in that more of their ten levels were significantly different from one another, than in the other two types.

The results of Experiment 2 did not support the four assumptions made by the Unitary View's approach to categories, their representation, structure and process. In the study, participants were shown to have dual representation of the categories, storing more than one kind of information about them. Their categories had clear-cut boundaries, and their items were not categorized in a single, one-stage decision process. Overall, these results support a Binary View of categories, which holds that categories are the result of concepts and theories we have about the world.

This possibility was tested in Experiment 3, which showed that participants found the most relevant information about animals to be concerned with goals, needs and preferences, whilst about artifacts, the information concerned their functions and abilities. Contrary to prediction, the study found

no differences between the importance of physical alterations (condition 2), and explanations for those physical alterations (condition 6). Since the claim is that the conceptual core consists of theories and beliefs about a category, then condition 6 should have achieved a greater rate of change in people's judgments (as compared to the control condition), than what was achieved in condition 2. However, the prediction that explanatory-based conditions would elicit differences in performance between the judgment tasks was upheld. Post hoc tests did indicate that, in condition 6, participants were using physical information for similarity judgments and explanatory information for categorization judgments. This was not the case in condition 2, where solely physical appearance was described, and people showed no differences in performance among the three judgment tasks.

6.02 HOW DO CONCEPTS ARISE?

The first question posed in this thesis was, how do concepts arise? The main point derived from the results of Experiment 1 was that people can share the same mental representations of what members might constitute a category, whether natural, property, or ad hoc category-types are involved.

Experiment 1 showed that people's generation of exemplars is not driven by strictly mathematical rules, so the possibility of a logically-based external environment which determines our categories was eliminated in this study. Consequently, it is concluded that the nature of the representation of the category-members does not involve a mathematical structure. If it did, then the distribution for the number of different items produced as exemplars of the category would have been a function of the increasing or decreasing number of people doing the producing. Instead, subjects produced a distribution which seemed to be based upon typicality of the items, with the number of different items produced lessening as the number of people increased. This suggests that the majority of people agreed upon which were the most typical exemplars of a category. Most people, when requested to produce the best exemplars of the category first, produced a small range of the same exemplars first. This was strong evidence for a stable membership structure based upon typicality of the instances, and for the argument that subjects were consulting a common or shared category representation, in a consistent and predictable fashion.

In Experiment 1, the individual instances were not organized in a haphazard manner, which would be the case if participants were using an algorithmic formula to generate them, so categories cannot be represented in an abstract fashion. The results imply that Anderson's (1990) theoretical assumption about a world structured by Bayesian formulae was mistaken, and so the source of meaning does not lie in such a world. For a more detailed description of this issue, see Appendix J.

If concepts originated mainly in the physical structure of the external environment, then the knowledge they contain should involve only normative knowledge about how the world (its objects and creatures) is "carved up". Experiment 2 showed decisively that this is not the case. The experimental results suggest that there was a third factor at work, one which was not tested for in Experiment 2, and that people were consulting this factor for their membership decisions and their ranking tasks. Questions are raised by the small size of the semi-partial correlations between predictor task (for example, measures of typicality or frequency of direct experience) and the criterion for mental representation of the category. These suggest that both typicality and direct experiential information constitute only a small amount of the knowledge represented about a category, leaving a great deal of the category representation unexplained. It is argued that this third factor is conceptual knowledge, such as that described by Landau (1982), which consists of knowing the general facts or common usage of what being a grandmother means, for example, as well as the specific biological definition.

A view of concepts which makes some allowance for people's theories, beliefs, social knowledge about the category takes the nature of concepts one step further than a strictly environment-based knowledge. Such a view proposes (as Kant did, see Appendix B) that sensory experience or conceptual understanding alone are not sufficient: both are required in concept representation. Kant (1787) suggested a mediation of the sensibility and the understanding by imagination. Such a view also allows for a much more active role to be played by the categorizer. It is pointed out that, as the stories of Experiment 3 based on the two-tier representation model showed (condition 5), people can draw inferences about an object or creature's category identity on the basis of their background knowledge of functions, needs, and preferences.

Medin (1989) has suggested that some of the stability evident in theory-based concepts might derive from certain tendencies people show in their reasoning and problem-solving behaviours, which are evident across cultures. This is consistent with Kant's (1787) argument that we all have certain knowledge, a priori, by virtue of having human minds, and that such a priori knowledge precedes all reasoning. Kant, in turn, based his ideas on Hume's discovery that certain relations among things in the real world cannot be attributed to events, but rather were "mental constructions" projected onto an "objective world" (Bruner, 1986).

One conclusion drawn from the empirical studies of the thesis is that concepts are constructed, not derived from metaphysical categories which we discover to be already existing in the universe, or developed from similarity structures inherent in the environment. Some of the stability in concepts is derived from people's innate tendency to perceive certain correlations between features in the environment, and then place their own "mental constructions" upon them. What those mental constructions might be, however, depends not only upon the cultural norms of the categorizer (Smith, 1984), but also on his or her individual experiences. In short, upon the accumulated knowledge of the "given" world in which the categorizer lives.

6.03 WHY DO WE HAVE THE CATEGORIES WE DO?

The second question investigated by the thesis, and discussed in chapter 2, asked why do we have the categories we do, and not others. One possible answer is the notion that the function of categories is for cognitive economy in the prototypical representation of the outside world. This view is known as the unitary approach, because it assumes that categories reflect something *direct* about the structures or essences of the outside world. The alternative answer is that we have the categories we do, as a result of the diagnostic criteria, which is contained in our concepts, and which we impose upon the outside world.

Rosch (1978) has argued cogently that we have categories in order to achieve cognitive economy in our mental representations of similarity structures inherent in the outside world. The cognitive economy principle claims that it is desirable to minimize effort, and the way to do this is by people being able to treat a grouping of objects or creatures in the same way. Furthermore, maximum

storage of information is achieved by the use of categories, so that our memories do not become swamped with irrelevant details about the individual object or creature (Murphy, 1993b). Cognitive economy is a clearly credible purpose for the existence of categories, but like prediction of features (the purpose for categories advocated by Anderson, 1991a), it also is a limited view of the variety of functions open to categories. People use categories for other purposes also, not only that of organizing the creatures and objects of the physical world they live in.

Experiment 2 tested the assumptions contained in a unitary approach to categories, which assumes similarity to be the basis for categorization. The results did not support the unitary approach, but supported the dual representation (or binary) approach to category representation, which has the drawback of not being cognitively economical in Roschean terms. Where people's processes were concerned, the unitary approach claims that categorization consists of a single stage of computation of similar, characteristic features. Experiment 2 showed this not to be the case, with participants undertaking a two-stage processing of items, as evidenced in their response times.

Furthermore, Experiment 2 showed that people do not treat all groupings of objects/creatures in the same way, nor did the different category-types (superordinate, property, ad hoc) consist of the same information. Each had single and dual representations. Prototypicality was present in all three normatively-based category-types, but it was not the sole basis for category representation, thus indicating that cognitive economy of information storage (in the Roschean sense) was not really being achieved.

In Experiment 2, where representation of the natural superordinate types was concerned, "cognitive economy in the representation of the physical environment" seems to be an appropriate function of categorization. The importance of personal experience and frequency of category-context in our understanding of natural categories was evident in superordinates, by the fact that the frequency-of-instantiation task was found to be a significant predictor of representation also. This finding suggests that the unitary approach's view of natural categories is too simple, and that physical appearance is not the only information encoded about them.

It must be concluded that Rosch's (1978) answer to the question is inadequate. We do not have the categories we do for the sole purpose of representing physical informational input in a cognitively economic fashion. This is most evident in ad hoc categories, which Experiment 2 showed were represented most uneconomically by three different kinds of information (frequency of experience, typicality, and membership criteria reflected in the Ranks variable).

The coherence of ad hoc types cannot be explained according to a unitary approach to categories. In the results from Experiments 1 and 2, the ad hoc types showed a significant gradience in structure which, though slight, indicated that they are categories in their own right. As such, they raise the question of how they can have a graded structure which is *not* based upon similarity of their items. Barsalou (1983) suggested that each exemplar signified how well it fulfilled the goal of forming the category in the first place. For example, in the category *Things to save from a burning home* the goal would be to list items of value. Thus, the degree of value inherent in the item (whether sentimental, monetary, or an intrinsic value such as life) would provide gradience to the category's membership structure.

The presence of content information (as well as structural typicality) in the representations of the three category-types would suggest that, in all three types, people were using a knowledge-based concept to generate their exemplars. It is argued that the coalescing of the various exemplars of any of the three category-types is due to the membership criteria specified in the concept for the category. This criterion may have nothing to do with the physical similarity of the items, but a great deal to do with beliefs about why those exemplars *appear* similar.

Concepts ensure coherence of structure by "diagnosing" objects and creatures, on the basis of something other than their physical appearance (Rips, 1975; 1989; Smith, 1989). A view of concepts as consisting of diagnostic beliefs about a domain would provide an explanation for the property of coherent structure in categories consisting of physically dissimilar objects (as in ad hoc categories). Perception of similarity is not fixed, but contingent upon the theory-based concepts or beliefs which people hold about a group of objects as a category. Thus, a woolly lamb and a woolly dog might look physically similar, but one meets the specification of what is relevant or important for belonging to the "doggy" category, and the other does not. Consequently, another reason or

role for concepts is to diagnose input from the external environment, in a way that category membership decisions are based on more than physical appearance or rules.

In Experiment 3, the stories in condition 6 were based on Medin's (1989) descriptions of contagion thinking and homeopathic problem-solving (see chapter 1). This story condition elicited the second highest rates of changed judgments (as compared to the control condition), out of the six experimental conditions. The subjects had no difficulty at all in comprehending the stories, or in drawing certain inferences. For example, one animal story (story item 3, see Appendix I) describes a change from lizard to owl. When a lizard stands too close to a bird on a rock, it catches the bird's contagious microbes, which infect its cold blood so that the lizard is now warm-blooded. Whilst the credibility of the story is low, subjects still found it comprehensible, and the information contained in it important enough to effect a significant change in their judgments, so that they considered the lizard to have changed its membership into the category of owls.

The results of Experiment 3 indicated that the explanatory concepts we construct about the objects and creatures in our world are the decisive factor in cohesiveness. However, they also showed that appearance is an important component of that diagnostic process, and such appearance need not necessarily be based upon physical similarity. In short, similarity is dynamic and sensitive to context-effects.

Finally, on the issue of whether concepts or categories come first (Hampton & Dubois, 1993), the thesis must take the position that it is concepts which determine categorization rules and decisions. We do not have the categories we do because they were already inherent in the environment, and were there waiting to be discovered. We do not have the categories we do in order to predict features or represent the physical environment in a cognitively economical fashion. We have categories because of the theories we hold about the physical world around us, using such beliefs and theories to *diagnose* creatures or objects and assign them to some category or other. We have the categories we do because we are the sort of organisms we are (Wattenmaker, Nakamura and Medin, 1988).

6.04 THE ROLE OF CONCEPTS IN COGNITION

Murphy (1993b) suggests that people use their theory-embedded concepts to interact with their sensory environment and to make sense of it. Thus, a concept model should portray representations of physical appearance as interacting in predictable ways with representations of concepts. Recent research has shifted to investigation of the categorizer, rather than hypotheses about the essential nature of the outside world, or its metaphysical structure. The nature of the world is not wholly ignored, but rather, the focus is upon the interaction of intelligent organisms with their environment (Murphy, 1993b; Rips, 1986; 1990).

The thesis argues that the overall purpose of concepts is to construct some meaning for the world we live in. The three functions of concepts detailed by the theory-based view of concepts are specific, and it is in carrying out these functions that three properties of people's cognitive behaviour become evident. Of the three approaches to concepts examined in this thesis, the view of concepts as theory-embedded is the only one which can explain stability of representation, flexibility of categorization, and coherence of structure. So taking into consideration this account's explanatory capacity, it would seem to be the most valid one of the three. Also, the account should be able to explain some of the unexpected findings from the empirical studies.

6.04.1 A flexible categorization of creatures and objects

Experiment 3 showed that judgments of an animal or artifact could be influenced by the story-context, as could the participants' perception of the animal or artifact. In other words, a person's judgment was not carried out on its own merits, and similarity was not judged strictly on information about physical features.

Experiment 3 compared subject performance in six experimental conditions, asking whether an item should be conceptualized or identified with one concept or with another. The results indicated that similarity relations between an object and its category are not fixed solely by physical information concerning their appearance. For example, in the stories, subjects changed their judgments of an object's similarity to a particular concept when function (condition 4) or essence (condition 3) were varied. Where categorization

judgments were concerned, the object's category identity changed, even when the information consisted solely of details about physical appearance.

Schank, Collins, and Hunter (1986) criticize category induction theories because these assume that the categorizer has access automatically to all relevant and important features. One of their excellent examples includes that of predicting stripes if the animal is a zebra. They discuss some of the problems which might ensue if some zebras do not have stripes, in which case a categorizer might mistakenly take them to be horses. In short, they conclude that, "the importance of a feature is not static, and can only be determined by pragmatic judgments about the features, their context, and the system's goals" (Schank, Collins, & Hunter, 1986, p. 642). This was borne out by Experiment 3, where similarity judgments which included the same physical feature differed according to the story context where that physical feature was described. In short, prototypicality did not seem to be a *fixed* perception in the stories of Experiment 3, either, where variations to an object's or creature's functions or needs influenced subjects' perceptions of its similarity and its category identity. This means that the number of categories an artifact or animal can belong to are more than one, two, or even three. In fact, everything can share at least one feature with something else, and a new category can be formed on the basis of that shared similarity.

The main drawback of the theory-based view of concepts is that the categorization processes which they describe are so flexible as to be almost unconstrained (Barsalou & Medin, 1986). This is because features that are correlated in people's mental representations do not always reflect actual empirical relations in the world, but may derive instead from people's theories or beliefs about the observed relations between the features. Relations between features do not need to be actually observed. They may emerge as a consequence of someone's theories about the world. When a correlation is perceived to exist on the basis of one's theories, but has no basis in empirical fact, it is called an *illusory correlation* (Murphy & Medin, 1985). Since people are said to perceive similarities according to beliefs and theories, anything might be perceived as similar to anything else. So why do we have the categories we do, *but not others?* Roschean theory provides no constraints upon these illusory correlations, since it makes no attempt to explain why certain features (those which went into the mental calculations of similarity) might be chosen to be compared or perceived as being similar in the first place.

The flexibility of similarity relations needs to be constrained, and concepts achieve that constraint by specifying what is relevant *to the category.* Constraints on such flexibility are one of the functions of concepts, insofar that a concept is said to specify what information is *relevant* or *important* to the category (Wattenmaker, Nakamura, & Medin, 1989). In this way, it is claimed, the categorizer makes his or her decision about an instance's membership, by knowing which similar features should be taken into consideration. The question then becomes one of what is the relevant information. Theory-based views of concepts claim that beliefs and theories specify what are the relevant features to take into account during a membership decision. This description of what is *relevant* information does not agree completely with the empirical results from Experiment 3.

6.04.2 A coherent structure for categories

Just any explanatory theory will not do. In Experiment 3, one of the unexpected findings was that story conditions 2 and 6 were equal in their influence upon people's judgments. Just a plain description of an alteration to physical appearance (condition 2), had as much force and influence on judgment tasks as when an explanation was provided for the transformed appearance (condition 6). As the lack of difference between conditions 2 and 6 showed, just any explanation will not do.

The beliefs drawn upon in condition 6, might influence *constructed* similarity, since the similarity judgments in this condition were significantly higher than the categorization judgments. However, this constructed similarity was still not enough to influence categorization *to a greater degree* than the physical similarity described in condition 2. The degree of changed judgments in condition 6 were no different from the degree of change effected by the stories of Condition 2. The explanatory story condition which did achieve this was that of condition 5. The essential difference between condition 6 and condition 5 (which both provided explanations for any transformations) was that the latter provided personal details (about animals) or functional details about artifacts and the needs of their owners, and based its explanation on those.

Of the six experimental conditions tested in Experiment 3, the most relevant information for participants was that contained in the stories of

condition 5. These were stories concerned with an animal's needs, its intentions and preferences, or an artifact's functions and abilities. It is argued that such knowledge, for the categorizer, is embedded in self-reference. The categorizer is using the knowledge gained from his/her own experience of needs and preferences to judge the animal stories in condition 5, (and his/her own experience of artifact functions), to judge the *plausibility* and *credibility* of the stories themselves.

This is not the same kind of relevant information portrayed by the stories in condition 6 (psychological essentialism), though these did gain significant differences from the control condition also. The knowledge contained in the condition 6 stories involved the use of theoretical information which might be gained from a book or from school. It certainly did not involve the use of knowledge which is credible because it is gained directly from being human, and sharing the world with other humans.

Medin (1989) speaks of the need for similarity, to provide constraint upon relations within a category. Goodman (1977) points out that each similarity judgment needs a frame of reference to stabilize comparisons, and avoid the charge of relativism. Perhaps a need for plausibility also exists, to provide a guide to the credibility of a theory, some way by which subjects can judge how believable a theory might be. Plausibility is not the same as coherence; it does not serve the same functions as coherence, that is, diagnosis of membership. A theory might be coherent, but not plausible, as Johnson-Laird (1983) has observed. It is claimed here that plausibility serves to help the categorizer decide whether to accept or reject any explanatory theory, on the basis of whether that theory "fits in" with the version of the world which he or she has created for themselves. By providing a frame of reference, concepts which are embedded in self-reference are fulfilling the function of specifying what is *plausible* and important information to take into account during categorization.

This kind of self-reference (knowledge gained from direct experience) might be argued against on the basis of subjectivism, where everything is relative to everything else. Self-reference might be argued to be too subjective, in which case how can we communicate with one another, if the meanings we construct are completely idiosyncratic? The next section on stability of conceptual representation deals with the need for both subjective *and* normative knowledge.

6.04.3 A stable representation for concepts

The empirical results gained from Experiment 2 suggested that experiential knowledge encoded subjectively is just as important as normative knowledge gained from social norms. At least, the data gained from the use of idiosyncratic stimuli was as useful as that gained from using normative stimuli, and sometimes more profitable in terms of producing a greater number of significant results.

In Experiment 2's regression analyses of category representation, each subject's data were analysed individually. The accountability ratios elicited by each individual's performance when using idiosyncratic stimuli were shown to be equally as high as those elicited by the use of normative stimuli. If the argument were supported that it is the subjective components of information which produce instability, then the accountability ratios of the predictor tasks using idiosyncratic stimuli should have been far lower than when the same tasks were performed with normative stimuli. Instead, the values were roughly equal, irrespective of whether the stimulus words used for a task were idiosyncratic or normative.

In the experiment's "judges' agreement" analyses of category membership, the results showed opposing outcomes in the superordinate and property category-types, depending upon whether the data from the normative stimuli were being used, or those from the idiosyncratic stimuli. Judges agreed about category boundaries when the normative stimuli were used, suggesting that both superordinate and property types had clear-cut and precise membership; but the opposite occurred when idiosyncratic stimuli were used. Also, in the experiment's second analysis of the membership decision response times, the analysis of the idiosyncratic-based data produced a greater number of significant results than the analysis of the normative-based data.

These results of Experiment 2 would suggest that idiosyncratic knowledge gained by direct experience is at least as important as normative knowledge gained from society's norms. Overall, the main conclusion reached from this section of the results is that future studies on concepts and categories might find it profitable (in terms of significance of results) to use not only the normative organization of category members which has been extracted across hundreds of

participants, but also each participant's idiosyncratic organization of his or her category members. Certainly, the same task (but with different stimuli) produced data which often produced differing results.

As was described in chapter 1, Rey (1983) suggested that two kinds of conceptual stability need to be accounted for, in any adequate theory of concepts: within-person stability and between-person stability. Within-person stability is what occurs when a person has the same concept at different times, and it is this within-person stability which provides the basis for the person's conceptual competence (Rey, 1983). For example, a person's understanding of how a sewing machine functions is usually learned through direct experience, often through trial-and-error. It is necessary for the same person to have this same concept at different times. Although the person might be sewing different garments on different occasions, the within-person stability of an understanding of how a sewing machine functions is necessary on every occasion. Otherwise, it would be necessary to re-learn the same mechanisms each time she or he wants to sew something. Within-person stability of concepts, then, is grounded in personal and direct experience of the world.

Idiosyncratic knowledge, beliefs derived from personal direct experience of the world and its creatures, seems to be a valid basis for within-person stability of concepts. Knowledge of something learned at first hand, through direct experience or in an emotion-laden context, is likely to be better recalled or better recognized (than statements of cold fact). This knowledge derived from direct experience or emotions contributes towards stability within-persons, through self-reference. Idiosyncratic knowledge should hold meaning for an individual through its association with one's self.

Between-person stability occurs when different people can share similar concepts at the same and different times, providing the basis for comparisons of norms across people in a society. Normative knowledge of something learnt through indirect, vicarious experience (for example, from a book or at school) may not have the same salience or force as idiosyncratic knowledge. Comparison of participants' performances with normative stimuli, as compared with idiosyncratic stimuli, would suggest that participants may have subjective knowledge associated with their categories, as well as a normative organization.

Theories as a basis for conceptual stability are said to serve as an "anchoring" function for concepts (Medin & Ortony, 1989; Keil, 1989), yet they have been criticized because of their lack of specificity. As Keil's (1989) notion of causal homeostasis implies, concepts and the background theories from which they derive are highly interrelated, so how are they differentiated from each other? The proposal that ordinary, everyday concepts might be represented as beliefs and embedded in theories needs to be more explicit, to avoid the danger of circularity of explanation (Komatsu, 1992). The thesis suggests that, by allowing a concept to have both subjective and normative components, Rey's (1983) conditions for the stability of representation would be achieved. Furthermore, the concept would be differentiated from the background theory by virtue of its subjective component of knowledge, by which the categorizer can judge the plausibility of the theory.

6.04.4 Constructed worlds

Goodman (1984) sees the greatest problem with the idea of "constructed" concepts as being one of recursiveness, the explanatory "buck" keeps being passed *ad infinitum.* He proposed that certain theories (or prior worlds as he describes them) be taken as "given" for the individual, so that the categorizer is constrained by the nature of the world version with which he or she began remaking concepts. To illustrate how this might occur, there is an instructive exchange between Marco Polo and Kublai Khan in Italo Calvino's *Invisible Cities.* It begins when Marco says:

> "Sire, now I have told you about all the cities I know."
> "There is still one of which you never speak... Venice," the Khan said.
> Marco smiled. "What else do you believe I have been talking to you about? .... Every time I describe a city I am saying something about Venice."
> "When I ask you about other cities I want to hear about them. And about Venice, when I ask you about Venice."
> "To distinguish the other cities' qualities, I must speak of a first city that remains implicit. For me it is Venice." (Calvino, 1972, p.86).

By taking certain constructed worlds as "given", whether they be through the categorizer's direct experience or through living in a certain culture, the charge of relativity is avoided. Jerome Bruner (1986) has argued for a constructivist view: that we cannot know an aboriginal reality; that there is none, that any reality we create is based on a transmutation of some prior "reality" that we have taken as given. We construct many realities, and do so

from differing intentions (Bruner, 1986, p.158). We construct our worlds (or realities) out of the myriad forms in which we structure experience, whether it be the experience of the senses, the deeply symbolically encoded experience we gain through interacting with our social world, or the vicarious experience we achieve in the act of reading.

If the general overall purpose of concepts is not only to build, but also create conceptual knowledge, then by constructing concepts we are constructing worlds. Such functions cannot be reduced to simple feature prediction, or the efficient storage and processing of the physical structures of the external world (Barsalou, 1992; Smith, 1989). If there are meanings "incarnate" in the world, Goodman (1984) argues, we transform them in the act of accepting them into our transformed world, and that transformed world then becomes the world with which others start, or that we then offer.

REFERENCES

Anderberg, M.R. (1973). *Cluster analysis for applications.* San Diego, CA: Academic Press.

Anderson, J.R. (1978). Arguments concerning representations for mental images. *Psychological Review,* 85, 249-277.

Anderson, J.R. (1990). *The adaptive character of thought.* Hillsdale, NJ: Erlbaum.

Anderson, J.R. (1991a). The adaptive nature of human categorization. *Psychological Review,* 98, 409-429.

Anderson, J.R. (1991b). Is human cognition adaptive? *Behavioural and Brain Sciences,* 14, 471-517.

Anderson, J.R., & Matessa, M. (1990). A rational analysis of categorization. In M. Kaufmann (Ed.), Proceedings of the Seventh International Machine Learning Conference. Palo Alto, CA.

Anderson, J.R., & Milson, R. (1989). Human memory: An adaptive perspective. *Psychological Review,* 96, 703-719.

Aristotle. (1968). *Metaphysics,* (R. Hope, Trans.) Ann Arbor, Michigan: University of Michigan Press.

Aristotle. (1984) *The complete works of Aristotle.* 2 volumes. (J.A. Smith and D. Ross, Trans.) Oxford: Johnathon Barnes Press.

Armstrong, S.L., Gleitman, L.R., & Gleitman, H. (1983). What some concepts might not be. *Cognition,* 13, 263-308.

Ashby, F.G., & Townsend, J.T. (1980). Decomposing the reaction time distribution: Pure insertion and selective influence revisited. *Journal of Mathematical Psychology,* 2, 93 - 123.

Ashcraft, M.H. (1978a). Property dominance and typicality effects in property statement verification. *Journal of Verbal Learning and Verbal Behavior,* 17, 155-164.

Ashcraft, M.H. (1978b). Property norms for typical and atypical items from 17 categories: A description and discussion. *Memory & Cognition,* 6, 227-232.

Balzano, G.J., & McCabe, V. (1986). An ecological perspective on concepts and cognition. In V. McCabe and G.J. Balzano (Eds.), *Event cognition: an ecological perspective* (pp. 93 - 112). Hillsdale, NJ: Erlbaum.

Barr, R.A., & Caplan, L.J. (1987). Category representations and their implications for category structure. *Memory and Cognition,* 15, 397-418.

Barsalou, L.W. (1983). Ad hoc categories. *Memory and Cognition,* 11, 211-227.

Barsalou, L.W. (1985). Ideals, central tendency, and frequency of instantiation as determinants of graded structure in categories. *Journal of Experimental Psychology: Learning, Memory, and Cognition,* 11, 629-654.

Barsalou, L.W. (1987). The instability of graded structure: Implications for the nature of concepts. In U. Neisser (Ed.), *Concepts and conceptual development: Ecological and intellectual factors in categorization* (pp.101-140). New York: Cambridge University Press.

Barsalou, L.W. (1989). Intra-concept similarity and its implications for inter-concept similarity. In S. Vosniadou & A. Ortony (Eds.), *Similarity and analogical reasoning* (pp.76-121). New York: Cambridge University Press.

Barsalou, L.W. (1991). Deriving categories to achieve goals. In G.H. Bower (Ed.), *The psychology of learning and motivation: advances in research and theory,* Vol. 27, (pp.1 - 64). San Diego, CA: Academic Press.

Barsalou, L.W. (1992). *Cognitive Psychology: An overview for cognitive scientists.* Hillsdale, NJ: Erlbaum.

Barsalou, L.W., & Medin, D.L. (1986). Concepts: fixed definitions or dynamic context-dependent representations? *Cahiers de psychologie cognitive,* 6, 187 - 202.

Barsalou, L.W., & Ross, B.H. (1986). The roles of automatic and strategic processing in sensitivity to superordinate and property frequency. *Journal of Experimental Psychology: Learning, Memory, and Cognition,* 12, 116-134.

Barsalou, L.W., & Sewell, D.R. (1985). Contrasting the representation of scripts and categories. *Journal of Memory and Language,* 24, 646-665.

Bartlett, F.E. (1932). *Remembering: A study in experimental and social psychology.* Cambridge, U.K.: Cambridge University Press.

Barton, M.E., & Komatsu, L. K. (1989). Defining features of natural kinds and artifacts. *Journal of Psycholinguistic Research,* 18, 433-447.

Battig, W.F., & Montague, W.E. (1969). Category norms for verbal items in 56 categories: A replication and extension of the Connecticut category norms. *Journal of Experimental Psychology Monographs,* 8 (3, Pt.2).

Begg, I., & Snider, A. (1987). The generation effect: Evidence for generalized inhibition. *Journal of Experimental Psychology: Learning, Memory, and Cognition,* 13, 553-563.

Bellezza, F.S. (1984a). Reliability of retrieval from semantic memory: Common categories. *Bulletin of the Psychonomic Society,* 22, 324-326.

Bellezza, F.S. (1984b). Reliability of retrieval from semantic memory: Noun meanings. *Bulletin of the Psychonomic Society,* 22, 377-380.

Berger, J.O. (1985). *Statistical decision theory and Bayesian analyses.* New York: Springer-Verlag.

Berlin, B. (1972). Speculations on the growth of ethno-botanical nomenclature. *Language in Society,* 1, 55-86.

Bierwisch, M. (1971). On classifying semantic features. In L. Jakobowitz & D. Steinberg (Eds.), *Semantics.* Cambridge: Cambridge University Press.

Borges, J.L. (1966). *Other inquisitions.* New York: Washington Square Press.

Bourne, L.E., Jr. (1970). Knowing and using concepts. *Psychological Review,* 77, 546-556.

Brewer, W.F. (1993). What are concepts? Issues of representation and ontology. In G.V. Nakamura, D.L. Medin, & R. Taraban (Eds.), *The psychology of learning and motivation*: Vol. 29. *Categorization by humans and machines* (pp. 495-534). San Diego, CA: Academic Press.

Brooks, L.R. (1978). Nonanalytic concept formation and memory for instances. In E.Rosch & B.B.Lloyd (Eds.), *Cognition and categorization* (pp.169-211). Hillsdale, NJ: Erlbaum.

Brooks, L.R. (1987). Decentralized control of categorization: the role of prior processing episodes. In U. Neisser & E. Winograd (Eds.), *Remembering reconsidered: ecological and traditional approaches to the study of memory* (pp. 141 - 174). New York: Cambridge University Press.

Bruner, J.S. (1986). *Actual minds, possible worlds.* Cambridge, Mass: Harvard University Press.

Bruner, J.S., Goodnow, J., & Austin, G. (1956). *A study of thinking.* New York: Wiley.

Calvino, I. (1972). *Invisible Cities* (W. Weaver, Trans.). New York: Harcourt Brace Jovanovich.

Carey, S. (1985). *Conceptual change in childhood.* Cambridge, MA: MIT Press.

Carey, S. (1994). Does learning a language require the child to reconceptualize the world? In L.R. Gleitman & B. Landau (Eds.), *Lexical acquisition. Lingua,* 92, (special volume).

Cherniak, C. (1984). Prototypicality and deductive reasoning. *Journal of Verbal Learning and Verbal Behavior,* 23, 625 - 642.

Chesterton, G.K. (1929). The Perishing of the Pendragons. In *The Wisdom of Father Brown.* Ringwood, Victoria: Penguin Books Australia.

Chi, M.T.H., Feltovich, P.J., & Glaser, R. (1981). Categorization and representation of physics problems by experts and novices. *Cognitive Science,* 5, 121 - 152.

Cohen, B., & Murphy, G.L. (1984). Models of concepts. *Cognitive Science,* 8, 27-58.

Cohen, B.H., Bousfield, W.A., & Whitmarsh, G.A. (1957). *Cultural norms for verbal items in 43 categories* (ONR Tech. Rep. No. 22). Storrs, CT: University of Connecticut.

Collins, A.M., & Loftus, E.F. (1975). A spreading-activation theory of semantic processing. *Psychological Review,* 82, 407-428.

Collins, A.M., & Quillian, M.R. (1969). Retrieval time from semantic memory. *Journal of Verbal Learning and Verbal Behavior,* 8, 240-247.

Conrad, C. (1972). Cognitive economy in semantic memory. *Journal of Experimental Psychology,* 92, 149-154.

Conway, M.A. (1990). Associations between autobiographical memories and concepts. *Journal of Experimental Psychology: Learning, Memory and Cognition,* 16, 799-812.

Corter, J.E. (1991). Normative theories of categorization. Comment on J.R. Anderson, Is human cognition adaptive? *Behavioral and Brain Sciences,* 14, 491-492.

D'Andrade, R.G. (1981). The cultural part of cognition. *Cognitive Science,* 5, 179-195.

D'Andrade, R.G. (1989). Cultural cognition. In M.I. Posner, (Ed.), *Foundations of Cognitive Science* (pp. 795 - 830). Cambridge, MA: MIT Press.

de Sousa, R. (1991). Rational analysis: too rational for comfort? Comment on J.R. Anderson, Is human cognition adaptive? *Behavioural and Brain Sciences,* 14, p.492.

Dickinson, B.W. (1991). Adaptivity and rational analysis. Comment on J.R. Anderson, Is human cognition adaptive? *Behavioral and Brain Sciences,* 14, 492-493.

Dickinson, A., Shanks, D. & Evenden, J. (1984) Judgment of act-outcomes contingency: The role of selective attribution. *Quarterly Journal of Experimental Psychology,* 36A, 29-50.

Dixon, R.M.W. (1968). Noun classes. *Lingua,* 21, 104-25.

Dixon, R.M.W. (1982). *Where have all the adjectives gone?* Berlin: Walter de Gruyter.

Dobzhansky, T. (1937). *Genetics and the origin of species.* New York: Columbia University Press.

Donders, (1969). On the speed of mental processes. In W.G. Koster, (Ed. and Trans.), *Attention and performance* (Vol. 2). *Acta Psychologica,* 30, 412-431. (Original work published 1868).

Dougherty, J. (1978). Salience and relativity in classification. *American Ethnologist,* 5, 66 - 80.

Douglas, M. (1966). *Purity and Danger.* London: Routledge & Kegan Paul.

Einhorn, J.H., & Hogarth, R.M. (1986). Judging probable cause. *Psychological Bulletin,* 99, 3-19.

Elio, R., & Anderson, J.R. (1984). The effects of information order and learning mode on schema abstraction. *Memory and Cognition,* 12, 20-30.

Estes, W.K. (1986). Memory storage and retrieval processes in category learning. *Journal of Experimental Psychology: General,* 115, 155-174.

Evans, J. St. B.T. (1991) Adaptive cognition: the question is how. Comment on J.R. Anderson, Is human cognition adaptive? *Behavioral and Brain Sciences,* 14, 493-494.

Eysenck, M.W., & Keane, M.T. (1990). *Cognitive Psychology: A student's handbook.* Hove, UK: Erlbaum.

Fisher, D.H. (1987). Knowledge acquisition via incremental conceptual clustering. *Machine Learning,* 2, 139-172.

Flannagan, M.J., Fried, L.S., & Holyoak, K.J. (1986). Distributional expectations and the induction of category structure. *Journal of Experimental Psychology: Learning, Memory and Cognition,* 12, 241-256.

Frazer, J.G. (1959). *The new golden bough.* New York: Criterion Books.

Frege, G. (1892). Uber Sinn und Bedeutung, *Zeitschrift fur Philosophie und philosophische Kritik,* 100, 25-50. (On sense and reference. In P.T. Geach and M. Black (Eds.), (1952), *Philosophical writings of Gottlob Frege).* Oxford, Blackwell.

Fried, L.S., & Holyoak, K.J. (1984). Induction of category distributions: A framework for classification learning. *Journal of Experimental Psychology: Learning, Memory, and Cognition,* 10, 234-257.

Freyd, J.J. (1983). Shareability: The social psychology of epistemology. *Cognitive Science,* 7, 191-210

Gardner, H. (1987). *The mind's new science: a history of the cognitive revolution.* New York: Basic Books.

Gati, I., & Tversky, A. (1984). Weighting common and distinctive features in perceptual and conceptual judgments. *Cognitive Psychology,* 16, 341-370.

Gibson, J.J. (1966). *The senses considered as perceptual systems.* Boston: Houghton Mifflin.

Gigeranzer, G. (1991). Does the environment have the same structure as Bayes' theorem? Comment on J.R. Anderson, Is human cognition adaptive? *Behavioral and Brain Sciences,* 14, 495 - 496.

Glass, A.L., & Holyoak, K.J. (1975). Alternative conceptions of semantic memory. *Cognition,* 3, 313-339.

Gleitman, L.R., Armstrong, S.L, & Gleitman, H. (1983). On doubting the concept 'concept'. In E.K. Scholnick (Ed.), *New Trends in conceptual representation: challenges to Piaget's theory?* (pp.87-110). Hillsdale, NJ: Erlbaum.

Goodman, N. (1972). Seven strictures on similarity. In N. Goodman (Ed.), *Problems and projects* (pp. 437-446). New York: Bobbs-Merrill.

Goodman, N. (1977). The structure of appearance. In R.S. Cohen & M.W. Wartofsky (Eds.), *Boston Studies in the philosophy of science,* 107. Boston: D. Reidel Publishing.

Goodman, N. (1978). *Ways of worldmaking.* Hassocks, Sussex: The Harvester Press.

Goodman, N. (1984). *Of Mind and Other Matters.* Cambridge, Mass: Harvard University Press.

Greene, R.L. (1989). On the relationship between categorical frequency estimation and cued recall. *Memory and Cognition,* 17, 235-239.

Gregory, R.L. (1987). *The Oxford Companion to the Mind.* Oxford, Oxford University Press.

Gregson, R.A.M. (1991). Bayes in the context of suboptimality. Comment on J.R. Anderson, Is human cognition adaptive? *Behavioral and Brain Sciences,* 14, 497-498.

Hampton, J.A. (1979). Polymorphous concepts in semantic memory. *Journal of Verbal Learning and Verbal Behavior,* 18, 441-461.

Hampton, J.A. (1981). An investigation of the nature of abstract concepts. *Memory and Cognition,* 9,149-156.

Hampton, J.A. (1984). The verification of category and property statements. *Memory and Cognition,* 12, 345-354.

Hampton, J.A. (1987). Inheritance of attributes in natural concept conjunctions. *Memory and Cognition,* 15, 55-71.

Hampton, J.A. (1988). Overextension of conjunctive concepts: Evidence for a unitary model of concept typicality and class inclusion. *Journal of Experimental Psychology: Learning, Memory, and Cognition,* 14, 12-32.

Hampton, J.A. (1993). Prototype models of concept representation. In I.Van Mechelen, J. Hampton, R.S. Michalski, and P. Theuns (Eds.), *Categories and Concepts: Theoretical Views and Inductive Data Analysis* (pp.67-95). London: Academic Press Limited.

Hampton, J., & Dubois, D. (1993). Psychological models of concepts: Introduction. In I. Van Mechelen, J. Hampton, R.S. Michalski, and P. Theuns (Eds.), *Categories and Concepts: Theoretical Views and Inductive Data Analysis* (pp.11-33). London: Academic Press.

Hampton, J.A., & Gardiner, M.M. (1983). Measures of internal category structure: a correlational analysis of normative data. *British Journal of Psychology,* 74, 491-516.

Hempel, C.G. (1966). *Philosophy of natural science.* Englewood Cliffs, NJ: Prentice-Hall.

Hintzman, D.L. (1986). "Schema abstraction" in a multiple-trace memory model. *Psychological Review,* 93, 411-428.

Hintzman, D.L., & Ludlam, G. (1980). Differential forgetting of prototypes and old instances: Simulation by an exemplar-based classification model. *Memory and Cognition,* 8, 378-382.

Hollan, J.D. (1975). Features and semantic memory: Set-theoretic or network model. *Psychological Review,* 82, 154-155.

Homa, D. (1984). On the nature of categories. In G. Bower (Ed.), *The psychology of learning and motivation: advances in research and theory,* Vol.18 (pp.49-94). New York: Academic Press.

Homa, D., & Vosburgh, R. (1976). Category breadth and abstraction of prototypical information. *Journal of Experimental Psychology: Human Learning and Memory,* 2, 322-330.

Hospers, J. (1990). *An introduction to philosophical analysis.* London: Routledge.

Howell, D.C. (1987). *Statistical Methods for Psychology.* Boston: PWS-Kent Publishing Company.

Hume, D. (1911). *A Treatise of Human Nature.* London and New York: J.M. Dent and Sons Ltd. and E.P. Dutton and Co.

Jacobson, R. (1963). *Essais de Linguistique Generale.* Paris: Editions de Minuit.

Jacoby, L.L., & Brooks, L.R. (1984). Nonanalytic cognition: memory, perception and conceptual learning. In G.H. Bower (Ed.), *The Psychology of learning and motivation: advances in research and theory,* Vol. 18, (pp.1 - 47). New York: Academic Press.

Johnson-Laird, P.N. (1983). *Mental models: towards a cognitive science of language, inference, and consciousness.* Cambridge,MA: Harvard University Press.

Johnson-Laird, P.N. (1989). Mental models. In M.I. Posner (Ed.), *Foundations of Cognitive Science* (pp. 469 - 499). Cambridge, MA: MIT Press.

Johnson-Laird, P.N., Hermann, D.J., & Chaffin, R. (1984). Only connections: a critique of semantic networks. *Psychological Bulletin,* 96, 292-305.

Kahneman, D., & Miller, D.T. (1986). Norm theory: comparing reality to its alternatives. *Psychological Review,* 93, 136-153.

Kahneman, D., & Tversky, A. (1972). Subjective probability: A judgment of representativeness. *Cognitive Psychology,* 3, 430-454.

Kant, I. (1934). *The Critique of Pure Reason* (2nd ed.) (J.M.D. Meiklejohn, Trans.). London: Dent. (Original work published 1787)

Katz, J.J. (1972). *Semantic theory.* New York: Harper & Row.

Katz, J.J., & Fodor, J.A. (1963). The structure of a semantic theory. *Language,* 39, 170-210.

Keil, F.C. (1986). The acquisition of natural kind and artifact terms. In W. Demopoulos & A. Marras, (Eds.), *Language learning and concept acquisition.* Norwood, NJ: Ablex.

Keil, F.C. (1989). *Concepts, kinds, and cognitive development.* Cambridge, MA: MIT Press.

Keil, F.C. (1994). Explanation, association, and the acquisition of word meaning. In L.R. Gleitman & B. Landau (Eds.), *Lexical Acquisition. Lingua,* 92, (special volume).

Kipling, R. (1987). How the leopard got his spots. In *Just So Stories.* Hammondsworth, Middlesex: Penguin. (Original work published 1902).

Komatsu, L.K. (1992). Recent views of conceptual structure. *Psychological Bulletin,* 112, 500-526.

Kripke, S. (1972). Naming and necessity. In D. Davidson & G. Harman (Eds.), *Semantics of natural language* (2nd ed., pp. 253-355). Dordrecht, Holland: Reidel.

Lakoff, G. (1987). *Women, fire, and dangerous things: What categories reveal about the mind.* Chicago: University of Chicago Press.

Landau, B. (1982). Will the real grandmother please stand up? The psychological reality of dual meaning representations. *Journal of Psycholinguistic Research,* 11, 47-62.

Landau, B. (1994). Object shape, object name, and object kind: Representation and development. In D. L. Medin (Ed.), *The psychology of learning and motivation: advances in research and theory,* Vol. 31 (pp. 253 - 304). San Diego, CA: Academic Press.

Lebowitz, M. (1986). Integrated learning: controlling explanation. *Cognitive Science,* 10, 219-240.

Lebowitz, M. (1987). Experiments with incremental concept formation: UNIMEM. *Machine Learning,* 2, 103-138.

Locke, J. (1968). An essay concerning human understanding. In A.J. Ayer & R. Winch (Eds.), *British empirical philosophers.* New York: Simon & Schuster. (Original work published 1690)

Loftus, E.F. (1973). Category dominance, instance dominance, and categorization time. *Journal of Experimental Psychology,* 97 (1), 70-74.

Loftus, E.F., & Scheff, R.W. (1971). Categorization norms for fifty representative instances. *Journal of Experimental Psychology,* 91, 355-364.

Long, D.L., Golding, J.M., Graesser, A.C., & Clark, L.F. (1990). Goal, event, and state inferences: an investigation of inference generation during story comprehension. In A.C. Graesser and G.H. Bower *The psychology of learning and motivation: advances in research and theory,* Vol.25, *Inferences and text comprehension.* (pp.89 - 102). San Diego, CA: Academic Press.

Losonsky, M. (1990). The nature of artifacts. *Philosophy,* 65, 81-88.

Lucas, M. M. (1991). Semantic representation of meaning: A defense. *Psychological Bulletin,* 110, 254-263.

Lyons, J. (1977). *Semantics* (2 vols.). New York: Cambridge University Press.

McClelland, J.L. (1979). On the time relations of mental processes: An examination of systems of processes in cascade. *Psychological Review,* 86, 287 - 330.

McCloskey, M.E., & Glucksberg, S. (1978). Natural categories: Well-defined or fuzzy sets? *Memory & Cognition,* 6, 462-472.

McCloskey, M.E., & Glucksberg, S. (1979). Decision processes in verifying category membership statements: Implications for models of semantic memory. *Cognitive Psychology,* 11, 1-37.

McFarland, C.E., Jr., Frey, T.J., & Rhodes, D.D. (1980). Retrieval of internally versus externally generated words in episodic memory. *Journal of Verbal Learning and Verbal Behavior,* 19, 210-255.

McMullen, T. (1988). Psychology and realism. Paper presented at the Twenty-fourth International Congress of Psychology, Sydney, Australia.

McMullen, T. (1991). Concepts are "out there" not "in here". Staff Colloquium, Department of Psychology, University of Sydney.

McNamara, T.P., & Sternberg, R.J. (1983). Mental models of word meaning. *Journal of Verbal Learning and Verbal Behavior,* 22, 449-474.

Malt, B.C. (1985). Hedges and the mental representation of categories. CC-AI: *The Journal for the integrated study of Artificial Intelligence, Cognitive Science, and Applied Epistemology,* 2, 13 - 23.

Malt, B.C. (1990). Features and beliefs in the mental representation of categories. *Journal of Memory and Language,* 29, 289 - 315.

Malt, B.C. (1993). Concept structure and category boundaries. In G.V. Nakamura, D.L. Medin, and R. Taraban (Eds.), *The Psychology of Learning and Motivation:* Vol. 29. *Categorization by Humans and Machines,* (pp.363 - 390). San Diego, CA: Academic Press.

Malt, B.C. & Johnson, E.C. (1992). Do artifact concepts have cores? *Journal of Memory and Language,* 31, 195 - 217.

Malt, B.C., & Smith, E.E. (1982). The role of familiarity in determining typicality. *Memory and Cognition,* 10, 69-75.

Malt, B.C., & Smith, E.E. (1984). Correlated properties in natural categories. *Journal of Verbal Learning and Verbal Behavior,* 23, 250-269.

Mayr, E. (1982). *The growth of biological thought: Diversity, evolution and inheritance.* Cambridge, MA: Belknap Press.

Maze, J.R. (1983). *The meaning of behaviour.* London: Allen & Unwin.

Maze, J.R. (1991). Representationism, realism, and the redundancy of "mentalese". *Theory and Psychology,* 1, 163-185.

Medin, D.L. (1983). Structural principles in categorization. In T. Tighe and B.E. Shepp (Eds.), *Perception, Cognition, and Development: Interactional Analyses* (pp. 203-230). Hillsdale, NJ: Erlbaum.

Medin, D.L. (1989). Concepts and conceptual structure. *American Psychologist,* 44, 1469-1481.

Medin, D.L., Altom, M.W., Edelson, S.M., & Freko, D. (1982). Correlated symptoms and simulated medical classification. *Journal of Experimental Psychology: Learning, Memory, and Cognition,* 8, 37-50.

Medin, D.L., Goldstone, R.L., & Gentner, D. (1993). Respects for similarity. *Psychological Review,* 100, (2), 254-278.

Medin, D.L., & Ortony, A. (1989). Psychological essentialism. In S. Vosniadou & A. Ortony (Eds.), *Similarity and analogical reasoning* (pp.179-195). Cambridge, England: Cambridge University Press.

Medin, D.L., & Ross, B.H. (1989). The specific character of abstract thought: Categorization, problem-solving, and induction. In R.J. Sternberg (Ed.), *Advances in the psychology of human intelligence* (Volume 5, pp. 189-223). Hillsdale, NJ: Erlbaum.

Medin, D.L., & Schaffer, M.M. (1978). Context theory of classification learning. *Psychological Review,* 85, 207-238.

Medin, D.L., & Shoben, E.J. (1988). Context and structure in conceptual combination. *Cognitive Psychology,* 20, 158-190.

Medin, D.L., & Smith, E.E. (1984). Concepts and concept formation. *Annual Review of Psychology,* 35, 113-138.

Medin, D.L., & Wattenmaker, W.D. (1987). Category cohesiveness, theories, and cognitive archeology. In U. Neisser (Ed.), *Concepts and conceptual development* (pp. 25 -62). Cambridge, England: Cambridge University Press.

Mervis, C.B., Catlin, J., & Rosch, E. (1976). Relationships among goodness-of-example, category norms, and word frequency. *Bulletin of the Psychonomic Society*, 7, 283-284.

Mervis, C.B., & Rosch, E. (1981). Categorization of natural objects. *Annual Review of Psychology*, 32, 89-115.

Michalski, R.S. (1989). Two-tiered concept meaning, inferential matching, and conceptual cohesiveness. In S. Vosniadou & A. Ortony (Eds.), *Similarity and analogical reasoning* (pp. 122 - 145). New York: Cambridge University Press.

Michalski, R.S. (1993). Beyond prototypes and frames: the two-tiered concept representation. In I.Van Mechelen, J. Hampton, R.S. Michalski, and P. Theuns (Eds.), *Categories and Concepts: Theoretical Views and Inductive Data Analysis* (pp.145-172). London: Academic Press.

Michell, J.B. (1988). Maze's direct realism and the character of cognition. *Australian Journal of Psychology*, 40, 227-249.

Michotte, A. (1963). *Perception of causality.* London: Methuen.

Miller, G.A., & Johnson-Laird, P.N. (1976). *Language and perception.* Cambridge, MA: Harvard University Press.

Murphy, G.L. (1988). Comprehending complex concepts. *Cognitive Science*, 12, 529-562.

Murphy, G.L. (1993a). Theories and concept formation. In I.Van Mechelen, J. Hampton, R.S. Michalski, & P. Theuns (Eds.), *Categories and Concepts: Theoretical Views and Inductive Data Analysis.* (pp.174-200) London: Academic Press.

Murphy, G.L. (1993b). A Rational Theory of Concepts. In G.V. Nakamura, D.L. Medin, and R. Taraban (Eds.), *The Psychology of Learning and Motivation:*

Vol. 29. *Categorization by Humans and Machines,* (pp. 327-359). San Diego, CA: Academic Press.

Murphy, G.L., & Medin, D.L. (1985). The role of theories in conceptual coherence. *Psychological Review,* 92, 289-316.

Murphy, G.L., & Wisniewski, E.J. (1989). Feature correlations in conceptual representations. In G. T. Tiberghien (Ed.), *Advances in cognitive science:* Vol. 2. *Theory and applications* (pp.23-45). Chichester: Ellis Horwood.

Murphy, G.L., & Wright, J.C. (1984). Changes in conceptual structure with expertise: differences between real-world experts and novices. *Journal of Experimental Psychology: Learning, Memory, and Cognition,* 10, 144-155.

Neisser, U. (1967). *Cognitive Psychology* Englewood Cliffs, NJ: Prentice-Hall.

Neisser, U. (1987). From direct perception to conceptual structure. In U. Neisser (Ed.), *Concepts and conceptual development* (pp.11-24). Cambridge, England: Cambridge University Press.

Nelson, K. (1974). Concept, word and sentence: Inter-relations in acquisition and development. *Psychological Review,* 81, 267 - 285.

Nosofsky, R.M. (1988). Exemplar-based accounts of relations between classification, recognition, and typicality. *Journal of Experimental Psychology: Learning, Memory, and Cognition,* 14, 700-708.

Nosofsky, R.M. (1989). Further tests of an exemplar-similarity approach to relating identification and classification. *Perception and Psychophysics,* 45, 279-290.

Oden, G.C. (1977). Integration of fuzzy logical information. *Journal of Experimental Psychology: Human Perception and Performance,* 3, 565-575.

Oden, G.C. (1987). Concepts, knowledge, and thought. *Annual Review of Psychology,* 38, 203-227.

Ortony, A., Vondruska, R.J., Foss, M.A., & Jones, L.E. (1985). Salience, similes, and the asymmetry of similarity. *Journal of Memory and Language,* 24, 569-594.

Osherson, D.N. (1978). Three conditions on conceptual naturalness. *Cognition,* 6, 263-289.

Osherson, D.N., & Smith, E.E. (1981). On the adequacy of prototype theory as a theory of concepts. *Cognition,* 9, 35-58.

Osherson, D.N., & Smith, E.E. (1982). Gradedness and conceptual conjunction. *Cognition,* 12, 299 - 318.

Pinker, S. (1979). Formal models of language learning. *Cognition,* 7, 217-283.

Plato. (1941). *The Republic* (F.M. Cornford, Trans.), Oxford.

Plato. (1956). *Great Dialogues of Plato.* E.H. Warmington & P.G. Rouse (Eds.). New York: The New American Library.

Posner, M.I., & Keele, S. (1968). On the genesis of abstract ideas. *Journal of Experimental Psychology,* 77, 353-363.

Putnam, H. (1975a). Is semantics possible? In H. Putnam (Ed.), *Philosophical papers* (Vol. 2). *Mind, language and reality* (pp.139-152). Cambridge, England: Cambridge University Press.

Putnam, H. (1975b). The meaning of "meaning". In K. Gunderson (Ed.), *Language, Mind and Knowledge: Minnesota Studies in the Philosophy of Science,* (Vol. 7, pp.215-271). Minneapolis: University of Minnesota Press.

Putnam, H. (1977). Meaning and reference. In S.P. Schwartz (Ed.), *Naming, necessity, and natural kinds* (pp.119-132). London: Cornell University Press.

Putnam, H. (1981). *Reason, truth, and history.* Cambridge, England: Cambridge University Press.

Putnam, H. (1989). *Representation and Reality.* Cambridge, Massachusetts: MIT Press.

Pylyshyn, Z.W., & Demopoulos, W. (Eds.), (1986). *Meaning and cognitive structure: Issues in the computational theory of mind.* Norwood, New Jersey: Ablex.

Quine, W.v.O. (1969). Natural kinds. In W.v.O. Quine, *Ontological relativity and other essays.* New York: Columbia University Press.

Quine, W.v.O. (1977). Natural kinds. In S.P. Schwartz (Ed.), *Naming, necessity, and natural kinds* (pp.155-175). London: Cornell University Press.

Quinlan, J.R. (1986). Induction of decision trees. *Machine Learning,* 1, 81-106.

Reed, S.K. (1972). Pattern recognition and categorization. *Cognitive Psychology,* 3, 382-407.

Rey, G. (1983). Concepts and stereotypes. *Cognition,* 15, 237-262.

Rey, G. (1985). Concepts and conceptions: A reply to Smith, Medin and Rips. *Cognition,* 19, 297-303.

Rips, L.J. (1975). Inductive judgments about natural categories. *Journal of Verbal Learning and Verbal Behavior,* 14, 665-681.

Rips, L.J. (1986). Mental muddles. In M. Brand & R.M. Harnish, (Eds.), *Representation of knowledge and belief* (pp. 258 - 286). Tucson, AZ : University of Arizona Press.

Rips, L.J. (1988). Deduction. In R.J. Sternberg & E.E. Smith (Eds.), *The Psychology of Human Thought* (pp. 116 - 152). Cambridge: Cambridge University Press.

Rips, L.J. (1989). Similarity, typicality, and categorization. In S. Vosniadou & A. Ortony (Eds.), *Similarity and analogical reasoning* (pp. 21-59). Cambridge, England: Cambridge University Press.

Rips, L.J. (1990). Reasoning. *Annual Review of Psychology,* 41, 321 - 353.

Rips, L.J., Shoben, E.J., & Smith, E.E. (1973). Semantic distance and the verification of semantic relations. *Journal of Verbal Learning and Verbal Behavior,* 12, 1-20.

Rogers, T.B., Kulper, N.A., & Kirker, W.S. (1977). Self-reference and the encoding of personal information. *Journal of Personality and Social Psychology,* 35, 677-688.

Rosch, E. (1973). On the internal structure of perceptual and semantic categories. In T.E. Moore (Ed.), *Cognitive development and the acquisition of language* (pp.123-142). San Diego, CA: Academic Press.

Rosch, E. (1975a). Cognitive representations of semantic categories. *Journal of Experimental Psychology,* 104, 192-233.

Rosch, E. (1975b). Cognitive reference points. *Cognitive Psychology,* 7, 532-547.

Rosch, E. (1975c). Reply to Loftus. *Journal of Experimental Psychology: General,* 104, 241-243.

Rosch, E. (1978). Principles of categorization. In E. Rosch & B.B. Lloyd (Eds.), *Cognition and categorization* (pp. 27 - 48). Hillsdale, NJ: Erlbaum.

Rosch, E. (1983). Prototype classification and logical classification: The two systems. In E.K. Scholnick (Ed.), *New Trends in Conceptual Representation: Challenges to Piaget's Theory?* (pp.73-85). Hillsdale, NJ: Erlbaum.

Rosch, E., & Mervis, C.B. (1975). Family resemblances: Studies in the internal structure of categories. *Cognitive Psychology,* 7, 573-605.

Rosch, E., Mervis, C.B., Gray, W.D., Johnson, D.M., & Boyes-Braem, P. (1976). Basic objects in natural categories. *Cognitive Psychology,* 8, 382-439.

Rosch, E., Simpson, C., & Miller, R.S. (1976). Structural bases of typicality effects. *Journal of Experimental Psychology: Human Perception and Performance,* 2, 491-502.

Roth, E.M., & Shoben, E.J. (1983). The effect of context on the structure of categories. *Cognitive Psychology,* 15, 346-378.

Rumelhart, D. (1980). Schemata: The building blocks of cognition. In R.J. Spiro, B.C. Bruce, & W.F. Brewer (Eds.), *Theoretical issues in reading comprehension* (pp. 33 - 58). Hillsdale, NJ: Erlbaum.

Ruse, M. (1969). Definitions of species in biology. *British Journal for the Philosophy of Science,* 20, 97-119.

Santambrogio, M., & Violi, P. (1988). Introduction. In U. Eco, M. Santambrogio, & P. Violi (Eds.), *Meaning and mental representations* (pp.3-22). Bloomington, IL: Indiana University Press.

Schank, R.C., Collins, G.C., & Hunter, L.E. (1986). Transcending inductive category formation in learning. *Behavioral and Brain Sciences,* 9, 639 - 686.

Schwartz, S.P. (1977). *Naming, necessity, and natural kinds.* London: Cornell University Press.

Schwartz, S.P. (1978). Putnam on artifacts. *Philosophical Review,* 87, 566 - 574.

Schwartz, S.P. (1979). Natural kind terms. *Cognition,* 7, 301-315.

Schweder, R.A. (1977) Likeness and likelihood in everyday thought: Magical thinking in judgments about personality. *Current Anthropology,* 18, 4.

Schweickert, R. (1978). A critical path generalization of the additive factor method: analysis of a Stroop task. *Journal of Mathematical Psychology,* 18, 105 - 139.

Schweickert, R. (1983). Latent network theory: Scheduling of processes in sentence verification and the Stroop effect. *Journal of Experimental Psychology: Learning, Memory and Cognition,* 9, 353 - 383.

Schyns, P.G. & Murphy, G.L. (1994). The ontogeny of part representation in object concepts. In D. L. Medin (Ed.), *The psychology of learning and motivation:*

advances in research and theory, Vol. 31 (pp. 309 - 349). San Diego, CA: Academic Press.

Shanon, B. (1988a). Semantic representation of meaning: A critique. *Psychological Bulletin,* 104, 70-83.

Shanon, B. (1988b). On similarity of features. *New Ideas in Psychology,* 6, 307-321.

Shapiro, S.L., & Palermo, D.S. (1970). Conceptual organization and class membership: Normative data for representatives of 100 categories. *Psychonomic Monograph Supplements,* 3, 107-127.

Shipley, E. (1993). Categories, hierarchies, and induction. In D.L. Medin (Ed.)., *The psychology of learning and motivation: Representation and processing of categories and concepts,* Vol.30, (pp.225 - 264). San Diego, CA: Academic Press.

Slamecka, N.J., & Graf, P. (1978). The generation effect: Delineation of a phenomenon. *Journal of Experimental Psychology: Human Learning and Memory,* 4, 592-604.

Slamecka, N.J. & Katsaiti, L.T. (1987). The generation effect as an artifact of selective displaced rehearsal. *Journal of Memory and Language,* 26, 689-607.

Smith, E.E. (1978). Theories of semantic memory. In W.K. Estes (Ed.), *Handbook of learning and cognitive processes* (Vol. 6, pp. 1 - 56). Hillsdale, NJ: Erlbaum.

Smith, E.E. (1989). Concepts and induction. In M.I. Posner (Ed.), *Foundations of cognitive science* (pp. 501 - 526). Cambridge, MA: MIT Press.

Smith, E.E. (1990). Categorization. In D.N. Osherson & E.E. Smith (Eds.), *Thinking: An invitation to cognitive science* (Vol. 3, pp. 33-53). Cambridge, MA: MIT Press.

Smith, E.E., & Medin, D.L. (1981). *Categories and Concepts.* Cambridge, Mass: Harvard University Press.

Smith, E.E., Medin, D.L., & Rips, L.J. (1984). A psychological approach to concepts: Comments on Rey's "Concepts and stereotypes." *Cognition,* 17, 265-274.

Smith, E.E, Shoben, E.J., & Rips, L.J. (1974). Structure and process in semantic memory: A featural model for semantic decisions. *Psychological Review,* 81, 214-241.

Smith, E.R. (1984). Models of social inference processes. *Psychological Review,* 91, 392-413.

Snow, P. (1991) Rationality and irrationality: still fighting words. Comment on J.R. Anderson, Is human cognition adaptive? *Behavioral and Brain Sciences,* 14, 505-506.

Sternberg, S. (1969a). The discovery of processing stages: extensions of Donders' method. In W.G. Koster (Ed.), *Attention and Performance* (Vol. 2), *Acta Psychologica,* 30, 276-315.

Sternberg, S. (1969b). Memory scanning: mental processes revealed by reaction time experiments. *American Scientist,* 57, 421-457.

Sternberg, S. (1975). Memory scanning: new findings and current controversies. *Quarterly Journal of Experimental Psychology,* 27, 1-32.

Suppe, F. (Ed.). (1977). *The structure of scientific theories.* Urbana, IL: University of Illinois Press.

Sutcliffe, J.P. (1993). Concept, class, and category in the tradition of Aristotle. In I.Van Mechelen, J. Hampton, R.S. Michalski, & P. Theuns (Eds.), *Categories and Concepts: Theoretical Views and Inductive Data Analysis* (pp.35-65). London: Academic Press.

Townsend, J.T. (1990). Serial versus parallel processing: Sometimes they look like Tweedledum and Tweedledee, but they can (and should) be distinguished. *Psychological Science,* 1, 46-54.

Tversky, A. (1977). Features of similarity. *Psychological Review,* 84, 327-352.

Tversky, A., & Gati, I. (1978). Studies of similarity. In E. Rosch & B.B. Lloyd (Eds.) *Cognition and categorization* (pp.81-98). Hillsdale, NJ: Erlbaum.

Tversky, B. & Hemenway, K. (1984). Objects, parts, and categories. *Journal of Experimental Psychology: General,* 113, 169 - 193.

Vandierendonck, A. (1988). Typicality gradient in well-defined artificial categories. *Acta Psychologica,* 69, 61-81.

Vandierendonck, A. (1990). Rule structure, frequency, typicality gradients, and the representation of diagnostic categories. In K.J. Gilhooly, M.T.G. Keane, R.H. Logie, & G. Erdos (Eds.), *Lines of Thinking: Reflections on the psychology of thought. Volume 1: Representation, Reasoning, Analogy and Decision Making* (pp. 29-40). Chichester: Wiley.

Van Mechelen, I., De Boeck, P., Theuns, P., & Degreef, E. (1993). Categories and Concepts: Theoretical views and inductive data analysis. In I.Van Mechelen, J. Hampton, R.S. Michalski, & P. Theuns (Eds.), *Categories and Concepts: Theoretical Views and Inductive Data Analysis* (pp.333-351). London, Academic Press.

Van den Broek, P. (1990). Causal inferences and the comprehension of narrative texts. In A.C. Graesser and G.H. Bower *The psychology of learning and motivation: advances in research and theory,* Vol.25, *Inferences and text comprehension.* (pp.175 - 196). San Diego, CA: Academic Press.

Ward, T.B. (1993). Processing biases, knowledge, and context in category formation. In G.V. Nakamura, D.L. Medin, and R. Taraban (Eds.), *The Psychology of Learning and Motivation:* Vol. 29. *Categorization by Humans and Machines,* (pp. 257 - 282). San Diego, CA: Academic Press.

Watanabe, S. (1969). *Knowing and guessing: A formal and quantitative study.* New York: Wiley.

Wattenmaker, W.D., Nakamura, G.V., & Medin, D.L. (1988). Relationships between similarity-based and explanation-based categorization. In D.J. Hilton

(Ed.), *Contemporary Science and Natural Explanation: Commonsense Conceptions of Causality* (pp. 204 - 240). Brighton, Sussex: Harvester Press.

Whewell, W. (1967). *The philosophy of the inductive sciences* (2 Vols.). New York: Johnson Reprint. (Original work published 1847)

Whorf, B.L. (1956). *Language, thought, and reality: Selected writings of Benjamin Lee Whorf* (J.B. Carroll, Ed.). Cambridge, MA: MIT Press.

Wiggins, D. (1980). *Sameness and substance.* Cambridge, MA: Harvard University Press.

Wilkins, A.J. (1971). Conjoint frequency, category size, and categorization time. *Journal of Verbal Learning and Verbal Behavior,* 10, 382-385.

Wittgenstein, L. (1953). *Philosophical investigations* (2nd ed.), (G.E.M.Anscombe, Trans.). Oxford: Blackwell.

Zadeh, L. (1965). Fuzzy sets. *Information and Control,* 8, 338-353.

Zadeh, L. (1978). PRUF. A meaning representation language for natural languages. *International Journal of Man-Machine Studies,* 10, 395-460.

APPENDICES

APPENDIX A

ADDENDUM TO CHAPTER ONE

GLOSSARY OF TERMS AND PHRASES

Any definitions of terms involving categories and concepts will vary according to the perspectives of the different writers in the field. Those provided here are, at best, approximations to the general consensus. They are based upon terms specified by Murphy and Medin (1985) and by Hampton and Dubois (1993).

Human beings, in their thoughts and language, treat particular objects, living entities and events as members of *categories.* A *category* is a class or set of entities in the world (whether they be individual objects, actions, states, qualities or events) which seem to belong together on the basis of some criterion or rule. *Category* as defined here can be understood as a set of real objects in the world, or a set of mentally represented objects. A *concept* is the idea used to understand such a category, and is used to organize and select those entities or items which belong to the category. *Concept* as defined here can be constituted of an algorithmic formula, essential features, a prototype, diagnostic information or as an individual *exemplar. Exemplars* or *instances* are category members and can be any object or entity in the world which instantiates some mental concept. It is important to distinguish between *concept* and *category* as the two do not necessarily equate, as when someone's concept of *Animal* does not actually include all animals in the world (Murphy & Medin, 1985, Footnote 1, p. 290).

Classes are not the same as *categories*; their instances do not have an underlying structure, but are more like a grouping of objects. For example, linguistic classes would serve to classify an unstructured list of nouns. *Categorization* is the mental grouping of objects which are individually different, yet share certain characteristics in common. Categorization processes are the means by which a concept's representational structure and the external world interact. How an individual actually decides about membership in any particular situation need not be the same as the normative rule used by most people to map intensions onto extensions (Hampton & Dubois, 1993). Different concepts provide different categorization criteria, but almost all are based upon descriptive *property* information which enables the categorizer to divide the

world into, for example, *chairs* and *non-chairs*. *Property* refers to any predicate that can be truthfully stated of all or most of a category's instances.

Property is a generic term and Hampton and Dubois (1993) have listed various applications. Some descriptions involve perceptual properties, such as *wooden* or *dark*; while other properties, such as *supports weight* or *expensive*, require background knowledge to be known and applied by the categorizer. *Attribute* and *value* involve more abstract properties, and capture the existence of contrastive sets of properties in category members. *Attribute* is a property with a variety of mutually exclusive alternative possibilities termed its *values*. The attribute forms the dimension or aspect upon which the members of a category vary, while the values provide the different forms those aspects can take.

Thus, the foods of the category *What not to eat on a diet* will all have the attribute/property of being fattening, but have differently weighted values according to the number of calories they contain. *Feature* refers to an attribute which has only two values, present or absent (Jacobson, 1963; Bierwisch, 1971). Features have traditionally been considered to be perceptual or semantic primitives, the unanalyzed stuff out of which categories are made (Katz & Fodor, 1963). More specifically, *feature* usually means a physical property such as *wings* or *fins*.

Mental Representation is the form used by a person's mind to re-present an object or group of objects. In other words, the symbol (or type) stands for some object (or token) in its absence. "The token" can be an aspect of the external world or of one's own imagination (the internal world). *Structure* refers to the organized relationships among concepts which represent different categories. If the criteria for item-membership is not clearly defined, then a concept's boundaries with other concepts may be imprecise and "fuzzy". *Internal structure* refers to the relatedness of items within the same category. When a concept's internal structure is ill-defined, this "fuzziness" creates a gradience in the item's membership, so that some items have greater degrees of membership than others. This results in internal gradient structure, often described in the literature as *typicality*, though there is some controversy in the literature on whether *typicality* could be said to be the same as *membership*.

APPENDIX B

ADDENDUM TO CHAPTER ONE

PHILOSOPHICAL BACKGROUND

Plato and Aristotle gave distinctly opposed accounts for the origins of knowledge and the stuff of reality, but they agree on the *logical* nature of knowledge and the passivity of the mind which contains or reflects it. Plato (born 427 BC) believed that a person is born with an innate knowledge of ideal forms. Not all people are born with the same degree of knowledge, and this determines the stratum of society the person is born into, the highest being the Philosopher Kings. Aristotle (born 384 BC) began at the opposite end of the scale, describing the newborn infant's mind as a blank slate, waiting to be written upon by life, so that a person's degree of understanding was based upon his or her breadth of experience throughout a lifetime.

Plato's worldview

While Aristotle made no divisions between the study of mind and the study of matter, Plato described a world where reality was composed of three levels: the ideal, the tangible, and the copy, as in a work of art. For Plato, general concepts or ideal forms had objective reality and were embodied in sensible objects. Specific objects and living things of the perceptual world depended upon ideal forms for their existence, which in their turn existed in a real, but to us invisible, world. As an example, in Book 10 of *The Republic* (circa 380 B.C.), he argued that, over and above the particular objects that are beautiful, exists a separate form for beauty itself. There is an absolute and eternal Form which corresponds with any single term (*Furniture*) used for a group of particulars (*beds, tables*) which are subject to change and decay. These latter objects were only imperfect examples of the ideal form which existed in a timeless and unchanging realm.

> "The craftsman, in making either of these articles of furniture, keeps his eye upon the ideal and so makes the beds or tables which we use accordingly, and so with other things." (Plato, Book 10 of *The Republic*)

Aristotle's worldview

Overall, Aristotle made no division between the study of mind and the study of matter, and he did not propose a primary level of reality consisting of unseen, ideal forms. The primary substance of reality is the specific and concrete token (*bed*) while the species or type of particular object (*Furniture*) becomes only a secondary kind of substance. For Aristotle, knowledge was based upon a subjective experience of substance, so that all thoughts and perceptions of reality arose through the senses, and were determined by them. Aristotle's *De Anima* is for the most part empiricist and materialist in its approach to the concept of mind, which he describes as a passive "tabula rasa" upon which experiences are engraved.

> "In general, those things are really united which must be conceived by the same formula for their essential being." (Aristotle, Book Delta in the *Metaphysics*).

Both philosophers were metaphysical realists. Metaphysical realism is the doctrine that meanings are determined by the nature of the world, and are wholly independent of the way in which the mind works. Universal categories are "out there" and their existence is in no way dependent on minds or our own processes of conceptualization. If there were no minds to apprehend universals, they would still exist, as universals constitute primary reality, and it is the mind's task to "discover" them.

One traditional metaphysical issue between materialists and idealists concerns into what categories reality is divided. Since the problem is not an empirically resolvable one, it might be simply a verbal debate on how to categorize our experiences. But metaphysicians see their task as being one of "slicing reality at its joints", to paraphrase Plato and Rosch. For that, assumptions first need to be made about the primary substance of reality: are boundaries drawn between Plato's intangible and material levels of the world, or between Aristotle's bundles of material properties (Hospers, 1990)?

Things in the real world are of many different kinds - wood, chalk, granite, and so on - but the constituents of these various kinds are relatively small in number. Hospers (1990) claims that about a hundred basic elements are known, from which all objects and entities are composed in various mixtures or combinations, so that each material thing or entity has many different

characteristic elements. Is the primary reality of an entity an Aristotelian formula defining its complex of material properties, or do these properties presuppose some Platonic intangible form? One way to answer this is to first consider which is prior: substance or form?

How do objects and their constituents undergo change? To give an example taken from Hospers (1990), gold has a certain colour, melting-point, malleability, weight per unit of volume, and so on. The question is asked, "How many properties could be removed and still have the specific thing remain gold?" The physical property of colour might be removed, but the object would still be gold. To give a clear answer, one would have to know the defining characteristics of gold. So if these were removed, while the thing in question would no longer be called "gold", we would still be left with *some material substance or other.*

The metaphysical puzzle begins when all the material properties are removed, including extension, mass, and shape: would *nothing at all* be left? The answer given by an Aristotelian would be that not only is no material substance left, there is nothing left: no properties left, and no "it" to possess them. The defining formula needs the various physical elements to be present before it can come into being. Gold is no more than the sum of its parts, and the primary substance of reality is material properties.

A Platonic answer would be that gold is one thing and its properties are something else. Gold (or "it") has to exist , before the properties of gold can exist. Logically (not chrono-logically), gold is seen as a spiritual and intangible substance which exists prior to its elements. Gold is more than the sum of its parts: the phrase "its parts (or properties)" implies an "it" existing prior to them, to which such properties have to belong. Intangible substance serves to tie the bundle of physical properties together and make gold an entity. Unlike Aristotle's formulas, this pure qualityless form can also exist independently of a physical configuration of properties. If the whole debate about the nature of primary reality (substance or form) is simply a verbal or linguistic problem, then a nominalist position on categories is being assumed. This explains the Platonic "it" as simply the name given to a collection of properties coexisting in place and time, creating *an illusion* of something that exists other than the object's properties (Hospers, 1990).

These dichotomous views on what constituted primary reality were reflected in the classical categories of the ancient Greeks. Where Plato spoke of universal forms, Aristotle spoke of universal essences. In Aristotelian philosophy, a thing's essence is given by specifying its defining properties - its "essential" as opposed to "accidental" properties. Thus what sets a triangle apart from a square is the former's essential property of three-sidedness. Concerning categories, Aristotle argued that what makes a man a man is a set of essential characteristics, which do not have a separate existence, but must always be instantiated or embodied in particular individuals.

Both philosophers held the view that categories are "discovered" through passive abstractions. They simply differ in their accounts on how that abstraction came about, because they began with differing assumptions about the origins of knowledge: either it is innate, or it is due to environmental conditioning. Aristotle (who was a mathematician) describes the discovery of a universal algorithm or formula which covers many of the same experiences and facilitates memory of them. Notice that Aristotle uses the phrase "the same thing" rather than "similar things", suggesting that what is abstracted is an algorithm based upon essences defining membership

> "As a result of seeing the same thing happen many times we would look for the universal and have a proof; the universal becomes clear from a number of particular instances." (Aristotle, *Posterior Analytics,* Chapter 31, Book 1)

For Plato, the abstract plan governing membership of a classical category was the absolute and eternal Form, there in its own right, and irrespective of mankind's existence. The mind could possess (remember) all things through its use of such plans or organizing principles. The knowledge of innate ideal forms (or general rules) could be applied to discover the category to which an object belonged, and of which it was an embodiment. This innate abstraction is clearly a more economical way of storing knowledge than an Aristotelian universal algorithm applied to specific experiences. However, because such a mind can remember only the organizing principle underlying the many exemplars, rather than any specific exemplar, many specific details of experience would be lost.

The classical theories of categorization put forward by the ancient Greeks do not allow for much flexibility in drawing inferences, because the assumption is that each object in the world has one, and only one, correct category to which it belongs. A Platonic mind allows for inferential processes to be at work

discovering ideal forms, but these are unchanging and eternal, and any instance must belong to its category and no other. Such a mind has little room for alternative points of view. Similarly, the Aristotelian mind would entail that processes be automatic, making no allowance for effects of context. Both accounts of mind are describing more or less inflexible processes of categorization for new members (Gardner, 1987; Lakoff, 1987).

To summarize the two worldviews, Aristotle was claiming that the physical environment alone determines our concepts, engraving experiences upon our minds as upon a blank slate. Plato's world had an extra level of intangible reality which consisted of perfect ideals, and these forms (of which mankind had an innate knowledge) determined how we categorize our tangible reality. The main area of agreement among the ancient Greeks was that an objective reality does exist irrespective of mankind's presence or absence from the world, and that only one "correct" or truthful reality is possible.

The role of experience in knowledge: passive or active minds?

The ancient Greeks had been concerned with the metaphysical problem of "what is". With the advent of the era of Enlightenment, philosophers became concerned with "our knowledge of what is" or epistemology (Gardner, 1987). These later philosophers began to question whether minds passively "discover" laws of nature: or do they take a more active role in interpreting or creating reality, so that knowledge might be constituted of many people's different realities. Both the Empiricists and the Rationalists seem to have had difficulty in letting-go of the belief in one ultimate Truth, but they disagreed on where it was to be found.

One area of the debate concerned the role of sensory experience of the world around us: are the senses the source of all error, or our only source of reliable knowledge (Gregory, 1987)? A related area concerned the ontological status of concepts and categories. The Rationalists started on the assumption that we are born with *a priori* concepts which determine how we categorize our experiences and generally understand the world around us. The Empiricists believed that the world's objects, their properties and relations which we experienced, would influence the concepts we induced from the world's naturally occurring categories (Hampton & Dubois, 1993).

For Rationalist philosophers such as Descartes, the mind possesses innate awareness of certain fundamental concepts (God, triangle, mind, body) and elementary propositions of logic (such as it is impossible for the same thing to be and not to be). It is this innate awareness that enables the mind to arrive at knowledge which exists *a priori,* independently of the senses. Descartes gave the body a negative role in the construction of knowledge, describing the inconstancies of sense-experience as the source of all human error. He attributed thought and creativity to the mind, whose self-awareness was the ultimate arbiter of truth. Plato's theory of innate ideas played a crucial role in the metaphysical systems of seventeenth century Rationalist philosophers (Gregory, 1987).

The Rationalists' views were challenged by a group of philosophers known as the British empiricists, who lived and wrote between the 1650's and the 1770's: John Locke, George Berkeley, and David Hume. Although very different in detail, the common theme of all empiricist philosophies is that observations are taken as the source of all knowledge, and sensory knowledge is taken to be unquestionably true in order to give a basis for certain knowledge, although empiricist philosophers seldom agree as to what knowledge is certain. Empiricist philosophers derived their theories from Aristotle.

Locke introduced the notion of ideas and their relation to objects in the external world. His term "idea" refers to various things, including sensations, memories and concepts. Echoing Aristotle, in his "*Essay concerning human understanding*", John Locke (1968) described a mind that at birth was akin to a blank page.

> " Whence has it all the materials of Reason and Knowledge? How then comes it to be furnished with that vast store which the busy and boundless fancy of man has painted on it? To this I answer in one word, from experience." (Locke, 1968)

Locke firmly believed that ideas based upon reflection do not lead to *reliable* knowledge. This is where the Empiricist philosophers differed most from Descartes. Unlike Descartes who believed "I think, therefore I am", introspective reflection was not considered enough to *prove* the existence of a thing, or arrive at the truth of a proposition. Such testing and verification was only possible through sense experiences. Simple concepts were induced from the sensory experience of associating the different objects in the world.

The debate between the Empiricists and the Rationalists was resolved by Immanuel Kant (1724-1804) with his philosophy of "transcendental idealism" which was actually a synthesis of rationalism and empiricism. On the one hand, he condemns the aspirations of the Rationalists for a world of pure, *a priori* knowledge independent of the senses; whilst on the other hand, he rejects the Empiricist notion that knowledge is founded purely on sensory data (Gregory, 1987).

A major theme in his philosophy is the question of whether human knowledge can transcend the senses; and of whether and in what sense, *a priori* knowledge is possible. He resolved the drawbacks of both philosophies by introducing the notion of mental representations of knowledge to explain how we use both *a priori* knowledge and sensory information to understand experience. In his *Critique of Pure Reason* (1934), Kant argues that in order to understand the world, the mind is born armed with certain concepts. These concepts are derived from certain fundamental categories (such as the Category of substance and the Category of causality). The Categories are *a priori* in that they already exist, but our concept of them can only be brought to awareness by experience. Kant (1934) distinguishes two primary subjective sources of these concepts: the *sensibility* and the *understanding*, with imagination serving as the go-between. In general, we cannot characterize even a momentary perception except by giving it a label of some sort: we see what we see *asa* tree, or *asa* cat. Thus, we unite an instantaneous impression with past impressions (of the same object or of objects of the same kind).

Kant (1934) saw imagination as a necessary and transcendental mediator, and as the source of those very general *a priori* concepts (the Categories) which were used in experience to organize types of objects and events. It is the subjective source of those general principles of conceptualization (the Categories) which enable and require us to conceptualize our intuitions in such a fashion that order is imposed upon our world. Consequently, we perceive objects as existing in a law-governed world (Gregory, 1987).

To sum up the debate, the Rationalists believed that the mind exhibits innate powers of reasoning and that innate concepts help us to achieve insight and understanding of the world of sensory experience. The Empiricists believed that our concepts either reflect, or are constructed on the basis of, external sensory impressions and the associations between them. Kant's (1781) account of an active mind which imposed order upon external reality, and created stable

mental representations of it, through use of its innate categories seemed to have resolved the debate. It fell into disfavour, however, with the rise of the Behaviourists, who distrusted any argument based on unseen and individual mental processes. Their theories renewed enthusiasm for the notion of a passive mind whose conditioning by sensory experience explained many abnormal and learned behaviours. They, in turn, were challenged by the advent of the computer and artificial intelligence, so that cognitive processes and representations again became the area of interest (Gardner, 1987).

Ultimately, the origins of knowledge first debated by the Rationalists and Empiricists have far-reaching implications for what constitutes genuine knowledge about the world. Does meaning and knowledge lie within ourselves, or should we look to the outside world and nature for it? The positions taken up by the Rationalists and Empiricists on this question meant that they differed on the ontological status of concepts and categories, which of these came first and consequently was the source of genuine knowledge and meaning. The *a priori* innate concepts described by Descartes were used to interpret meaning from the chaos of external reality by organizing it into categories. The Empiricists saw concepts and their rules as being induced from, and governed by, the ontological categories of the outside world (Hampton & Dubois, 1993; Van Mechelen, de Boeck, Theuns & Degreef, 1993). Yet a third view of concepts and their categories would probably derive from Kant's notions of the imagination acting as a mediator between understanding (innate knowledge) and sensibility (sensory input from the outside world). This last view might be termed constructivist, insofar that people are said to actively construe their own mental representation of how they conceptualize external reality (Hampton & Dubois, 1993; Murphy, 1993a; 1993b).

APPENDIX C

ADDENDUM TO CHAPTER TWO

ROSCH'S EARLY STUDIES IN PROTOTYPE THEORY

The Prototype as an abstract composite

In 1973 and 1975a, Rosch conducted studies where subjects were presented with the names of everyday categories, each followed by a randomly ordered list of members. Their task was to rate each category member according to how good an example it might be of that category, using a 7-point scale. Large numbers of subjects were used for such studies so that the data would provide a standardised control or cultural norm. The results showed that some category members were considered to be more typical than others, and there was a high level of agreement between ratings for an item given by different subjects.

But it could be argued that the high level of subject agreement about ratings, rather than indicating genuine typicality effects, might simply signify that most subjects used the same heuristics during task performance. In addition, a mere goodness-of-example task cannot undermine classical theories of categorization, as it cannot be said to be measuring membership decisions directly. Consequently, for the 1973 study, Rosch also used a semantic categorization task, and was able to show that highly typical instances are categorized more readily than atypical instances.

In this study, subjects were given, on each trial, the name of a target category such as *Bird* followed by a test item such as *robin*. The task was to decide as quickly as possible whether or not the test item was a member of the target category. Results showed that more typical items elicited faster response times and fewer errors. Supporting studies by Rosch showed that typicality can affect the order in which category items are remembered. For instance, when subjects are asked to list all the members of a given category, they tend to produce items in order of their typicality.

The Prototype as an independent feature list

Rosch and Mervis (1975) asked their subjects to list the attributes they associated with members of particular categories. Their aim was for subjects to externalize the defining characteristics of a category. Subjects were given

randomly ordered lists of terms belonging to everyday common categories such as *Fruit,* ranging from highly typical items like *orange* to culturally atypical items like *coconut.* Their task was to list any attributes such as *sweet* or *juicy* which they associated with the term. Results showed that subjects listed more shared attributes for highly typical items than for atypical ones. The atypical items generated some attributes which were generated for atypical items of a contrast category. This was evidence that subjects were using the attributes to characterize the categories in terms of what they are most typically like, rather than to provide an "either-or" rule to determine category membership.

The study could be criticized on a number of points. Firstly, the task of attribute-listing may not capture knowledge of defining attributes, if such knowledge is implicit and the subject is unaware of using it during membership decisions. Secondly, Rosch's instructions did not encourage subjects to give defining attributes but rather asked for *any* attributes associated with the categories. Thirdly, the instructions biased responses towards perceptual features rather than those attributes (perhaps functional ones) shared by all members.

The Prototype as a specific exemplar instance

In her 1975b paper, "Cognitive reference points", Rosch suggested that the most typical instance of a category might act as an ideal-type anchor to which other instances are seen to relate. For example, it seems more natural to say "A zebra is virtually a horse", than vice versa. The second noun, then, might be referred to as the *reference point.* In this study, subjects placed pairs of word-stimuli into sentences consisting of linguistic "hedges" or terms referring to types of metaphorical distance such as "almost", "virtually", "roughly" and "loosely speaking". For example, "A_____ is virtually, almost, essentially, a _____." The stimuli consisted of words for colours, lines and numbers. Subjects were given pairs of stimuli and their task was to place them in the sentence frame, according to whichever sequence of words made the most sense, or seemed to be most true. Results showed the proposed reference point words being placed in the second (reference) slot in the sentence frame. Rosch suggested that this evidence of a specific exemplar acting as prototype might also apply to common semantic categories, such as *Furniture, Bird* and *Vehicle.*

Prototypes as bundles of correlated features in a natural hierarchy

The aim of the Rosch, Mervis, Gray, Johnson, and Boyes-Braem (1976) study, "Attribute listings for basic level categories", was to investigate the attributes which people list for categories at three different levels in conceptual hierarchies. One level (the intermediate level) is predicted to be the most inclusive level at which subjects list many attributes common to most category members, and few in common with contrast categories. The task was similar to that used in the Rosch and Mervis (1975) study, with subjects being presented with lists of category labels, and asked to list the attributes they associated with each. In this case, the category labels were divided into hierarchies, for example, the superordinate (*Fruit*), intermediate terms (*orange, apple*) and subordinates (*Navel orange, Seville orange*). In their study, the stimulus materials used as natural categories included man-made (that is, artifact) objects such as *musical instruments, tools, furniture, clothing*, and natural objects such as food, like *Fruit, Vegetables* and *Animals*. Results showed that, as predicted, subjects tended to list more attributes for the intermediate level of artifactual categories than at the other two levels. However, the hypothesis was not supported in the case of biological categories, because, in this case, the higher number of attributes listed occurred at the superordinate level (e.g., *Birds, Trees, Fish*).

APPENDIX D

Twelve levels of exemplar production frequencies per category in three different category-types, nine categories each (N = 100).

Category-Type: Natural Superordinate

Vegetable		Furniture		Musical Instruments	
1. Potato	90	Table	96	Piano	89
2. Carrot	85	Chair	93	Guitar	74
3. Pumpkin	71	Bed	90	Flute	69
4. Peas	66	Lounge	59	Drums	66
5. Broccoli	63	Desk	57	Violin	63
6. Bean	60	Cupboard	43	Trumpet	50
7. Cauliflower	44	Wardrobe	37	Clarinet	45
8. Zucchini	30	Bookcase	34	Cello	38
9. Cabbage	29	Stool	32	Saxophone	34
10. Onion	27	Cabinet	19	Harp	28
11.Tomato	26	Lamp	19	Organ	25
12.Lettuce	23	Chest	18	Trombone	23

Clothing		Utensils		Beverages	
1. Shirt	76	Knife	87	Coffee	85
2. Jumper	70	Spoon	76	Tea	82
3. Socks	70	Fork	74	Juice	69
4. Skirt	52	Frypan	40	Water	60
5. Jeans	52	Saucepan	33	Beer	55
6. Dress	50	Spatula	32	Wine	52
7. Shoes	47	Bowl	29	Milk	51
8. Jacket	44	Whisk	28	Spirits	42
9. Coat	44	Plate	22	Coke	35
10.Trousers	27	Collander	21	Lemonade	30
11.Shorts	26	Saucer	21	Cordial	27
12.Hat	25	Canopener	20	Liqueur	25

Weapons		Birds		Fish	
1. Gun	91	Magpie	63	Shark	61
2. Knife	90	Budgie	49	Trout	54
3. Rifle	51	Sparrow	48	Goldfish	52
4. Sword	46	Parrot	44	Bream	41
5. Bomb	42	Cockatoo	42	Flathead	40
6. Spear	36	Emu	31	Cod	40
7. Pistol	32	Galah	29	Salmon	38
8. Bow	29	Kookaburra	27	Tuna	31
9. Cannon	27	Finch	25	Barramundi	28
10. Grenade	24	Crow	23	Whiting	24
11. Missile	20	Canary	22	Perch	24
12. Axe	19	Hawk	21	Catfish	23

Category-Type: Property

Poisonous Things		Hot-on-tongue Things		Indistinct Sounds	
1. Spiders	84	Chillies	87	Whispers	53
2. Snakes	81	Curry	71	Voices	44
3. Arsenic	55	Pepper	70	Wind	39
4. Toadstools	55	Sauce	67	Rustling	38
5. Plants	41	Coffee	63	Mumbling	37
6. Chemicals	41	Tea	44	Murmuring	32
7. Cyanide	30	Spices	37	Traffic/cars	31
8. Drugs	25	Soup	36	Footsteps	28
9. Alcohol	25	Alcohol	28	Waves	25
10. Nicotine	23	Pepperoni	26	Static	24
11. Petrol	21	Onions	23	Music	19
12. Fish	21	Garlic	15	Humming	18

Grating Sounds		Red Things		Smelly Things	
1. Screams	45	Blood	47	Perfume	67
2. Chalk	43	Cars	45	Flowers	52
3. Fingernails	42	Apples	41	Food	52
4. Drills	40	Fire-engine	40	Roses	28
5. Music	35	Roses	35	People	24
6. Shrieks	31	Tomatoes	34	Pigs	21
7. Saw	23	Stoplight	27	Sweat	21
8. Machinery	22	Strawberry	25	Skunks	20
9. Voices	21	Sunset	22	Grass	20
10. Crying	20	Pens	21	Shoes	18
11. Violin	20	Clothes	19	Garlic	17
12. Alarm	19	Wine	18	Garbage	16

Comfortable Things		Disgusting Things		Things which make eyes water	
1. Bed	85	Crudity	37	Onions	87
2. Clothes	45	Vomit	34	Sadness	54
3. Pillow	43	Violence	34	Pain	38
4. Chair	43	Pornography	31	Smoke	37
5. Friends	39	Drunkeness	30	Laughter	35
6. Lounges	38	Dishonesty	25	Chilli	30
7. Slippers	35	Swearing	23	Wind	28
8. Hugs	30	Littering	22	Dust	27
9. Warmth	25	Dirt	21	Crying	25
10. Bath-tub	24	Murder	21	Chemicals	23
11. Jumper	21	Rape	21	Movies	17
12. Home	17	Mobsters	21	Colds	17

Category-Type: Ad Hoc

	What not to eat on a diet		Traits which will facilitate friendship		Things to take on a picnic	
1.	Chocolate	83	Honesty	54	Rug	74
2.	Cake	71	Trust	50	Hamper	57
3.	Ice-cream	52	Humour	47	Food	51
4.	Chips	50	Interests	46	Drinks	46
5.	Biscuits	48	Caring	34	Plates	40
6.	Lollies	43	Friendly	29	Friend	33
7.	Cream	42	Kind	26	Cutlery	28
8.	Butter	40	Open	26	Sunshine	27
9.	Sugar	38	Cheerful	26	Sandwiches	24
10.	Pies	26	Personality	23	Cups	23
11.	Fat	23	Sharing	21	Wine	20
12.	Bread	21	Empathy	19	Napkins	20

	Things which can be looked through		Things which can get you past barriers		Things to save from a burning home	
1.	Window	92	Keys	44	People	75
2.	Glass	67	Determination	38	Cash	62
3.	Spectacles	58	Passport	34	Jewellery	60
4.	Key-hole	45	Money	30	Pets	55
5.	Telescope	42	Knowledge	26	Photographs	46
6.	Plastic	39	Effort	25	Clothes	32
7.	Binoculars	37	Work	25	Books	29
8.	Doors	25	Strength	23	Documents	28
9.	Microscope	24	Force	22	Paintings	27
10.	Books	20	Power	21	Television	27
11.	Windscreen	18	Tank	19	Stereo	25
12.	Mirror	17	Contacts	19	Keycards	22

	Things to be walked upon		Entertainments for the week-end		Containers to be used for liquids	
1.	Carpet	70	Movies	58	Bottle	70
2.	Grass	69	Reading	50	Cup	63
3.	Roads	55	Visiting	49	Glass	60
4.	Foot-paths	53	Parties	37	Bowl	64
5.	Floor	49	Television	36	Jug	43
6.	Concrete	44	Sports	35	Body	30
7.	Earth	40	Picnics	34	Pool	21
8.	Ground	34	Restaurants	33	Thermos	20
9.	Sand	31	Walking	32	Mug	20
10.	Bridges	29	Sleeping	31	Sink	19
11.	Stairs	22	Drinking	29	Bath-tub	19
12.	Shoes	21	Videos	24	Jar	19

APPENDIX E

INSTRUCTIONS FOR TASKS, EXPERIMENT 2.

Order of Generation Task

In the following pages you will find category labels for fifteen categories. Under each category label there are twelve blank lines. Your task is to write twelve items representative of that category, in the order in which they occur to you.

Membership Decision Task

You will be presented with a CATEGORY name on this screen. You are to read it, and then press the '+' key. A word in lower case letters will appear, directly under the category name. Your task is to decide if the lower case word is an example of the category. If it is a valid example of the category, press the '+' key; if it is not, press the ' - ' key. The items will be presented in three blocks, each block consisting of a different category-type. The first items in each block are for practice.

Goodness-of-Example Task

In the following pages you will find lists of items, belonging to fifteen categories. Each category holds six representative items, randomly listed. Your task is to arrange each word according to how good an example it is of its category. You have to judge how typical is the word you have chosen of the category it represents. Rate each word along a scale going from 1 to 6, where 1 stands for 'best example' of the category, and 6 signifies the very 'poorest example'. The numbers in-between should be used to allocate gradations of each item's goodness as an example of its category. EACH RANKING CAN BE USED ONLY ONCE. Proceed as follows :-

(a) Make sure you know how to use the scale, using the key;

(b) Read the category name given below the key, and the six items listed as examples; and

(c) Beside each of the six, place a number from 1 to 6, which you think best expresses that word's goodness as an example of its category. Each number can be used only once.

Guide for Judgment Rankings: Most people would say that 'Church' is a good example of the category 'Buildings'; and better than, say, 'Telephone Box' which some people would classify as a less appropriate example. Yet telephone boxes are seen much more often than churches. This description serves to illustrate the fact that a category item which is familiar to you as in, for example, 'telephone box', will not necessarily be also a very typical example. Here is a guide on questions to ask yourself: 'How good an example is Blanket of the category Comfortable Things?'

Frequency-of-Instantiation Task

In the following pages you will find lists of items belonging to fifteen categories. Each category holds six representative items, randomly listed. Your task is to rate each item of the six according to how often it has occurred in that particular category. In other words, you have to estimate how often that particular item has occurred in that context in your experience.

You will rate each word along a scale ranging from 1 to 6, where 1 represents the item most often occurring in that category, and 6 represents the item least often found in that context. The numbers in-between should be used to represent gradations in occurrence of each word-category context. EACH NUMBER CAN BE USED ONLY ONCE. Proceed as follows:

(a) Make sure you know how to use the scale, using the key at the top of the page;

(b) Read the category-name below that, and the six items listed as instantiations of that category-context;

(c) Beside each of the six, place a number ranging from 1 to 6, which you think best expresses the relative frequency of occurrence of that item in that category-context, starting from 1 'most frequent' to 6 ' least frequent'. Each number can be used only once.

Guide for Judgment Rankings: Most people would say that 'Magpie' *occurs more often* than 'Robin' in the category 'Bird' but then they might say that 'Robin' is *a better example* of a bird. This serves to illustrate the point that each word's frequency should be judged according to how often, IN YOUR EXPERIENCE, it occurs specifically in that category-context. Here is a guide on questions to ask yourself: 'IN MY EXPERIENCE of the category Comfortable Things, how often has a Blanket occurred, and does it occur more often than Slippers?'

APPENDIX F

STATISTICAL TABLES 9 TO 14, EXPERIMENT 2.

Table 9: Natural Superordinate Category-Types, Idiosyncratic items Results of multiple regression analyses for individual subjects, using order of generation as the criterion measure (dependent variable).

Subjs.	R^2	df	Frequency	Instant	GoodExample		Ranks	
			T-stat	sr^2	T-stat	sr^2	T-stat	sr^2
2.	.607	3/20	3.074	0.186				
3.	.673	3/23	3.712	0.196				
4.	.207	3/24	2.167	0.155				
5.	.774	3/22			4.794	.236	2.521	.065
6.	.630	3/25			3.525	.184	3.223	.154
7.	.352	3/22	2.437	0.175				
8.	.499	3/26	3.597	0.249				
9.	.633	3/22	4.591	0.352				
10.	.387	3/23			2.337	.145		
11.	.408	3/26			3.065	.214		
12.	.337	3/21	2.154	0.146				
13.	.277	3/26	2.953	0.242				

Note: See Table 9.1 in Chapter Four for a summary of Table 9; Table 10.1 in Chapter Four for a summary of Table 10 here; and so on for all the tables contained in this Appendix.

Table 10 Natural Superordinate Category-Types, Normative items
Results of multiple regression analyses for individual subjects, using frequency of production as the criterion measure (dependent variable).

Subjs.	R^2	df	FrequencyInstant		GoodExample		Ranks	
			T-stat	sr^2	T-stat	sr^2	T-stat	sr^2
1.	.614	3/24	3.954	.251	3.572	.205		
2.	.827	3/23			4.213	.134	4.138	.129
3.	.559	3/21	2.127	.095	3.578	.269		
4.	.493	3/22			3.693	.314		
5.	.751	3/23			6.653	.920		
6.	.618	3/24			5.895	.553		
7.	.530	3/24	3.093	.187	3.485	.238		
8.	.815	3/23	2.210	.039	4.362	.153		
9.	.867	3/23	5.722	.189	3.049	.054		
10.	.320	3/24			3.137	.279		
11.	.329	3/26			3.554	.326		
12.	.834	3/24			10.564	.772		
13.	.592	3/21			4.146	.334		

Table 11: Property Category-Types, Idiosyncratic items
Results of multiple regression analyses for individual subjects, using order of generation as the criterion measure (dependent variable).

Subjs.	R^2	df	FrequencyInstant		GoodExample		Ranks	
			T-stat	sr^2	T-stat	sr^2	T-stat	sr^2
1.	.354	3/20	2.258	.165				
4.	.515	3/22					4.555	.457
5.	.189	3/25					2.928	.278
6.	.264	3/21					2.776	.270
8.	.458	3/22			2.172	.116		
9.	.203	3/22					2.323	.195
10.	.216	3/26	2.809	.237				
11.	.213	3/26					2.982	.269
12.	.408	3/26			2.137	.104	3.035	.209
13.	.389	3/26	3.291	.254	2.305	.125	2.297	.124

Table 12: Property Category-Types, Normative items
Results of multiple regression analyses for individual subjects, using production frequency as the criterion measure (dependent variable).

Subjs.	R^2	df	Frequency	Instant	GoodExample		Ranks	
			T-stat	sr^2	T-stat	sr^2	T-stat	sr^2
1.	.518	3/22			2.969	.193	2.327	.119
2.	.230	3/25					2.114	.138
3.	.628	3/19					4.259	.355
4.	.294	3/23			3.233	.321		
5.	.465	3/21			4.097	.428		
7.	.511	3/22					5.233	.609
9.	.435	3/19			2.866	.244		
10.	.682	3/22			6.035	.526		
11.	.238	3/22			2.334	.189		
12.	.405	3/21	2.108	.126	3.278	.304		
13.	.671	3/23			5.371	.413	3.314	.157

Table 13: Ad Hoc Category-Types, Idiosyncratic items
Results of multiple regression analyses for individual subjects, using order of generation as the criterion measure (dependent variable).

Subjs.	R^2	df	Frequency	Instant	GoodExample		Ranks	
			T-stat	sr^2	T-stat	sr^2	T-stat	sr^2
2.	.361	3/25			2.489	.160		
3.	.763	3/20			4.906	.285	3.822	.173
4.	.605	3/25	2.267	.081	4.202	.279		
5.	.831	3/20			10.288	.894		
6.	.536	3/24			3.396	.223	2.972	.171
7.	.236	3/22	2.234	.173				
8.	.251	3/24			3.363	.297		
10.	.400	3/22			3.851	.404		
11.	.108	3/25			2.405	.206		
12.	.279	3/21	2.345	.096	4.095	.292	4.461	.347
13.	.578	3/24	6.306	.414	2.104	.046	2.499	.065

Table 14: Ad Hoc Category-Types, Normative items
Results of multiple regression analyses for individual subjects, using production frequency as the criterion measure (dependent variable).

Subjs.	R^2	df	Frequency T-stat	Instant sr^2	Good T-stat	Example sr^2	Ranks T-stat	sr^2
1.	.345	3/23	3.378	.325				
2.	.478	3/23			2.996	.204		
3.	.785	3/20	4.321	.201				
4.	.563	3/24	3.877	.274				
5.	.488	3/21	2.449	.146	3.141	.241		
6.	.339	3/22			2.954	.262		
7.	.131	3/26			2.629	.231		
8.	.619	3/23	4.712	.368	2.618	.114		
9.	.568	3/21	2.430	.122	2.706	.151		
10.	.470	3/23			3.305	.252		
11.	.432	3/24			3.338	.264	2.158	.110
12.	.313	3/23			3.366	.338		
13.	.801	3/22			7.492	.508	2.430	.054

APPENDIX G

DESCRIPTION OF STORY CONDITIONS.

The general empirical question being asked in Experiment 3 concerns what underlies a change from concept X to concept Y in people's judgments of categorization, similarity and typicality.

The independent variable for experiment three consisted of fourteen stories, which were divided into two concept-types: seven were concerned with some artifact object and seven involved a living creature. Each control condition had six variations upon a basic theme. The theme was that of change: the original artifact object or living creature undergoes a transformation of some sort. For example, a washing machine has its operating principle altered so that it can operate only as a cement mixer; or a horse which collapses in the desert needs to develop the characteristics of a camel in order to survive. The question is whether the washing machine is still a washing machine after its function changes, or whether the horse is still a horse, after its internal organs change?

The stories vary as to the kind of alteration undergone by the artifact or creature, the explanations for its occurrence, and the situation. Each of the six variations corresponds to a different experimental condition which is meant to test a different model of category representation. The seven conditions consist of control and six variations. The examples below have titles (i.e., Clock to Toaster), but these were not included in the participants' actual booklets, as they might bias their judgments.

DESCRIPTION OF CONDITIONS AND EXAMPLES OF SEVEN ARTIFACT STORIES, EXPERIMENT THREE

Condition 1: Control Statement

Describes the function, essence (either the abstract principle underlying the operating mechanism or an internal biological feature) and lists the 3 physical features of X, one of which is the function-part.

Example: Clock to Toaster

The Troid's function is to keep time, and it operates according to a repeatability principle whereby an oscillating pendulum swings back and forth repeatedly. The Troid has a flat face on which are attached two arms.

Condition 2: Family Resemblance

Appearance change of the three physical properties is listed, making X more similar to Y. Each "old" property of X is described as changing to, or being replaced by, a "new" property of Y. Because Rosch and Mervis's (1975) feature theory (or family resemblance) treats properties as independent of each other, no relationships among the "new" properties are described.

Example: Clock to Toaster
The Troid's function is to keep time, and it operates according to a repeatability principle whereby an oscillating pendulum swings back and forth repeatedly. The Troid has a flat face on which are attached two arms.

This particular Troid was owned by a housewife who discovered that it had been altered. It was fitted with an electric, automatic timer. Two slots for bread had been made. Everything was placed in a metal box.

Condition 3: Classical

A change is described in the defining criterial property, with no appearance change. This assesses the potency of core essential properties alone to induce a change in judgement. In this condition, the essential core of the artifact object is either some internal product (for example, heavy banging sounds) or the abstract principle on which its mechanism operates (e.g. electricity).

Example: Clock to Toaster
The Troid's function is to keep time, and it operates according to a repeatability principle whereby an oscillating pendulum swings back and forth repeatedly. The Troid has a flat face on which are attached two arms.

This particular Troid was owned by a housewife who found its operation had changed from one based on a repeatability principle to an object operating on electricity and automaticity.

Condition 4: Function-part relations

This condition consists of a change of function part which results in a new function. It assesses the potency of a contingent relationship to induce a change in judgment. The core for this condition is the function and the physical feature is the function-part.

Example: Clock to Toaster
The Troid's function is to keep time, and it operates according to a repeatability principle whereby an oscillating pendulum swings back and forth repeatedly. The Troid has a flat face on which are attached two arms.

This particular Troid was owned by a housewife who discovered that the two arms had been replaced with two slots into which bread could be placed to cook.

Condition 5: Two-tier representation

The core for this condition is the function of the object, and there are two physical features: the function-part and one ordinary physical feature. The explanation is *implicit*: For artifacts, the owner's new need is stated, then a change in the two physical features is described, but not explicitly connected to the new need, then there is a statement about fulfilment of the new need by a change in function. The physical appearance change is described first, with the physical features in the appearance change being described as implicit contrast sets, or before-and-after pairs. Then the core change is described, and the core in this condition is assumed to involve purpose and function of the object.

This condition tests the hypothesis that categorization judgments can involve implicit inferences derived from a core representation, which is based on purpose and function information about the object. The artifact owner's needs, emotions or preferences lead him or her to change the object's function. It is an explanation-based model as these circumstances are considered sufficient for the reader to decide upon a change in the object's categorization. Schwartz (1979) considers artifacts to belong to nominal kinds because they do not share a common, hidden nature (see C6 below); just a common function.

Example: Clock to Toaster

The Troid's function is to keep time, and it operates according to a repeatability principle whereby an oscillating pendulum swings back and forth repeatedly. The Troid has a flat face on which are attached two arms.

This particular Troid was owned by a housewife, whose family liked to have a hearty breakfast, with all the trimmings.

One day, she decided to alter the Troid. First she removed the pendulum and fitted an electric, automatic timer in its place. Then she made two slots for bread in place of the two arms.

From that day forward, she used the Troid to cook some of the breakfast, and it seemed to her that it had never tasted so good.

Condition 6: Essential core plus prototype

This condition involves an appearance (prototype) plus core change, where the core change is seen as causing the appearance change. The structure of the story reflects the psychological essentialism approach (Medin & Ortony, 1989) which sees the core as "the person's theory of an internal essence" of the object upon which diagnostic category decisions are based, and its appearance as the physical, outward expression of that essence.

The core for this condition is the mechanistic essence, and there are two physical features which are the same as in C5 above: the function-part and one ordinary physical feature. The explanation is *explicit*: For artifacts, the operating mechanism becomes worn-out, so it is "explicitly" stated that certain physical features have to change, so that a new operating mechanism/abstract principle can take over. Briefly, the essence change is given first in the story, before the appearance change, as it is assumed that conceptual (or top-down) processing is involved. The physical features in the appearance change are described as implicit contrast sets, or before-and-after pairs.

This condition tests the hypothesis that categorization judgments involve both the core representation and appearance of an object, where a category's core is considered to involve the metaphysical nature of the object. More specifically, the reader's ideas (which could be naive or expert or culturally influenced) about such a metaphysical nature are what constitute the internal core.

It is an explanation-based model because the circumstances under which the transformation takes place are said to be an important factor in the reader's decision to change category. Here, the artifact is said to be old and the abstract principle on which it operated is no longer working.

Philosophers like Losonsky (1990) and Putnam (1989), but not Schwartz (1979), claim that artifacts in the same category do share a metaphysical or underlying nature. They suggest such nature might be the internal product of the object (for example, heavy banging sounds) or the abstract principle on which its mechanism operates (for example, electricity). Losonsky (1990) claims that artifacts are not members of the same kind simply because they perform the same function; but they derive their "nature", they are "animated" by the work they do, either to produce something else or for consumption.

Example: Clock to Toaster
The Troid's function is to keep time, and it operates according to a repeatability principle whereby an oscillating pendulum swings back and forth repeatedly. The Troid has a flat face on which are attached two arms.

This particular Troid was owned by a housewife who altered it because it was worn-out. It had been a present long ago. Now, for sentimental reasons, rather than throw it out, she would change its operation from one of repeatability to one of electric automaticity.

Consequently, she removed the pendulum and fitted an electric automatic timer in its place. The place of the two arms was taken by two slots for bread.

Condition 7: Ideal prototypes

This involves the control condition content followed by a change to Y as a result of the manufacturer's intention, which is governed by consumers' demand for an artifact with the three physical features of Y. This tests the force of subjects' beliefs such as the law of supply and demand. Can an object be sold as another object, as long as there is enough demand and the two objects are very similar? If subjects have a strong belief about demand, then needing the second object would be enough to enable the first object to be sold as that.

What is of interest is whether background information about market forces (for example, consumer demand) is enough to bring about a change in the categorization judgement, which would be entirely belief-based, as there is no change in the appearance of the object.

Example: Clock to Toaster
The Troid's function is to keep time, and it operates according to a repeatability principle whereby an oscillating pendulum swings back and forth repeatedly. The Troid has a flat face on which are attached two arms.

One particular brand of Troids was not selling well and there was a glut of them on the market. However, there was heavy consumer-demand for utensils with timer mechanisms, two slots for bread, all set in a metal box. The manufacturers decided their products could be marketed and used by consumers as such items.

DESCRIPTION OF CONDITIONS AND EXAMPLES OF SEVEN ANIMAL STORIES, EXPERIMENT THREE

Condition 1: Control statement

Describes the function, essence (either the abstract principle underlying the operating mechanism or an internal biological feature) and lists the 3 physical features of X, one of which is the function-part.

Example: Swan to Bat
The Tarp is a warm-blooded creature. It has snowy white feathers on its wings, and a graceful head. The Tarp likes to paddle in rivers and lakes with webbed feet.

Condition 2: Family resemblance

Appearance change of the three physical properties is listed, making X more similar to Y. Each "old" property of X is described as changing to, or being replaced by, a "new" property of Y. Because Rosch and Mervis's (1975) feature theory (or family resemblance) treats properties as independent of each other, no relationships among the "new" properties are described.

Example: Swan to Bat
The Tarp is a warm-blooded creature. It has snowy white feathers on its wings, and a graceful head. The Tarp likes to paddle in rivers and lakes with webbed feet.

One day, a Tarp called Henty was caught in a trap. Some time later, Henty grew large flappy ears. His wing surfaces became rough and brown. His feet now resembled strong, clawlike fingers.

Condition 3: Classical

This condition involves a change in the defining property, with no appearance change. It assesses the potency of essential properties alone to induce a change in judgment. In this condition, the essential core of the animal is some internal biological feature (e.g. cold-bloodedness, internal gills, number of stomachs, type of brain, internal skeleton). In the case of the human animal, the essential feature chosen was the soul, as this contrasted best with the vampire's lack of soul (see story item one).

The main difficulty is knowing what constitutes the necessary and sufficient features, that is, the essential or defining property which determines categorization decisions. In this condition, the category-definition has been

assumed to be the internal essence of the natural kind. No explanation for the change is considered necessary.

> *Example*: Swan to Bat
> The Tarp is a warm-blooded creature. It has snowy white feathers on its wings, and a graceful head. The Tarp likes to paddle in rivers and lakes with webbed feet.
>
> One day, a Tarp called Henty was caught in a trap. Some time later, Henty became cold-blooded. His body temperature grew very cold and heat conservation became a problem.

Condition 4: Function-part contingent relations

There is a functional change, with appearance change. A change of function-part results in a new function, thus assessing the potency of a contingent relationship to induce change in judgment. The core for this condition is the function, and the physical feature is the function-part.

> *Example*: Swan to Bat
> The Tarp is a warm-blooded creature. It has snowy white feathers on its wings, and a graceful head. The Tarp likes to paddle in rivers and lakes with webbed feet.
>
> One day, a Tarp called Henty was caught in a trap. Some time later, his feet resembled strong clawlike fingers and he used these to hang from the branches of fruit-trees, or from the ceiling of dark caves.

Condition 5: Two-tier representation

The core for this condition is the function of the animal (its preferences, abilities, behaviour), and there are two physical features: the function-part and one ordinary physical feature. The explanation is *implicit*: For animals, a new situation arises, then a change in the two physical features is described, but not explicitly connected to the situation, then there is a statement about the consequences of the physical change, such as new abilities or preferences. Briefly, the physical appearance change is described first, with the physical features described implicit contrast sets, that is, before-and-after pairs. Next the core is changed, with the core in this condition assumed to involve the animal's functions, needs, intentions, or preferences.

This condition tests the hypothesis that categorization judgments can involve implicit inferences derived from a core representation, which is based on functional information about the animal and its behaviour: needs, abilities,

and/or intentions. Some event occurs which changes the animal's preferences, functions or abilities. It is an explanation-based model as the circumstances under which the transformation occurred are considered to influence the reader's decision.

> *Example*: Swan to Bat
> The Tarp is a warm-blooded creature. It has snowy white feathers on its wings, and a graceful head. The Tarp likes to paddle in rivers and lakes with webbed feet.
>
> One day, a Tarp called Henty was caught in a trap set by a researcher who was carrying out experiments on animals. Some time later, the graceful line of Henty's head was spoilt when he grew large flappy ears. His once-webbed feet now resembled strong, clawlike fingers.
>
> Gone was Henty's preference for paddling in rivers and lakes, his concerns now were with fruit-trees or inside dark caves.

Condition 6: Essential core plus prototype

This condition involves appearance (prototype) plus core change, where the core change is seen as causing the appearance change. The structure of the story reflects the psychological essentialism approach which sees the core as the "Essence" of the animal, such core being the basis for diagnostic category decisions, and appearance as the physical, outward expression of that essence.

The core for this condition is the biological essence, and there are two physical features which are the same as in C5 above: the function-part and 1 ordinary physical feature.The explanation is *explicit*: The animals are placed in a situation where an *explicit* statement is made about contagion, genetic engineering, inoculation, or hibernation. Whichever particular event is used in the story, the general outcome is that a new essence is caused to develop, and as a consequence, certain new physical features. For example, in the case of the human animal, a visit to a vampire results in blood-sucking, which results in loss of soul. Briefly, the essence change is given first in the story, before appearance change, as it is assumed that conceptual (or top-down) processing is involved. The physical features in the appearance change are described as implicit contrast sets, as before-and-after pairs.

This condition tests the hypothesis that categorization judgments involve both the core representation and appearance of an object, where a category's core

is considered to involve the metaphysical nature of the animal. It is an explanation-based model as the reader's ideas (which could be naive or expert or culturally influenced) about what constitutes such a metaphysical nature are the determining factor in decisions. Medin and Ortony stress that it is not the actual metaphysical essence, but what the categorizer believes to be the essence, which is the core.

According to explanation-based models, the *reason* for the transformation is relevant and is often based upon naive theories of the world. Here they include the supernatural, genetic engineering, eating an object (leads to acquisition of its essence), contagion (a cause must have some form of contact to transmit its effect) and homeopathy (cause and effect tend to be similar, as when sunstroke leads to adaptation to desert).

> *Example:* Swan to Bat
> The Tarp is a warm-blooded creature. It has snowy white feathers on its wings, and a graceful head. The Tarp likes to paddle in rivers and lakes with webbed feet.
>
> One day, a Tarp called Henty was caught in a trap set by a genetic engineer, who was carrying out research on animals. He injected Henty with the genes of a cold-blooded creature. Henty's body temperature grew very cold and heat conservation became a problem for him.
>
> Consequently, Henty grew large, flappy ears to roll up for heat conservation. His once-webbed feet now resembled strong, clawlike fingers.

Condition 7: Ideal prototypes

This involves the description of the control condition, followed by a change to Y as a result of the event described in C5 above. The effects of the event are not directly visible in the animal, but in the animal's offspring. This tests the force of subjects' beliefs such as the law *(sic)*of inherited traits. Does a progenitor really belong to another species, if it shows no physical evidence of certain physical sicknesses/traumas undergone during its lifetime, but its progeny do? The law of inherited traits would say that the physical evidence in the children suggests that the parent secretly possesses these traits, and so belongs to the new category.

What is of interest is whether beliefs about parent-child family resemblance will cause any change in the categorization judgement, which would be entirely belief-based. There is no appearance change in the animal.

Example: Swan to Bat
The Tarp is a warm-blooded creature. It has snowy white feathers on its wings, and a graceful head. The Tarp likes to paddle in rivers and lakes with webbed feet.

One day, a Tarp called Henty was caught in a trap set by a genetic engineer who was carrying out experiments on animals. His temporary captivity seemed to have left no apparent effect on Henty. He was still attracted to Tarps, but when his mate had offspring they did not resemble Tarps at all. They had large, flappy ears, their wings were covered in rough brown skin, and their feet resembled strong, clawlike fingers.

APPENDIX H

INSTRUCTIONS AND PRACTICE ITEMS FOR CATEGORIZATION TASKS.

The stories below are like puzzles which you can resolve by using the different kinds of information given in the story itself, and also by using your own knowledge of the world. There are no right-or-wrong answers, each individual has his or her own opinion and personal experience upon which to base the answers.

An animal, object or machine is the subject of each story. At the end of each story, your task is to decide which of two categories would be the most appropriate for the subject of the story. You indicate this by circling any number - one to six - on the rating scale, reflecting the degree to which the subject *belongs in the category* you have decided upon. Examples are given below.

Story Item Four: CONDITION ONE
The Souk is made of soft wool and its function is to keep the wearer warm against the chilly winter winds. The Souk consists of three sleeves: a wide one for the torso and two thinner ones for the arms. Because of the oils in the wool, it is water-resistant.

1.4 Indicate the degree to which you think this Souk now belongs more to the category of sweaters or to the category of brushes?

Sweaters 1 2 3 4 5 6 Brushes

1. Certainly a Sweater
2. Probably a Sweater
3. Possibly a Sweater
4. Possibly a Brush
5. Probably a Brush
6. Certainly a Brush

Story Item One: CONDITION TWO
The Shig is a thin creature, which flies from plant to plant with the aid of brightly coloured wings. It has a skeleton of hollow bones, and a pair of antennae.
One day, a Shig called Robin was drinking from a dam when he began to change: He grew flexible jointed legs; his body build changed to round and fat; and his body colour became dark grey.

1.1 Indicate the degree to which you think this Shig Robin now belongs more to the category of butterflies or to the category of spiders?

Butterflies 1 2 3 4 5 6 Spiders

1. Certainly a Butterfly
2. Probably a Butterfly
3. Possibly a Butterfly
4. Possibly a Spider
5. Probably a Spider
6. Certainly a Spider

Story Item One: CONDITION THREE
The Shig is a thin creature, which flies from plant to plant with the aid of brightly coloured wings. It has a skeleton of hollow bones, and a pair of antennae.

One day, a Shig called Robin was drinking from a dam when his skeleton of light, hollow bones became an external one.

1.1 Indicate the degree to which you think this Shig Robin now belongs more to the
category of butterflies or to the category of spiders?
Butterflies 1 2 3 4 5 6 Spiders

1. Certainly a Butterfly
2. Probably a Butterfly
3. Possibly a Butterfly
4. Possibly a Spider
5. Probably a Spider
6. Certainly a Spider

Story Item Four: CONDITION FOUR
The Souk is made of soft wool and its function is to keep the wearer warm against the chilly winter winds. The Souk consists of three sleeves: a wide one for the torso and two thinner ones for the arms. Because of the oils in the wool, it is water-resistant.

This particular Souk was owned by an old lady. One winter day, she found that the soft wool fibre had become hard and tough, and the Souk would serve only to scrub floors clean now.

1.4 Indicate the degree to which you think this Souk now belongs more to the category of sweaters or to the category of brushes?
Sweaters 1 2 3 4 5 6 Brushes

1. Certainly a Sweater
2. Probably a Sweater
3. Possibly a Sweater
4. Possibly a Brush
5. Probably a Brush
6. Certainly a Brush

Story Item Four: CONDITION FIVE
The Souk is made of soft wool and its function is to keep the wearer warm against the chilly winter winds. The Souk consists of three sleeves: a wide one for the torso and two thinner ones for the arms. Because of the oils in the wool, it is water-resistant.

This particular souk was owned by an old lady who had knitted it from one hundred percent soft red wool. One winter day, she went to take it off the Hills hoist after having left it there for many days. She found that it had changed.

The soft wool had dried out, making the fibre hard; and the two thinner sleeves now stuck together, so that the souk's shape was more like a rectangular block.

The Souk could no longer protect her against the winter winds. However, she did need an implement for washing floors clean, and with a little alteration, she believed the Souk might serve this purpose.

1.4 Indicate the degree to which you think this Souk now belongs more to the category of sweaters or to the category of brushes?

Sweaters 1 2 3 4 5 6 Brushes

1. Certainly a Sweater
2. Probably a Sweater
3. Possibly a Sweater
4. Possibly a Brush
5. Probably a Brush
6. Certainly a Brush

Story Item One: CONDITION SIX

The Shig is a thin creature, which flies from plant to plant with the aid of brightly coloured wings. It has a skeleton of hollow bones, and a pair of antennae.

One day, a Shig called Robin was drinking from a dam in which blue-green algae was growing in abundance. Upon drinking from the dam Robin fell unconscious due to the toxins released into the water by the algae. Over the next few days, Robin's genetic structure changed.

Consequently, he lost his antennae, but instead grew flexible jointed legs; his thin body became round and fat; and his brightly coloured body became dark grey in colour.

1.1 Indicate the degree to which you think this Shig Robin now belongs more to the category of butterflies or to the category of spiders?

Butterflies 1 2 3 4 5 6 Spiders

1. Certainly a Butterfly
2. Probably a Butterfly
3. Possibly a Butterfly
4. Possibly a Spider
5. Probably a Spider
6. Certainly a Spider

Story Item One: CONDITION SEVEN

The Shig is a thin creature, which flies from plant to plant with the aid of brightly coloured wings. It has a skeleton of hollow bones, and a pair of antennae.

One day, a Shig called Robin was drinking from a dam in which blue-green algae was growing in abundance. Upon drinking from the dam, he fell unconscious due to the toxins released into the water by the algae.

The effect of the toxins was not immediately apparent, but when Robin's mate produced offspring, they each had jointed flexible legs, round fat bodies, coloured dark grey.

1.1 Indicate the degree to which you think this Shig Robin now belongs more to the
category of butterflies or to the category of spiders?
Butterflies 1 2 3 4 5 6 Spiders

1. Certainly a Butterfly
2. Probably a Butterfly
3. Possibly a Butterfly
4. Possibly a Spider
5. Probably a Spider
6. Certainly a Spider

INSTRUCTIONS AND PRACTICE ITEMS FOR TYPICALITY TASKS.

The stories below are like puzzles which you can resolve by using the different kinds of information given in the story itself, and also by using your own knowledge of the world. There are no right-or-wrong answers, each individual has his or her own opinion and personal experience upon which to base the answers.

An animal, object or machine is the subject of each story. At the end of each story, your task is to decide which of two categories the subject is the better example. You indicate this be circling any number - one to six - on the rating scale, reflecting the degree of *goodness as an example* the subject is of that category. Examples are given below.

Story Item Four: CONDITION ONE
The Souk is made of soft wool and its function is to keep the wearer warm against the chilly winter winds. The Souk consists of three sleeves: a wide one for the torso and two thinner ones for the arms. Because of the oils in the wool, it is water-resistant.

2.4 Indicate the degree to which you think this Souk now is more typical of the category of sweaters or to the category of brushes?
Sweaters 1 2 3 4 5 6 Brushes

1. Good example of a Sweater
2. Fair example of a Sweater
3. Poor example of a Sweater
4. Poor example of a Brush
5. Fair example of a Brush
6. Good example of a Brush

Story Item One: CONDITION TWO
The Shig is a thin creature, which flies from plant to plant with the aid of brightly coloured wings. It has a skeleton of hollow bones, and a pair of antennae.

One day, a Shig called Robin was drinking from a dam when he began to change: He grew flexible jointed legs; his body build changed to round and fat; and his body colour became dark grey.

2.1 Indicate the degree to which you think this Shig Robin now is more typical of the category of butterflies or to the category of spiders?

Butterflies 1 2 3 4 5 6 Spiders

1. Good example of a Butterfly
2. Fair example of a Butterfly
3. Poor example of a Butterfly
4. Poor example of a Spider
5. Fair example of a Spider
6. Good example of a Spider

Story Item One: CONDITION THREE
The Shig is a thin creature, which flies from plant to plant with the aid of brightly coloured wings. It has a skeleton of hollow bones, and a pair of antennae.

One day, a Shig called Robin was drinking from a dam when his skeleton of light, hollow bones became an external one.

2.1 Indicate the degree to which you think this Shig Robin now is more typical of the category of butterflies or to the category of spiders?

Butterflies 1 2 3 4 5 6 Spiders

1. Good example of a Butterfly
2. Fair example of a Butterfly
3. Poor example of a Butterfly
4. Poor example of a Spider
5. Fair example of a Spider
6. Good example of a Spider

Story Item Four: CONDITION FOUR
The Souk is made of soft wool and its function is to keep the wearer warm against the chilly winter winds. The Souk consists of three sleeves: a wide one for the torso and two thinner ones for the arms. Because of the oils in the wool, it is water-resistant.

This particular Souk was owned by an old lady. One winter day, she found that the soft wool fibre had become hard and tough, and the Souk would serve only to scrub floors clean now.

2.4 Indicate the degree to which you think this Souk now is more typical of the category of sweaters or to the category of brushes?

Sweaters 1 2 3 4 5 6 Brushes

1. Good example of a Sweater
2. Fair example of a Sweater
3. Poor example of a Sweater
4. Poor example of a Brush
5. Fair example of a Brush
6. Good example of a Brush

Story Item Four: CONDITION FIVE
The Souk is made of soft wool and its function is to keep the wearer warm against the chilly winter winds. The Souk consists of three sleeves: a wide one for the torso and two thinner ones for the arms. Because of the oils in the wool, it is water-resistant.

This particular souk was owned by an old lady who had knitted it from one hundred percent soft red wool. One winter day, she went to take it off the Hills hoist after having left it there for many days. She found that it had changed.

The soft wool had dried out, making the fibre hard; and the two thinner sleeves now stuck together, so that the souk's shape was more like a rectangular block.

The Souk could no longer protect her against the winter winds. However, she did need an implement for washing floors clean, and with a little alteration, she believed the Souk might serve this purpose.

2.4 Indicate the degree to which you think this Souk now is more typical of the category of sweaters or to the category of brushes?

Sweaters 1 2 3 4 5 6 Brushes

1. Good example of a Sweater
2. Fair example of a Sweater
3. Poor example of a Sweater
4. Poor example of a Brush
5. Fair example of a Brush
6. Good example of a Brush

Story Item One: CONDITION SIX
The Shig is a thin creature, which flies from plant to plant with the aid of brightly coloured wings. It has a skeleton of hollow bones, and a pair of antennae.

One day, a Shig called Robin was drinking from a dam in which blue-green algae was growing in abundance. Upon drinking from the dam Robin fell unconscious due to the toxins released into the water by the algae. Over the next few days, Robin's genetic structure changed.

Consequently, he lost his antennae, but instead grew flexible jointed legs; his thin body became round and fat; and his brightly coloured body became dark grey in colour.

2.1 Indicate the degree to which you think this Shig Robin now is more typical of the category of butterflies or to the category of spiders?

Butterflies 1 2 3 4 5 6 Spiders

1. Good example of a Butterfly
2. Fair example of a Butterfly
3. Poor example of a Butterfly
4. Poor example of a Spider
5. Fair example of a Spider
6. Good example of a Spider

Story Item One: CONDITION SEVEN

The Shig is a thin creature, which flies from plant to plant with the aid of brightly coloured wings. It has a skeleton of hollow bones, and a pair of antennae.

One day, a Shig called Robin was drinking from a dam in which blue-green algae was growing in abundance. Upon drinking from the dam, he fell unconscious due to the toxins released into the water by the algae.

The effect of the toxins was not immediately apparent, but when Robin's mate produced offspring, they each had jointed flexible legs, round fat bodies, coloured dark grey.

2.1 Indicate the degree to which you think this Shig Robin now is more typical of the category of butterflies or to the category of spiders?

Butterflies 1 2 3 4 5 6 Spiders

1. Good example of a Butterfly
2. Fair example of a Butterfly
3. Poor example of a Butterfly
4. Poor example of a Spider
5. Fair example of a Spider
6. Good example of a Spider

INSTRUCTIONS AND PRACTICE ITEMS FOR SIMILARITY TASKS.

The stories below are like puzzles which you can resolve by using the different kinds of information given in the story itself, and also by using your own knowledge of the world. There are no right-or-wrong answers, each individual has his or her own opinion and personal experience upon which to base the answers.

An animal, object or machine is the subject of each story. At the end of each story, your task is to decide to which of two categories the subject is most similar. You indicate this by circling any number - one to six - on the rating scale, reflecting the degree of *similarity or likeness* the subject has to that category. Examples are given below.

Story Item Four: CONDITION ONE
The Souk is made of soft wool and its function is to keep the wearer warm against the chilly winter winds. The Souk consists of three sleeves: a wide one for the torso and two thinner ones for the arms. Because of the oils in the wool, it is water-resistant.

3.4 Indicate the degree to which you think this Souk now is more similar to the category of sweaters or to the category of brushes?

Sweaters 1 2 3 4 5 6 Brushes

1. Very similar to a Sweater
2. Rather similar to a Sweater
3. Barely similar to a Sweater
4. Barely similar to a Brush
5. Rather similar to a Brush
6. Very similar to a Brush

Story Item One: CONDITION TWO
The Shig is a thin creature, which flies from plant to plant with the aid of brightly coloured wings. It has a skeleton of hollow bones, and a pair of antennae.

One day, a Shig called Robin was drinking from a dam when he began to change: He grew flexible jointed legs; his body build changed to round and fat; and his body colour became dark grey.

3.1 Indicate the degree to which you think this Shig Robin now is more similar to the category of butterflies or to the category of spiders?

Butterflies 1 2 3 4 5 6 Spiders

1. Very similar to a Butterfly
2. Rather similar to a Butterfly
3. Barely similar to a Butterfly
4. Barely similar to a Spider
5. Rather similar to a Spider
6. Very similar to a Spider

Story Item One: CONDITION THREE
The Shig is a thin creature, which flies from plant to plant with the aid of brightly coloured wings. It has a skeleton of hollow bones, and a pair of antennae.

One day, a Shig called Robin was drinking from a dam when his skeleton of light, hollow bones became an external one.

3.1 Indicate the degree to which you think this Shig Robin now is more similar to the category of butterflies or to the category of spiders?

Butterflies 1 2 3 4 5 6 Spiders

1. Very similar to a Butterfly
2. Rather similar to a Butterfly
3. Barely similar to a Butterfly
4. Barely similar to a Spider
5. Rather similar to a Spider
6. Very similar to a Spider

Story Item Four: CONDITION FOUR
The Souk is made of soft wool and its function is to keep the wearer warm against the chilly winter winds. The Souk consists of three sleeves: a wide one for the torso and two thinner ones for the arms. Because of the oils in the wool, it is water-resistant.

This particular Souk was owned by an old lady. One winter day, she found that the soft wool fibre had become hard and tough, and the Souk would serve only to scrub floors clean now.

3.4 Indicate the degree to which you think this Souk now is more similar to the category of sweaters or to the category of brushes?

Sweaters 1 2 3 4 5 6 Brushes

1. Very similar to a Sweater
2. Rather similar to a Sweater
3. Barely similar to a Sweater
4. Barely similar to a Brush
5. Rather similar to a Brush
6. Very similar to a Brush

Story Item Four: CONDITION FIVE
The Souk is made of soft wool and its function is to keep the wearer warm against the chilly winter winds. The Souk consists of three sleeves: a wide one for the torso and two thinner ones for the arms. Because of the oils in the wool, it is water-resistant.

This particular Souk was owned by an old lady who had knitted it from one hundred percent soft red wool. One winter day, she went to take it off the Hills hoist after having left it there for many days. She found that it had changed.

The soft wool had dried out, making the fibre hard; and the two thinner sleeves now stuck together, so that the Souk's shape was more like a rectangular block.

The Souk could no longer protect her against the winter winds. However, she did need an implement for washing floors clean, and with a little alteration, she believed the Souk might serve this purpose.

3.4 Indicate the degree to which you think this Souk now is more similar to the category of sweaters or to the category of brushes?

Sweaters 1 2 3 4 5 6 Brushes

1. Very similar to a Sweater
2. Rather similar to a Sweater
3. Barely similar to a Sweater
4. Barely similar to a Brush
5. Rather similar to a Brush
6. Very similar to a Brush

Story Item One: CONDITION SIX
The Shig is a thin creature, which flies from plant to plant with the aid of brightly coloured wings. It has a skeleton of hollow bones, and a pair of antennae.

One day, a Shig called Robin was drinking from a dam in which blue-green algae was growing in abundance. Upon drinking from the dam Robin fell unconscious due to the toxins released into the water by the algae. Over the next few days, Robin's genetic structure changed.

Consequently, he lost his antennae, but instead grew flexible jointed legs; his thin body became round and fat; and his brightly coloured body became dark grey in colour.

3.1 Indicate the degree to which you think this Shig Robin now is more similar to the category of butterflies or to the category of spiders?

Butterflies 1 2 3 4 5 6 Spiders

1. Very similar to a Butterfly
2. Rather similar to a Butterfly
3. Barely similar to a Butterfly
4. Barely similar to a Spider
5. Rather similar to a Spider
6. Very similar to a Spider

Story Item One: CONDITION SEVEN

The Shig is a thin creature, which flies from plant to plant with the aid of brightly coloured wings. It has a skeleton of hollow bones, and a pair of antennae.

One day, a Shig called Robin was drinking from a dam in which blue-green algae was growing in abundance. Upon drinking from the dam, he fell unconscious due to the toxins released into the water by the algae.

The effect of the toxins was not immediately apparent, but when Robin's mate produced offspring, they each had jointed flexible legs, round fat bodies, coloured dark grey.

3.1 Indicate the degree to which you think this Shig Robin now is more similar to the category of butterflies or to the category of spiders?

Butterflies 1 2 3 4 5 6 Spiders

1. Very similar to a Butterfly
2. Rather similar to a Butterfly
3. Barely similar to a Butterfly
4. Barely similar to a Spider
5. Rather similar to a Spider
6. Very similar to a Spider

APPENDIX I

14 STORY-STIMULI FOR EXPERIMENT THREE

STORIES ABOUT ANIMAL CREATURES

Story Item One: Man to Vampire, CONTROL
The Noid is a soulful creature with a rosy complexion and a lively expression in its eyes. Because it likes to eat both meat and vegetables, it possesses all four types of teeth: incisors, canines, premolars, molars.

Story Item One: Man to Vampire, CONDITION TWO
The Noid is a soulful creature with a rosy complexion and a lively expression in its eyes. Because it likes to eat both meat and vegetables, it possesses all four types of teeth: incisors, canines, premolars, molars.

An energetic Noid called Fred went for a walk in the mountains. When Fred returned from his walk, his eyes held a staring, blank expression. The only teeth he had now were incisors and pointed canines at each side of his mouth.

Story Item One: Man to Vampire, CONDITION THREE
The Noid is a soulful creature with a rosy complexion and a lively expression in its eyes. Because it likes to eat both meat and vegetables, it possesses all four types of teeth: incisors, canines, premolars, molars.

An energetic Noid called Fred went for a walk in the mountains. When Fred returned from his walk, he had lost his soul.

Story Item One: Man to Vampire, CONDITION FOUR
The Noid is a soulful creature with a rosy complexion and a lively expression in its eyes. Because it likes to eat both meat and vegetables, it possesses all four types of teeth: incisors, canines, premolars, molars.

An energetic Noid called Fred went for a walk in the mountains. When Fred returned from his walk, the only teeth he had left were the incisors, and pointed canines at each side of his mouth. He used these to suck blood, as he no longer liked to eat meat and vegetables.

Story Item One: Man to Vampire, CONDITION FIVE
The Noid is a soulful creature with a rosy complexion and a lively expression in its eyes. Because it likes to eat both meat and vegetables, it possesses all four types of teeth: incisors, canines, premolars, molars.

One sunny morning in Transylvania, an energetic Noid called Fred walked from his chalet to visit an old ruined castle, where he found the owner resting in his coffin in the library.

When he returned from his walk, Fred's once lively eyes held a blank expression. The only teeth he had now were incisors and pointed canines at each side of his mouth. Gone was Fred's need for meat and vegetables. Now, his sole desire was for a different kind of food.

Story Item One: Man to Vampire, CONDITION SIX
The Noid is a soulful creature with a rosy complexion and a lively expression in its eyes. Because it likes to eat both meat and vegetables, it possesses all four types of teeth: incisors, canines, premolars, molars.

One sunny morning in Transylvania, an energetic Noid called Fred walked from his chalet to visit an old ruined castle, where he found the owner resting in his coffin in the castle library. With one blood-sucking bite, the castle owner took over Fred's body and soul.

As a result, Fred's eyes held a blank expression. The only teeth he had now were incisors and pointed canines at each side of his mouth.

Story Item One: Man to Vampire, CONDITION SEVEN
The Noid is a soulful creature with a rosy complexion and a lively expression in its eyes. Because it likes to eat both meat and vegetables, it possesses all four types of teeth: incisors, canines, premolars, molars.

One sunny morning in Transylvania, an energetic Noid called Fred walked from his chalet to visit an old ruined castle, where he found the owner resting in his coffin in the library. The castle owner greeted Fred with a blood-sucking bite.

This disturbing encounter seemed to have no apparent effect on Fred. He was still attracted to Noids, but when his mate had offspring, they did not resemble Noids at all.
Their faces were very white, their eyes held little expression, and their only teeth were the incisors and pointed canines at the side of the mouth.

Story Item Two: Swan to Bat, CONTROL.
The Tarp is a warm-blooded creature. It has snowy white feathers on its wings, and a graceful head. The Tarp likes to paddle in rivers and lakes with webbed feet.

Story Item Two: Swan to Bat, CONDITION TWO
The Tarp is a warm-blooded creature. It has snowy white feathers on its wings, and a graceful head. The Tarp likes to paddle in rivers and lakes with webbed feet.

One day, a Tarp called Henty was caught in a trap. Some time later, Henty grew large flappy ears. His wing surfaces became rough and brown. His feet now resembled strong, clawlike fingers.

Story Item Two: Swan to Bat, CONDITION THREE:
The Tarp is a warm-blooded creature. It has snowy white feathers on its wings, and a graceful head. The Tarp likes to paddle in rivers and lakes with webbed feet.

One day, a Tarp called Henty was caught in a trap. Some time later, Henty became cold-blooded. His body temperature grew very cold and heat conservation became a problem.

Story Item Two: Swan to Bat, CONDITION FOUR:
The Tarp is a warm-blooded creature. It has snowy white feathers on its wings, and a graceful head. The Tarp likes to paddle in rivers and lakes with webbed feet.

One day, a Tarp called Henty was caught in a trap. Some time later, his feet resembled strong clawlike fingers and he used these to hang from the branches of fruit-trees, or from the ceiling of dark caves.

Story Item Two: Swan to Bat, CONDITION FIVE
The Tarp is a warm-blooded creature. It has snowy white feathers on its wings, and a graceful head. The Tarp likes to paddle in rivers and lakes with webbed feet.

One day, a Tarp called Henty was caught in a trap set by a researcher who was carrying out experiments on animals. Some time later, the graceful line of Henty's head was spoilt when he grew large flappy ears. His once-webbed feet now resembled strong, clawlike fingers.

Gone was Henty's preference for paddling in rivers and lakes, his concerns now were with fruit-trees or inside dark caves.

Story Item Two: Swan to Bat, CONDITION SIX
The Tarp is a warm-blooded creature. It has snowy white feathers on its wings, and a graceful head. The Tarp likes to paddle in rivers and lakes with webbed feet.

One day, a Tarp called Henty was caught in a trap set by a genetic engineer, who was carrying out research on animals. He injected Henty with the genes of a cold-blooded creature. Henty's body temperature grew very cold and heat conservation became a problem for him.

Consequently, Henty grew large, flappy ears to roll up for heat conservation. His once-webbed feet now resembled strong, clawlike fingers.

Story Item Two: Swan to Bat, CONDITION SEVEN
The Tarp is a warm-blooded creature. It has snowy white feathers on its wings, and a graceful head. The Tarp likes to paddle in rivers and lakes with webbed feet.

One day, a Tarp called Henty was caught in a trap set by a genetic engineer who was carrying out experiments on animals.

His temporary captivity seemed to have left no apparent effect on Henty. He was still attracted to Tarps, but when his mate had offspring they did not resemble Tarps at all. They had large, flappy ears, their wings were covered in rough brown skin, and their feet resembled strong, clawlike fingers.

Story Item Three: Lizard to Owl, CONTROL
The Sarin is a cold-blooded creature who operates during the day. It has small black eyes, long, thin jaws and its skin is covered in scales.

Story Item Three: Lizard to Owl, CONDITION TWO
The Sarin is a cold-blooded creature who operates during the day. It has small black eyes, long, thin jaws and its skin is covered in scales.

One cold morning, a Sarin called Toni began to change. She grew feathers on her skin. She acquired a flat, wide beak. Her eyes became large and yellow.

Story Item Three: Lizard to Owl, CONDITION THREE
The Sarin is a cold-blooded creature who operates during the day. It has small black eyes, long, thin jaws and its skin is covered in scales.
One cold morning, a Sarin called Toni became a warm-blooded creature.

Story Item Three: Lizard to Owl, CONDITION FOUR
The Sarin is a cold-blooded creature who operates during the day. It has small black eyes, long, thin jaws and its skin is covered in scales.

One cold morning, a Sarin called Toni found her small black eyes had become large and yellow, and that she could use them to see at night, but not during the day.

Story Item Three: Lizard to Owl, CONDITION FIVE
The Sarin is a cold-blooded creature who operates during the day. It has small black eyes, long, thin jaws and its skin is covered in scales.

One cold morning, a Sarin called Toni was keeping warm by sunning herself on a rock, when she was joined by a winged creature. They had to stand close together as there was very little room for them both on the rock. After a while, Toni's scales became feathers. Her small black eyes became large and yellow.

Gone was Toni's ability to operate during the day, she would become very sleepy during the day, and found the night time more congenial.

Story Item Three: Lizard to Owl, CONDITION SIX
The Sarin is a cold-blooded creature who operates during the day. It has small black eyes, long, thin jaws and its skin is covered in scales.

One cold morning, a Sarin called Toni was keeping warm by sunning herself on a rock, when she was joined by a winged creature. They had to stand close together as there was very little room for them both on the rock, so it was easy for the creature to transmit its contagious microbes. They infected Toni's blood, and she became warm-blooded.

Consequently, her scales became feathers. Her small black eyes became large and yellow.

Story Item Three: Lizard to Owl, CONDITION SEVEN
The Sarin is a cold-blooded creature who operates during the day. It has small black eyes, long, thin jaws and its skin is covered in scales.

One cold morning, a Sarin called Toni was keeping warm by sunning herself on a rock, when she was joined by a winged creature. They had to stand close together as there was very little room for them both on the rock, so it was easy for the creature to transmit its contagious microbes.

This close encounter seemed to have had no apparent effect on Toni. She was still attracted to Sarins, but when she had offspring, they did not resemble Sarins at all. Their skin was covered in feathers, they had flat wide beaks, and large yellow eyes.

Story Item Four: Trout to Frog, CONTROL
The Dolid uses internal gills to breathe in its water environment, and fins to swim. Its body is covered in rainbow scales. It has formidable teeth with which to crunch the seafood it eats.

Story Item Four: Trout to Frog, CONDITION TWO
The Dolid uses internal gills to breathe in its water environment, and fins to swim. Its body is covered in rainbow scales. It has formidable teeth with which to crunch the seafood it eats.

One morning, a Dolid named Robin grew a long tongue with a sticky, flypaper surface. He acquired a smooth green skin. He grew four legs.

Story Item Four: Trout to Frog, CONDITION THREE
The Dolid uses internal gills to breathe in its water environment, and fins to swim. Its body is covered in rainbow scales. It has formidable teeth with which to crunch the seafood it eats.

One morning, a Dolid named Robin found his internal gills had changed to a pair of lungs, suitable for breathing oxygen on land.

Story Item Four: Trout to Frog, CONDITION FOUR
The Dolid uses internal gills to breathe in its water environment, and fins to swim. Its body is covered in rainbow scales. It has formidable teeth with which to crunch the seafood it eats.

One morning, a Dolid named Robin found that he had grown a pair of legs with which he could hop about on land.

Story Item Four: Trout to Frog, CONDITION FIVE
The Dolid uses internal gills to breathe in its water environment, and fins to swim. Its body is covered in rainbow scales. It has formidable teeth with which to crunch the seafood it eats.

One morning, a Dolid named Robin was weak from lack of food, and keeping a keen look-out for breakfast, when he saw a lively green creature splash into his territory overhead. Soon after, Robin's rainbow colour changed to bright green. In place of the fins, he grew four legs.

Not only did Robin change his method of swimming, but now he could also travel on land.

Story Item Four: Trout to Frog, CONDITION SIX
The Dolid uses internal gills to breathe in its water environment, and fins to swim. Its body is covered in rainbow scales. It has formidable teeth with which to crunch the seafood it eats.

One morning, a Dolid named Robin was weak from lack of food, and keeping a keen look-out for breakfast, when he saw a lively green creature splash into his territory. Although he did not know what the lively green creature was, Robin ate it. He could not know that the lively green creature would easily infect him with its vital nature. He grew a pair of lungs to breathe oxygen on land.

Additionally, he grew four legs, in place of his fins. His rainbow colour changed to bright green.

Story Item Four: Trout to Frog, CONDITION SEVEN
The Dolid uses internal gills to breathe in its water environment, and fins to swim. Its body is covered in rainbow scales. It has formidable teeth with which to crunch the seafood it eats.

One morning, a Dolid named Robin was weak from lack of food, and keeping a keen look-out for breakfast, when he saw a lively green creature splash into his territory.
Although he did not know what the lively green creature was, Robin ate it.

The unknown food seemed to have had no apparent effect on Robin. He was still attracted to Dolids, but when his mate had offspring, they did not resemble Dolids at all. They were born bright green, with long tongues of a sticky flypaper surface, and four legs.

Story Item Five: Horse to Camel, CONTROL
The Lazik has bony hooves, regularly shoed. It has a curved back suitable for riding, and a heavy build. It has one stomach and dehydrates very easily.

Story Item Five: Horse to Camel, CONDITION TWO
The Lazik has bony hooves, regularly shoed. It has a curved back suitable for riding, and a heavy build. It has one stomach and dehydrates very easily.

Some years ago, a Lazik named Chris began to change. He became quite thin. He now had three-toed feet. His riding back developed a hump upon it.

Story Item Five: Horse to Camel, CONDITION THREE
The Lazik has bony hooves, regularly shoed. It has a curved back suitable for riding, and a heavy build. It has one stomach and dehydrates very easily.

Some years ago, a Lazik named Chris began to change. He grew an extra stomach, thus altering his ways of digesting fat and storing water.

Story Item Five: Horse to Camel, CONDITION FOUR
The Lazik has bony hooves, regularly shoed. It has a curved back suitable for riding, and a heavy build. It has one stomach and dehydrates very easily.

Some years ago, a Lazik named Chris found he had become very thin, and had acquired the ability to tolerate the loss of up to twenty-five percent of his body-weight in water, without suffering any dehydration.

Story Item Five: Horse to Camel, CONDITION FIVE
The Lazik has bony hooves, regularly shoed. It has a curved back suitable for riding, and a heavy build. It has one stomach and dehydrates very easily.

Some years ago, a Lazik named Chris was a member of a team carrying packs for archaeologists in the desert. One hot afternoon he collapsed from sunstroke. When he recovered, he had grown a hump on his back, which was formerly curved. He had lost a lot of weight and had a very thin build.

Chris was no longer susceptible to sunstroke. On the contrary, now he could tolerate the loss of up to twenty-five percent of his body-weight in water.

Story Item Five: Horse to Camel, CONDITION SIX
The Lazik has bony hooves, regularly shoed. It has a curved back suitable for riding, and a heavy build. It has one stomach and dehydrates very easily.

Some years ago, a Lazik named Chris was a member of a team carrying packs for archaeologists in the desert. One hot afternoon he collapsed from sunstroke. Fortunately, the sunstroke inoculated him against the heat, and gave him the means to withstand it. He grew an extra stomach so that his body now had a new method of digesting fat and storing water.

Consequently, he grew a hump on his back which was formerly curved. He lost a lot of weight and now had a thin build.

Story Item Five: Horse to Camel, CONDITION SEVEN
The Lazik has bony hooves, regularly shoed. It has a curved back suitable for riding, and a heavy build. It has one stomach and dehydrates very easily.

Some years ago, a Lazik named Chris was a member of a team carrying packs for archaeologists in the desert. One hot afternoon he collapsed from sunstroke but then recovered.

The sunstroke seemed to have left no apparent effect on Chris. He was still attracted to Laziks, but when his mate had offspring, they did not resemble Laziks at all. Each offspring had a thin build, three-toed feet, and a hump.

Story Item Six: Centipede to Dragonfly, CONTROL
The Thog is a crawling, wormlike creature with an incredible number of legs. It has small eyes and one pair of antennae. The major part of his brain is concerned with finding and eating food.

Story Item Six: Centipede to Dragonfly, CONDITION TWO
The Thog is a crawling, wormlike creature with an incredible number of legs. It has small eyes and one pair of antennae. The major part of his brain is concerned with finding and eating food.

One day, a Thog called Terry fell asleep. Terry awoke to find himself with large, complex eyes.
Now he had only six long legs. He had two pairs of wings.

Story Item Six: Centipede to Dragonfly, CONDITION THREE
The Thog is a crawling, wormlike creature, with an incredible number of legs. It has small eyes and one pair of antennae. The major part of his brain is concerned with finding and eating food.

One day, a Thog called Terry fell asleep. When Terry awoke, he found that the major part of his brain was being used for managing his new complex vision.

Story Item Six: Centipede to Dragonfly, CONDITION FOUR
The Thog is a crawling, wormlike creature, with an incredible number of legs. It has small eyes and one pair of antennae. The major part of his brain is concerned with finding and eating food.

One day, a Thog called Terry fell asleep. When Terry awoke, he found that he had sprouted two pairs of wings and could fly with them.

Story Item Six: Centipede to Dragonfly, CONDITION FIVE
The Thog is a crawling, wormlike creature, with an incredible number of legs. It has small eyes and one pair of antennae. The major part of his brain is concerned with finding and eating food.

One day, a Thog called Terry crawled into a flowering bush where he fell asleep for a long time.
Terry awoke to find himself with large, complex eyes instead of small ones. He had two pairs of wings.

Terry found he need no longer crawl slowly, but instead could travel without effort, in a light-hearted fashion.

Story Item Six: Centipede to Dragonfly, CONDITION SIX
The Thog is a crawling, wormlike creature, with an incredible number of legs. It has small eyes and one pair of antennae. The major part of his brain is concerned with finding and eating food.

One day, a Thog called Terry crawled into a flowering bush where he fell asleep for a long time. While he was hibernating, Terry's body began to mature. As part of the maturation process, the major part of Terry's brain became concerned with managing his vision.

Consequently, Terry developed large, complex eyes instead of small ones. He grew two pairs of wings.

Story Item Six: Centipede to Dragonfly, CONDITION SEVEN
The Thog is a crawling, wormlike creature, with an incredible number of legs. It has small eyes and one pair of antennae. The major part of his brain is concerned with finding and eating food.

One day, a Thog called Terry crawled into a flowering bush where he fell asleep for a long time.

The long sleep seemed to have left no apparent effects upon Terry. He was still attracted to Thogs, but when his mate had offspring, they did not resemble Thogs at all. They had huge complex eyes, only six legs, and two pairs of wings.

Story Item Seven: Tortoise to Piglet, CONTROL
The Madin likes to swim in ponds or rivers in order to keep cool, and has a reptilian thin build. It is covered in grey scales. It has an external skeleton in the form of an armour-like shell on its back.

Story Item Seven: Tortoise to Piglet, CONDITION TWO
The Madin likes to swim in ponds or rivers in order to keep cool, and has a reptilian thin build. It is covered in grey scales. It has an external skeleton in the form of an armour-like shell on its back.

A Madin called Tilli began to change. She acquired a short curly tail. Her skin turned smooth and pink. She became very fat.

Story Item Seven: Tortoise to Piglet, CONDITION THREE
The Madin likes to swim in ponds or rivers in order to keep cool, and has a reptilian thin build. It is covered in grey scales. It has an external skeleton in the form of an armour-like shell on its back.

A Madin called Tilli began to grow a spinal column. This meant that she had internalized her skeleton, which was no longer visible for all to see.

Story Item Seven: Tortoise to Piglet, CONDITION FOUR
The Madin likes to swim in ponds or rivers in order to keep cool, and has a reptilian thin build. It is covered in grey scales. It has an external skeleton in the form of an armour-like shell on its back.

A Madin called Tilli became so fat she could no longer swim in ponds or rivers, but now preferred to wallow in mud.

Story Item Seven: Tortoise to Piglet, CONDITION FIVE
The Madin likes to swim in ponds or rivers in order to keep cool, and has a reptilian thin build. It is covered in grey scales. It has an external skeleton in the form of an armour-like shell on its back.

One hot afternoon, a Madin called Tilli was keeping cool by lying in a large puddle of water, when she was joined by a fat creature. Because of the creature's size, there was very little room for them both in the puddle and they had to stand close together. After a while, Tilli began to change. She lost her heavy shell and instead acquired a short curly tail. She lost her reptilian thin build, and became very fat.

It was difficult to swim in ponds or rivers now, she no longer enjoyed it, but an alternative method of keeping cool seemed to come to her, as if it was second nature.

Story Item Seven: Tortoise to Piglet, CONDITION SIX
The Madin likes to swim in ponds or rivers in order to keep cool, and has a reptilian thin build. It is covered in grey scales. It has an external skeleton in the form of an armour-like shell on its back.

One hot afternoon, a Madin called Tilli was keeping cool by lying in a large puddle of water, when she was joined by a strange creature. Because the creature was so fat, there was very little room for them both in the puddle. They were so close together that it was easy for the strange creature to transmit its contagious microbes which affected Tilli's bones. This meant that she grew an internal spinal column.

As a result, she lost her heavy shell and instead acquired a short curly tail. She lost her reptilian thin build, and became very fat.

Story Item Seven: Tortoise to Piglet, CONDITION SEVEN
The Madin likes to swim in ponds or rivers in order to keep cool, and has a reptilian thin build. It is covered in grey scales. It has an external skeleton in the form of an armour-like shell on its back.

One hot afternoon, a Madin called Tilli was keeping cool by lying in a large puddle of water, when she was joined by a strange creature. Because the creature was so fat, there was very little room for them both in the puddle. They were so close together that it was easy for the strange creature to transmit its contagious microbes to Tilli.

This close encounter seemed to have left no apparent effect upon Tilli. She was still attracted to Madins, but when she had offspring, they did not resemble Madins at all. They had short curly tails, smooth pink skins, and they were very fat.

STORIES ABOUT ARTIFACT OBJECTS

Story Item Eight: Lamp to Umbrella, CONDITION ONE
The function of the Jeal is to give out light which is produced by electricity. The Jeal has an electric light-bulb around which is fixed an open frame, covered by a satin shade.

Story Item Eight: Lamp to Umbrella, CONDITION TWO
The function of the Jeal is to give out light which is produced by electricity. The Jeal has an electric light-bulb around which is fixed an open frame, covered by a satin shade.

This particular Jeal was owned by a chef, who found it altered. The shade's material had been changed to thick plastic. The frame was made more flexible. A push-button to open or shut the frame replaced the light-bulb.

Story Item Eight: Lamp to Umbrella, CONDITION THREE
The function of the Jeal is to give out light which is produced by electricity. The Jeal has an electric light-bulb around which is fixed an open frame, covered by a satin shade.

This particular Jeal was owned by a chef, who found that electricity to the Jeal had been cut off, thus making the Jeal insensitive to water.

Story Item Eight: Lamp to Umbrella, CONDITION FOUR
The function of the Jeal is to give out light which is produced by electricity. The Jeal has an electric light-bulb around which is fixed an open frame, covered by a satin shade.

This particular Jeal was owned by a chef, who found that the satin on the shade had been replaced with thick plastic which could protect whoever held the Jeal from the rain.

Story Item Eight: Lamp to Umbrella, CONDITION FIVE
The function of the Jeal is to give out light which is produced by electricity. The Jeal has an electric light-bulb around which is fixed an open frame, covered by a satin shade.

This particular Jeal was owned by a chef. One day, the rain was pouring down outside his house and he had to go to the supermarkets to buy groceries. He decided to alter the Jeal.

First, he replaced the satin on the shade with thick plastic. Then he replaced the light-bulb with a push-button to open or shut the frame.

From that day forward, if it was raining and he had to go out, he would use the Jeal.

Story Item Eight: Lamp to Umbrella, CONDITION SIX
The function of the Jeal is to give out light which is produced by electricity. The Jeal has an electric light-bulb around which is fixed an open frame, covered by a satin shade.

This particular Jeal was owned by a chef. One rainy day, its electric light died out as the wires were worn out and frayed. The Jeal was now insensitive to water, and its owner could make it water-proof.

Consequently, he replaced the satin on the shade with thick plastic. He replaced the light-bulb with a push-button to open or shut the frame.

Story Item Eight: Lamp to Umbrella, CONDITION SEVEN
The function of the Jeal is to give out light which is produced by electricity. The Jeal has an electric light-bulb around which is fixed an open frame, covered by a satin shade.

One particular brand of Jeals displayed in the stores was not selling as well as expected. However, there was a consumer demand for objects with plastic-

covered frames which could open and shut. The manufacturers decided their products could be marketed and used by consumers as such items.

Story Item Nine Trumpet to Hammer, CONTROL
The Paik's function is to entertain the listener. The Paik's owner blows into its mouthpiece, resulting in brassy, musical sounds which issue from its bell, and are controlled by the five pins which he presses.

Story Item Nine Trumpet to Hammer, CONDITION TWO
The Paik's function is to entertain the listener . The Paik's owner blows into its mouthpiece, resulting in brassy, musical sounds which issue from its bell, and are controlled by the five pins which he presses.

This particular Paik was the prized possession of my neighbour, who discovered that it had been altered. The five pins were moulded into a heavy handle bar. The rubber mouthpiece had been melted into a rubber grip for the handle. The brass bell had been moulded into an ironlike knob.

Story Item Nine Trumpet to Hammer, CONDITION THREE
The Paik's function is to entertain the listener. The Paik's owner blows into its mouthpiece, resulting in brassy, musical sounds which issue from its bell, and are controlled by the five pins which he presses.

This particular Paik was the prized possession of my neighbour. One day, he discovered that it had been altered so that instead of being brassy and musical, it produced heavy banging sounds most efficiently.

Story Item Nine Trumpet to Hammer, CONDITION FOUR
The Paik's function is to entertain the listener. The Paik's owner blows into its mouthpiece, resulting in brassy, musical sounds which issue from its bell, and are controlled by the five pins which he presses.

This particular Paik was the prized possession of my neighbour, who found that the brass bell had been moulded into an ironlike knob which could bang nails into walls.

Story Item Nine Trumpet to Hammer, CONDITION FIVE
The Paik's function is to entertain the listener. The Paik's owner blows into its mouthpiece, resulting in brassy, musical sounds which issue from its bell, and are controlled by the five pins which he presses.

This particular Paik was the prized possession of my neighbour. One day he realized he had run out of shelf space and needed to place more shelves along the wall.

He decided to alter the Paik. First, he melted the five pins into a heavy handle bar. Then, he moulded the brass bell into an ironlike knob at one end of the bar.

From that day forward, if he needed to do some odd jobs, he used the Paik which it served this purpose most efficiently.

Story Item Nine. Trumpet to Hammer, CONDITION SIX
The Paik's function is to entertain the listener. The Paik's owner blows into its mouthpiece, resulting in brassy, musical sounds which issue from its bell, and are controlled by the five pins which he presses.

This particular Paik was the prized possession of my neighbour, who altered it because, with time, its sounds had become very unpleasant, due to tarnishing and rust. He realized he need not throw it away as it was heavy and would be a most efficient banging implement.

Consequently, he melted the five pins into a heavy handle bar. Then he moulded the brass bell into an ironlike knob at one end of the bar.

Story Item Nine Trumpet to Hammer, CONDITION SEVEN
The Paik's function is to entertain the listener. The Paik's owner blows into its mouthpiece, resulting in brassy, musical sounds which issue from its bell, and are controlled by the five pins which he presses.

One particular brand of Paiks displayed in the stores was not selling as well as expected. However, there was a consumer demand for objects with rubber grips, heavy bar handles and ironlike knobs. The manufacturers decided their products could be marketed and used by consumers as such items.

Story Item Ten. Chair to Pin-Cushion, CONTROL
The Naik's purpose is to provide a place to sit upon, and it is built on the principle of being restful and comfortable. A Naik has a seat set upon four legs, with a back-rest.

Story Item Ten. Chair to Pin-Cushion, CONDITION TWO
The Naik's purpose is to provide a place to sit upon, and it is built on the principle of being restful and comfortable. A Naik has a seat set upon four legs, with a back-rest.

This particular Naik was owned by a woman who found it had been altered. Straw stuffing had been heaped onto the seat. Brocade from the back-rest was used to cover the stuffing. A frame for the stuffed seat had been made from the four legs.

Story Item Ten Chair to Pin-Cushion, CONDITION THREE
The Naik's purpose is to provide a place to sit upon, and it is built on the principle of being restful and comfortable. A Naik has a seat set upon four legs, with a back-rest.

This particular Naik was owned by a woman who discovered that it had been altered from a restful and comfortable Naik to a holder of sharp sewing implements.

Story Item Ten Chair to Pin-Cushion, CONDITION FOUR
The Naik's purpose is to provide a place to sit upon, and it is built on the principle of being restful and comfortable. A Naik has a seat set upon four legs, with a back-rest.

This particular Naik was owned by a woman who found that the seat had been covered with straw stuffing into which sharp sewing implements could be stuck.

Story Item Ten Chair to Pin-Cushion, CONDITION FIVE
The Naik's purpose is to provide a place to sit upon, and it is built on the principle of being restful and comfortable. A Naik has a seat set upon four legs, with a back-rest.

This particular Naik was owned by an avid sewer. One day she realized it was dangerous to leave sharp sewing implements lying about.

She decided to alter the Naik. First she covered the seat by heaping straw stuffing onto it. Then she sawed off the back-rest, and used its brocade to cover the stuffing.

From that day forward, whenever she had finished her sewing for the day, she used the Naik to make the sewing area safe.

Story Item Ten: Chair to Pin-Cushion, CONDITION SIX
The Naik's purpose is to provide a place to sit upon, and it is built on the principle of being restful and comfortable. A Naik has a seat set upon four legs, with a back-rest.

This particular Naik was owned by a woman who altered it because it was no longer comfortable or safe to sit upon, having been exposed to the wind and rain. The woman was an avid sewer and realized she could still use the Naik as a holder for her sharp sewing implements.

Consequently, she covered the seat by heaping straw stuffing onto it. She sawed off the back-rest, and used its brocade to cover the stuffing.

Story Item Ten Chair to Pin-Cushion, CONDITION SEVEN
The Naik's purpose is to provide a place to sit upon, and it is built on the principle of being restful and comfortable. An ordinary Naik has a seat set upon four legs, with two arm-rests and one back-rest.

One particular brand of Naiks was not selling well and there was a glut of them on the market. However, there was heavy consumer-demand for objects stuffed with straw, covered in brocade, and set in a frame. The manufacturers decided their products could be marketed and used by consumers as such items.

Story Item Eleven: Clock to Toaster, CONDITION ONE
The Troid's function is to keep time, and it operates according to a repeatability principle whereby an oscillating pendulum swings back and forth repeatedly.

The Troid has a flat face on which are attached two arms.

Story Item Eleven: Clock to Toaster, CONDITION TWO
The Troid's function is to keep time, and it operates according to a repeatability principle whereby an oscillating pendulum swings back and forth repeatedly.
The Troid has a flat face on which are attached two arms.

This particular Troid was owned by a housewife who discovered that it had been altered.
It was fitted with an electric, automatic timer. Two slots for bread had been made. Everything was placed in a metal box.

Story Item Eleven: Clock to Toaster, CONDITION THREE
The Troid's function is to keep time, and it operates according to a repeatability principle whereby an oscillating pendulum swings back and forth repeatedly.
The Troid has a flat face on which are attached two arms.

This particular Troid was owned by a housewife who found its operation had changed from one based on a repeatability principle to an object operating on electricity and automaticity.

Story Item Eleven: Clock to Toaster, CONDITION FOUR
The Troid's function is to keep time, and it operates according to a repeatability principle whereby an oscillating pendulum swings back and forth repeatedly. The Troid has a flat face on which are attached two arms.

This particular Troid was owned by a housewife who discovered that the two arms had been replaced with two slots into which bread could be placed to cook.

Story Item Eleven: Clock to Toaster, CONDITION FIVE
The Troid's function is to keep time, and it operates according to a repeatability principle whereby an oscillating pendulum swings back and forth repeatedly. The Troid has a flat face on which are attached two arms.

This particular Troid was owned by a housewife, whose family liked to have a hearty breakfast, with all the trimmings.

One day, she decided to alter the Troid. First she removed the pendulum and fitted an electric, automatic timer in its place. Then she made two slots for bread in place of the two arms.

From that day forward, she used the Troid to cook some of the breakfast, and it seemed to her that it had never tasted so good.

Story Item Eleven: Clock to Toaster, CONDITION SIX
The Troid's function is to keep time, and it operates according to a repeatability principle whereby an oscillating pendulum swings back and forth repeatedly. The Troid has a flat face on which are attached two arms.

This particular Troid was owned by a housewife who altered it because it was worn-out. It had been a present long ago. Now, for sentimental reasons, rather than throw it out, she would change its operation from one of repeatability to one of electric automaticity.

Consequently, she removed the pendulum and fitted an electric automatic timer in its place. The place of the two arms was taken by two slots for bread.

Story Item Eleven: Clock to Toaster, CONDITION SEVEN
The Troid's function is to keep time, and it operates according to a repeatability principle whereby an oscillating pendulum swings back and forth repeatedly. The Troid has a flat face on which are attached two arms.

One particular brand of Troids was not selling well and there was a glut of them on the market. However, there was heavy consumer-demand for utensils with timer mechanisms, two slots for bread, all set in a metal box. The manufacturers decided their products could be marketed and used by consumers as such items.

Story Item Twelve: Microwave to Television, CONDITION ONE
The Shiv's function is to heat and cook food in a very short time, and it operates on electro-magnetic radiation transmitted as energy waves. It has a rotating plate visible through a glass door, with a timer control panel to one side of it.

Story Item Twelve: Microwave to Television, CONDITION TWO
The Shiv's function is to heat and cook food in a very short time, and it operates on electro-magnetic radiation transmitted as energy waves. It has a rotating plate visible through a glass door, with a timer control panel to one side of it.

This particular Shiv belonged to a housewife, who found it altered. An electric tube had been placed inside the Shiv. A colour picture screen had been fixed on it. A control panel for channels, sound and colour was added.

Story Item Twelve: Microwave to Television, CONDITION THREE
The Shiv's function is to heat and cook food in a very short time, and it operates on electro-magnetic radiation transmitted as energy waves. It has a rotating plate visible through a glass door, with a timer control panel to one side of it.

This particular Shiv belonged to a housewife who found its operating principle had changed from one of electromagnetic waves to one where cathode rays or electrons are directed onto a screen.

Story Item Twelve: Microwave to Television, CONDITION FOUR
The Shiv's function is to heat and cook food in a very short time, and it operates on electro-magnetic radiation transmitted as energy waves. It has a rotating plate visible through a glass door, with a timer control panel to one side of it.

This particular Shiv belonged to a housewife who found that the glass door had been removed, and replaced with a screen which would transmit coloured pictures.

Story Item Twelve: Microwave to Television, CONDITION FIVE
The Shiv's function is to heat and cook food in a very short time, and it operates on electro-magnetic radiation transmitted as energy waves. It has a rotating plate visible through a glass door, with a timer control panel to one side of it.

This particular Shiv belonged to a bored housewife who had too much time on her hands, and not enough tasks to keep her busy.

She decided to alter the Shiv. First she removed the rotating plate and fixed an electric tube inside the Shiv. Then she unhinged the glass door and fixed a colour picture screen there instead.

From that day forward, she used the Shiv whenever there was any danger of being bored.

Story Item Twelve: Microwave to Television, CONDITION SIX
The Shiv's function is to heat and cook food in a very short time, and it operates on electro-magnetic radiation transmitted as energy waves. It has a rotating plate visible through a glass door, with a timer control panel to one side of it.

This particular Shiv belonged to a housewife who altered it because she had read that radiation might be poisonous for any food to be eaten. She realized the operating principle of electromagnetic waves would have to be changed to one of electrons directed at a screen.

Consequently, she removed the rotating plate and fixed an electric tube inside the Shiv.
Then she unhinged the glass door and fixed a colour picture screen there instead.

Story Item Twelve: Microwave to Television, CONDITION SEVEN
The Shiv's function is to heat and cook food in a very short time, and it operates on electro-magnetic radiation transmitted as energy waves. It has a rotating plate visible through a glass door, with a timer control panel to one side of it.

One particular brand of Shivs was not selling well and there was a glut of them on the market. However, there was heavy consumer-demand for objects with an electric tube, a colour picture screen, and a control panel for channels, sound and colour. The manufacturers decided their products could be marketed and used by consumers as such items.

Story Item Thirteen: Word Processor to Till, CONDITION ONE
The Trac's function is to process and store words, and this is carried out by its memory which consists of silicon chips. The information is entered via a keyboard, and the output displayed on a screen. Commands are issued by using a mouse.

Story Item Thirteen: Word Processor to Till, CONDITION TWO
The Trac's function is to process and store words, and this is carried out by its memory which consists of silicon chips. The information is entered via a keyboard, and the output displayed on a screen. Commands are issued by using a mouse.

One particular Trac was owned by a store's technician who found that it had been altered. A narrow display for cash amounts had been fixed onto the Trac. A partitioned drawer for paper money and coins was provided. A bell by which to register sales was attached.

Story Item Thirteen: Word Processor to Till, CONDITION THREE
The Trac's function is to process and store words, and this is carried out by its memory which consists of silicon chips. The information is entered via a keyboard, and the output displayed on a screen. Commands are issued by using a mouse.

One particular Trac was owned by a store's technician who found it altered from a machine with memory for processed and stored information, to one with a memory for numbers only.

Story Item Thirteen: Word Processor to Till, CONDITION FOUR
The Trac's function is to process and store words, and this is carried out by its memory which consists of silicon chips. The information is entered via a keyboard, and the output displayed on a screen. Commands are issued by using a mouse.

One particular Trac was owned by a store's technician who discovered that the mouse had been replaced with a bell which could record sales and change.

Story Item Thirteen: Word Processor to Till, CONDITION FIVE
The Trac's function is to process and store words, and this is carried out by its memory which consists of silicon chips. The information is entered via a keyboard, and the output displayed on a screen. Commands are issued by using a mouse.

One particular Trac was owned by a store's technician. One day, the new employee at the sports equipment counter said he could not calculate the correct change for customers.

The technician decided to alter the Trac. He removed the electric cord, and inserted a partitioned drawer for paper money and coins. He replaced the mouse with a bell to register sales.

From then on, the new employee used the machine, and there were no more complaints from customers about receiving the wrong change.

Story Item Thirteen: Word Processor to Till, CONDITION SIX
The Trac's function is to process and store words, and this is carried out by its memory which consists of silicon chips. The information is entered via a keyboard, and the output displayed on a screen. Commands are issued by using a mouse.

One particular Trac was owned by a store's technician who altered it because the Trac's memory bank was full, and could no longer store more information. Once

its information was stored elsewhere, the old Trac would be converted to a machine which had a memory only for numbers.

Consequently, the technician removed the electric cord, and inserted a partitioned drawer for paper money and coins. He replaced the mouse with a bell to register sales.

Story Item Thirteen: Word Processor to Till, CONDITION SEVEN
The Trac's function is to process and store words, and this is carried out by its memory which consists of silicon chips. The information is entered via a keyboard, and the output displayed on a screen. Commands are issued by using a mouse.

One particular brand of Tracs was not selling well, and there was a glut of them on the market. However there was heavy consumer-demand for machines with money drawers, cash display screens, and bells to register sales. The manufacturer decided that their products could be marketed and used by consumers as such machines.

Story Item Fourteen: Washer to Concrete Mixer, CONDITION ONE
The Rogel's function is to wash and rinse clothes, and operates according to a reversible rotation principle. The Rogel has a control panel, and an upright position on a four legged stand.

Story Item Fourteen: Washer to Concrete Mixer, CONDITION TWO
The Rogel's function is to wash and rinse clothes, and operates according to a reversible rotation principle. The Rogel has a control panel, and an upright position on a four legged stand.

This particular Rogel was owned by a construction worker, who one day found it altered.
A petrol motor had been attached to the Rogel. The Rogel had been placed on wheels. It was now tilted in an angle position.

Story Item Fourteen: Washer to Concrete Mixer, CONDITION THREE
The Rogel's function is to wash and rinse clothes, and operates according to a reversible rotation principle. The Rogel has a control panel, and an upright position on a four legged stand.

This particular Rogel was owned by a construction worker, who one day found that its reversible rotation principle had been changed to a simple one of rotation.

Story Item Fourteen: Washer to Concrete Mixer, CONDITION FOUR
The Rogel's function is to wash and rinse clothes, and operates according to a reversible rotation principle. The Rogel has a control panel, and an upright position on a four legged stand.

This particular Rogel was owned by a construction worker, who one day found that the Rogel's position had been changed from an upright one to a tilted angle, and that this allowed the Rogel to mix sand and mortar.

Story Item Fourteen: Washer to Concrete Mixer, CONDITION FIVE
The Rogel's function is to wash and rinse clothes, and operates according to a reversible rotation principle. The Rogel has a control panel, an upright position on a four-legged stand.

This particular Rogel was owned by a construction worker, who needed to lay a path through his front lawn, from the kerb to his house.

He decided to alter the Rogel. First, he removed the control panel from the Rogel, and attached a petrol motor instead. Then, he tilted and fixed the Rogel at an angle position, instead of its former upright one.

From then on, whenever the worker needed to construct something around his house or that of a neighbour, he used the Rogel.

Story Item Fourteen: Washer to Concrete Mixer, CONDITION SIX
The Rogel's function is to wash and rinse clothes, and operates according to a reversible rotation principle. The Rogel has a control panel, an upright position on a four-legged stand.

This particular Rogel was owned by a construction worker, who altered it because his wife had bought a new one, and this particular Rogel kept breaking down.

Consequently, he changed its operating principle to one of simple rotation. First, he removed the control panel from the Rogel, and attached a petrol motor instead. Then, he tilted and fixed the Rogel at an angle position, rather than an upright one.

Story Item Fourteen: Washer to Concrete Mixer, CONDITION SEVEN
The Rogel's function is to wash and rinse clothes, and operates according to a reversible rotation principle. The Rogel has a control panel, an upright position on a four-legged stand.

One particular brand of Rogels was not selling well, and there was a glut of them on the market. However, there was heavy consumer-demand for machines with petrol motors attached, tilted at an angle position, on wheels. The manufacturer decided that their products could be marketed and used by consumers as such machines.

APPENDIX J

THE STRUCTURE OF THE ENVIRONMENT

The questions in chapters 1 and 2 asked how do concepts arise, and why do we have the categories we do, and not others. The general answer offered by the thesis is that we have certain categories because of the concepts we construct, and we construct concepts in order to create some understanding and organization of the world around us. The world around us, in turn, does not have a set structure and organization. The two questions are really addressing the issue of which came first, categories or concepts:

> The question of whether categories or concepts are the more primitive notion - in the sense that concepts can determine categorization rules, or alternatively concepts can be inductively derived to fit the naturally occurring categories in the world - is a central issue in theories of concepts ... (Hampton & Dubois, 1993, p.13).

The issue of which comes first, categories or concepts, cannot be determined empirically and can only argued for, or against. However, such environmentally-bound theories seem to have trouble in accounting for three properties evident in human cognition when dealing with concepts and categories: stability of conceptual representation, coherence of structure among category exemplars, and flexibility of processing during categorization. Theories of concepts which accept the notion that categories in the world determine or constrain our concepts make descriptions of the outside world (its seen or unseen structure) a central part of their theory. Consequently, if ontological categories are the more primitive notion, then it would be logical to begin such a discussion with a description of the structure of the environment which contains the categories (Anderson, 1990).

The structure of the outside world is assumed to be the origin of categories in Anderson's rational universe (1990), Rosch's hierarchical, physical world (Rosch, Mervis, Gray, Johnson & Boyes-Braem, 1976), and Putnam's metaphysical world (Putnam, 1975a, 1975b). Each theory differs in its description of what constitutes reality, and consequently, in its accounting for human cognitive behaviour where categories are concerned. It is of interest that two of these theorists, Rosch and Putnam, have changed their

minds to some degree, and no longer argue for "fixed" or "constraining" ontological categories.

Anderson's universe of algorithmic formulae

Anderson (1990) has the strongest claims of the three theories of concepts described in chapter 1, making what Murphy (1993b) calls "armchair" or *a priori* assumptions about the external world, listed below:

(a) Objects in the world are neatly partitioned into categories in a disjoint fashion;
(b) Features are probabilistically associated with categories; and
(c) Features within a category are independently distributed.

Anderson (1990) uses biological species from which to derive these assumptions about category structure, claiming that the levels in the hierarchy of a biological species are disjointly partitioned. For example, an object can be a *chair* but not *a kitchen chair* nor *a piece of Furniture.* Murphy (1993b) takes issue with this, claiming that there is little in the nature of biological categories that supports the assumption that categories are disjoint. Of course, Murphy (1993b) is arguing from a representational view and how people (for example, scientists) might theoretically organize categories in their biological theories, whilst Anderson (1990) is arguing for how he believes biological species *should* be represented, because that is how he assumes they are "objectively" structured, that is, as abstract forms.

This thesis is not taking sides on the issue of scientific realism. After all, the structure of the world as described by the hard sciences might be the truthful and real objective structure of the world we all live in. It *is* argued though, that for purposes of study on a psychological level, an objective structure of the world which exists independently of human cognition is irrelevant. For example, knowledge of such structure would involve physics, which is too abstract for concrete experience. Another example would be highly specific knowledge-driven rules, such as the chemical formulae underlying blood tests which allow physicians to identify certain diseases. This highly specialized knowledge is not accessible to lay people. An objective structure of the world might exist, but since individuals (expert and lay persons alike) have no way of being *certain* as to what it is, then

metaphysical knowledge cannot determine our representation and use of conceptual knowledge (Brewer, 1993; de Sousa, 1991).

Murphy (1993a) provides an interesting critique on how biologists have derived their taxonomies in the past, with biological taxonomies changing radically over time, both in specific members and in their general underlying principles of organization. For example, Mayr (1982) has claimed that it was only when biologists had accepted the Darwinian theory of evolution, that they began to agree (more) on what the actual taxonomies should be. The implication is that, with the arrival of Darwinian theory, an organizing schema could be imposed upon creatures, grouping them into coherent and comprehensible categories, and specifying the relationships between them.

So, whilst any account of categories as originating in the metaphysical environment might seem to be, at first glance, an automatic explanation for the property of stability in categories, such an account cannot provide a psychologically real account of human processing. According to de Sousa (1991), human irrationality is "just brute fact", and so people are liable to make mistakes in ways for which Anderson's theory does not allow. The theory, therefore, is not really saying anything about shared concepts which may be mistaken, yet can be shared by a number of people who treat them as if they were true (for example, Putnam's lay stereotypes). This is one kind of conceptual stability for which Anderson has no explanation, especially since his theory does not include *representations* of the individual items in a category.

Putnam's world of metaphysical essences

In his early theory of direct reference, Putnam (1975a; 1975b) posited that metaphysical essences really existed and could be discovered by experts: it did not matter if the scientific tests were different from expert to expert, as long as they all came to the same determination of what truthfully constitutes the object's essence and its category. He later revised his opinion, pointing out that such experts' tests could be fallacious (Putnam, 1981). All experts might (mistakenly) agree as to what constituted the essential features of an object, but (because of their dependence on experts) people would still understand/categorize that object *as if* it possessed such essential featues. As

a result of this revision, Putnam's focus shifted to epistemology - people's "knowledge of what is" and their *beliefs about* essences. Putnam, in a debate reported by Pylyshyn and Demopoulos (1986), posed the problem in these words, indicating his revision of earlier statements about meanings not being "in the head":

> Given that there are infinitely many correspondences, how can something intrinsically correspond to one thing rather than another?
>
> My own solution is to give up the metaphysics which generates this problem: the picture of a world which is there quite independently of any concepts I use to carve it up (Putnam, 1986, pp. 241-242).

Putnam has replaced his theory of internal essentialism with one of internal realism, thus allocating a much more active role to the mind during categorization. He claims that essences do not exist in an objective world, but that people mentally act *as if* they do, having beliefs about the reality which underlies the world's appearance (1989). They see something, for example an *Animal*, and believe that its true reality lies inside it, not in its appearance. It is this belief which gives rise to naive theories of what really makes *a dog*, a dog, and explains why we do not categorize *whales* as *Fish* even though they are physically similar to members of the *Fish* family. People categorize according to a *psychological* essentialism rather than a *metaphysical* essentialism (Medin & Ortony, 1989).

From a psychological viewpoint, metaphysical (and to a lesser degree, physical) approaches to concepts and their categories have this drawback, that they assume the relationship between a referent object and its category to be an isomorphic one (one-to-one). This implies that only one possible "true" meaning exists for each object, because it does not allow any distinction to be made between the referent object and the category to which it belongs. For example, a heavy object might be categorized only as a *rock*, not as a *weapon*, *a door-stop* or as a *geological specimen*. Obviously, a theory which describes conceptual coherence as being dependent upon such a one-to-one relationship creates problems for itself, mainly in how to explain the psychological reality of people's flexibility in categorizing objects. As Wittgenstein (1953) pointed out, an object can be described in more than one way. After all, what is an *objective* category which exists in its own right? As both the *heavy object* and *feather* examples show, the same object can have

more than one interpretation, depending upon the person's goals, its uses and the situational context.

Rosch's environment of natural hierarchies

Rosch, Mervis, Gray, Johnson, & Boyes-Braem's (1976) view of categories considered people's perceptions of world structure, rather than "correct" metaphysical Truth. The main difference between the two accounts lies in the proposal that environmental structure consisted of "bundles of feature correlations" rather than a model where features within a category are independently distributed. Most researchers agree that people do represent such feature correlations (Malt & Smith, 1984; Medin, Altom, Edelson, & Freko, 1982; but see Murphy & Wisniewski, 1989). Rosch did not specify the structure of the environment *a priori* as did Anderson, with the consequence that she has produced a much more psychologically real structure.

The Roschean hierarchy is an improvement upon Anderson's rational world because it does not propose disjointed categories between levels, thus capturing some of the flexibility shown in human processing. In other words, the hierarchies are said to be built as nested categories, so that *kitchen chair* can also be a *chair, piece of furniture, artifact, thing.* One area where her hierarchy of natural categories (she intended both biological and artifact concepts) might have difficulty, however, is in the area of cross-classification. For example, her theory cannot explain how *carnivores* and *herbivores* might belong to the same biological species (Murphy, 1993b).

Where formal models like Anderson's and structural models like Rosch's are inadequate is in their lack of informational *content*. It is not enough to make assumptions *a priori* about the "objective" structure of the environment; or yet again, to claim that people's knowledge about the environment consists solely of its physical structure. Models which depend solely upon the environment as an explanation for category behaviour, cannot account for the *flexibility of categorization.* Context-effects upon categorization items are not considered, as they should be. The psychological reality of people's ability to cross-classify an object or creature as potentially belonging to more than one category needs to be explained.

Goodman's ways of world-making

Goodman (1984) defends a "constructivist" philosophy which argues that, contrary to Anderson's (1990) and Rosch's (1978) proposals, there is no "real world" out there which is independent of human existence, and which either determines or constrains people's understanding of categories. He argues that the world of appearance is created by mind through a complex set of activities which involve "making not with hands but with minds, or rather with languages or other symbol systems" (Goodman, 1978, p.42).

What the mind constructs is never the aboriginal reality, but always a transformed construct of a previous, "given" constructed world. Bruner (1986) suggests that Goodman's notion of stipulation, taking something as given, is reminiscent of recursion, the process whereby the mind loops back on the output of a prior computation and treats it as a given input for the next operation. Johnson-Laird (1983) discussed recursion at length, attributing human capacity for self-awareness and sense of self to this ability of the mind. The problem with the stance that no one world is more real than another is that no criterion remains for distinguishing true from false models of the world (Bruner, 1986). Goodman deals with it by distinguishing between versions and worlds, though he does not make clear what this distinction might be. Perhaps he means that versions are coherent, whilst worlds are coherent *and* plausible:

> When the world is lost and correspondence along with it, the first thought is usually coherence. But the answer cannot lie in coherence alone; for a false or otherwise wrong version can hold together as well as a right one. Nor do we have any self-evident truths, absolute axioms, unlimited warranties, to distinguish right from among coherent versions.... (Goodman, 1984. p.37)

D'Andrade (1981) has come to the same problem from a different angle, since he examines one example of "multiple worlds", that is, the society the categorizer lives in, claiming that people's understanding of the world is constructed. In his case, he argues that this construction is the result of culture, from which children learn programs for action and understanding. People are said to be interested, not so much in the logic of a theory or statement, but rather focus upon what can happen in the world

under such-and-such conditions. In other words, they do not judge a situation by whether it fits some logical criterion, but whether it matches the mental models they have constructed of their world. Much of the reasoning people do, D'Andrade (1989) claims, depends on *cultural* models, and these models are more than just some kind of package of information about the world.