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PROTOTYPICALITY, DISTINCTIVENESS, AND INTERCORRELATION: ANALYSES OF THE SEMANTIC ATTRIBUTES OF LIVING AND NONLIVING CONCEPTS

Peter Garrard
University of Cambridge Neurology Unit, Addenbrooke's Hospital, Cambridge, UK

Matthew A. Lambon Ralph
MRC Cognition and Brain Sciences Unit, Cambridge, UK.

John R. Hodges
University of Cambridge Neurology Unit, Addenbrooke's Hospital, Cambridge, UK and MRC Cognition and Brain Sciences Unit, Cambridge, UK.

Karalyn Patterson
MRC Cognition and Brain Sciences Unit, Cambridge, UK.

Many cognitive psychological, computational, and neuropsychological approaches to the organisation of semantic memory have incorporated the idea that concepts are, at least partly, represented in terms of their fine-grained features. We asked 20 normal volunteers to provide properties of 64 concrete items, drawn from living and nonliving categories, by completing simple sentence stems (e.g., an owl is __, has __, can__). At a later date, the same participants rated the same concepts for prototypicality and familiarity. The features generated were classified as to type of knowledge (sensory, functional, or encyclopaedic), and also quantified with regard to both dominance (the number of participants specifying that property for that concept) and distinctiveness (the proportion of exemplars within a conceptual category of which that feature was considered characteristic). The results demonstrate that rated prototypicality is related to both the familiarity of the concept and its distance from the average of the exemplars within the same category (the category centroid). The feature database was also used to replicate, resolve, and extend a variety of previous observations on the structure of semantic representations. Specifically, the results of our analyses (1) resolve two conflicting claims regarding the relative ratio of sensory to other kinds of attributes in living vs. nonliving concepts; (2) offer new information regarding the types of features—across different domains—that distinguish concepts from their category coordinates; and (3) corroborate some previous claims of higher intercorrelations between features of living things than those of artefacts.

INTRODUCTION

The neuropsychological study of brain-damaged individuals can provide insights into the nature of normal, intact cognitive systems, and studies of patients in whom semantic knowledge has been disrupted have made a number of important observations that bear on aspects of its underlying archi-

Requests for reprints should be addressed to Dr Peter Garrard, University of Cambridge Neurology Unit, Box 165, Addenbrooke's Hospital, Cambridge, CB2 2QQ, UK. (Email: garrard@cnbc.cmu.edu).

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tecture. In cases with progressive disintegration of semantic memory (such as occurs in some patients with dementia of Alzheimer's type [DAT; Hodges, Salmon, & Butters, 1992a; Chertkow & Bub, 1990] and, by definition, in those with the syndrome of semantic dementia [SD; Hodges, Patterson, Oxbury, & Funnell, 1992b] the course is typically gradual such that, in the early stages, knowledge is only partially disrupted (Warrington, 1975). With progression of the disease, the patient's performance changes in a characteristic fashion. For example, the ability to assign concepts to their superordinate categories invariably outlasts the ability to draw distinctions based on more specific criteria (e.g., to distinguish between fierce and nonfierce animals). Furthermore, in picture naming the tendency towards generic responses (i.e., the category label or the name of a highly prototypical category member) has been shown to increase with disease progression (Hodges, Graham, & Patterson, 1995).

Such phenomena have been interpreted as suggesting that semantic memory is organised according to a nested hierarchy, with superordinate distinctions (such as that between natural kinds and artefacts), categories (such as animals, birds, and tools), and individual exemplars (such as chimpanzees, flamingos, and sledgehammers) represented at different levels (Warrington, 1975). Despite the appeal of this view, a number of empirical observations about the nature of concepts and categories are somewhat difficult to reconcile with it. In the first place, category membership is often unclear (are tomatoes fruit or vegetables?), multiple (a horse could be categorised as both animal and vehicle), or simply unnatural (to what category of objects do traffic lights and railway platforms belong?). It is unclear how the rigid classification implied by a hierarchical model could incorporate such conceptual imprecisions. A similar argument applies to the fact that some categories seem much more internally coherent than others—compare the category of "birds" with that of "household items."

An alternative view holds that knowledge of higher-order (categorical and superordinate) structure is an emergent property of a distributed network of more fine-grained components. The underlying cognitive structure of such a network may thus be reducible to the overlapping organisation of discrete featural elements. This idea has much in common with theories which regard conceptual representations as equivalent to "some sort of measure of central tendency of the instances' properties or patterns" (Smith & Medin, 1981, p. 61). According to this view, categories do not have independent ontological status; rather, they are products of a collection of individual conceptual representations that share a partially common set of features. The "coherence" of the "category" is then directly related to the quantity, or proportion, of shared features.

A neuropsychological phenomenon that has been interpreted in this context is category-specific impairment of semantic memory. Cases exhibiting this phenomenon show disproportionate impairment of concepts belonging to one of two superordinate domains, broadly defined as biological kinds (such as animals, birds, and fruits/vegetables) or man-made artefacts (such as vehicles and tools). The majority of such cases have shown a disproportionate impairment of knowledge in the domain of natural kinds (e.g., Sartori, Job, Miozzo, Zago, & Marchiori, 1993; Warrington & Shallice, 1984) but the reverse dissociation has also been observed (e.g., Hillis & Caramazza, 1991; Sacchett & Humphreys, 1992; Warrington & McCarthy, 1987).

The basis of category specificity remains controversial: One influential view is that the natural kinds/artefacts dichotomy captures a fundamental difference in the nature of the representations underlying different semantic categories, rather than simply reflecting the presence of two distinct knowledge systems. Knowledge about one class of objects (dominated by natural kinds) is thought to be encoded principally in terms of perceptual features (size, shape, colour, etc.), whereas functional attributes (such as how we interact with or use the object) are more salient for another class of objects (predominantly artefacts). Thus, damage to the neural systems critical for the representation of perceptual attributes will result in disproportionate loss of knowledge about natural kinds. This explanation appeared to make more sense of findings in the experimental literature that could not easily be accommodated into purely taxonomic accounts. For example, knowledge of body parts (a biological category with highly salient functional properties) tends to be preserved along with artefacts, whereas certain inanimate subgroups, whose members are perceptually distinct but share a canonical function (e.g., fabrics, precious stones, and musical instruments) behave more like natural kinds (Warrington & McCarthy, 1987). The idea that category-specific deficits reflect disproportionate damage to an information type rather than to a category per se has come to be known as the sensory-functional theory (SFT). The possibility of emergent category effects appearing with damage to a noncategorically organised system has been established using a connectionist model (Farah & McClelland, 1991).

Two fundamentally different explanations have been proposed to account for the independent disruption of distinct types of knowledge. One idea is that representations of different knowledge types are located in separate regions of the brain, and that the location of brain damage is therefore critical in determining which domain of knowledge is preferentially disrupted. To the extent that many cases with a category-specific pattern appear to follow characteristic distributions of well-circumscribed brain damage (Gainotti, 1990; Garrard, Patterson, Watson, & Hodges, 1998), this account appears plausible. It also has parallels in neurophysiological models of the visual system, which distinguish between two functionally and anatomically separable pathways: an inferior temporal pathway specialised for item recognition and an inferior parietal pathway for visually guided hand movements (Goodale, Milner, Jakobson, & Carey, 1991). The richness of inferior parietal lobe projections to and from other cortical areas has led to the hypothesis that the latter region serves a supramodal sensory function by which visuospatial, tactile, and kinaesthetic information is integrated. It would therefore be a likely substrate for the representation of functional information, in contrast to more directly perceptual features such as colour and shape, which might be separately represented in the temporal lobes.

This model has been criticised, however, for a variety of reasons. First, although some patients with a disproportionate deficit for living categories have also been found to show the expected difference in their knowledge of sensory and functional attributes (Silveri & Gainotti, 1988), both deficits have also been described in isolation (Laiacona, Capitani, & Barbarotto, 1993), arguing strongly against a causal link. Equally problematic are cases SE (Laws, Evans, Hodges, & McCarthy, 1995), whose sizeable deficit for living things was accompanied by poor associative rather than visual knowledge, and IW (Lambon Ralph, Howard, Nightingale, & Ellis, 1998) who showed selective loss of visual knowledge together with relative preservation of living kinds. Finally, the SFT has not been considered adequate to account for the occurrence of category-specific deficits in the context of degenerative conditions in which the pathological lesion is less clearly localised, such as dementia of Alzheimer's type (DAT). Alternative accounts have therefore been proposed, which place greater importance on the statistical regularities—originally pointed out by Keil (1987, 1989) and Rosch (1978)—that exist between groups of elements in a feature network (Devlin, Gonnerman, Anderson, & Seidenberg, 1998; Durrant-Peatfield, Tyler, Moss, & Levy, 1997; Gonnerman, Andersen, Devlin, Kempler, & Seidenberg, 1997). These accounts suggest that statistical correlations identify mutually reinforcing groups of features, and that the presence of such feature coalitions within a concept's representation results in a greater degree of robustness in the face of mild degrees of diffuse damage. The same coalitional factor will, however, render such concepts vulnerable in the presence of more severe disruption, because the groups of features on which they jointly depend will tend to drop out en masse.

There are two variants of this hypothesis: One account (that of Devlin et al., 1998) proposes that feature intercorrelation is primarily a property of concepts in the living domain, whereas Durrant Peatfield et al. (1997) argue that groups of sensory and functional features, particularly those of artefacts ("form-function" correlations), tend to be the most highly correlated. These two models make opposing predictions about the relative robustness of living and nonliving categories in the face of mild semantic disruption, but there is still little empirical evidence, either from patients or feature norming studies, that would allow one to choose between them.

A third explanation for category-specific deficits has been provided by the organised unitary content hypothesis (OUCH; Hillis, Rapp, & Caramazza, 1995; Caramazza, Hillis, Rapp, & Romani, 1990). According to this formulation, the representation of conceptual knowledge depends on a single system, in which similar concepts tend to cluster together by virtue of their shared attribute structure. Localised cortical insults may therefore produce disproportionate impairments of concepts in similar regions of semantic space, leading to category-specific impairments. Among the advantages of this model is the fact that it can account for combinations of spared and affected categories that are not predicted by the SFT. For instance, Hillis and Caramazza (1991) described a patient with preserved knowledge of animals but impaired knowledge of fruits/vegetables and inanimate objects.

A problem for OUCH, however, is that while it appears to predict the possibility of selective impairment to a wide selection of individual categories, the patterns that are observed in brain-damaged patients are largely limited to the broad domains of animals, fruit/vegetables, and inanimate objects. To overcome this objection, Caramazza and Shelton (1998) have proposed that there may, in addition, be a categorical level of semantic organisation. They argue that separate areas of neural tissue may have become specialised, under evolutionary pressures, to represent items belonging to three broad domains—animals, plant life, and artefacts—and that category-specific semantic impairments result from damage to "categorically organised knowledge system[s] that represent all types of information relevant to that domain" (p.9). They thus challenge the reductionist notion that knowledge of items in each category depends on different types of property. They also suggest that some attempts (such as that of Farah and McClelland, 1991) to determine empirically the featural components of individual concepts have been subject to a major experimental bias: To define functional information as describing "what something is for" may have deterred subjects from associating such information with certain living categories. Caramazza and Shelton also point out that many of the case reports arguing for a complementary dissociation between feature types based on subjects' ability to answer different types of question (e.g., Farah, Hammond, Mehta, & Ratcliff, 1989; Basso, Capitani, & Laiacona, 1988; Silveri & Gainotti, 1988) have failed to control for the relative difficulty of visual and functional attribute judgements. Moreover, individual categories whose meanings are hypothesised to depend on the same feature modality (e.g., animals and fruits, which are both weighted heavily for perceptual attributes) may be independently damaged (Farah & Wallace, 1992; Hart, Berndt, & Caramazza, 1985; Hart & Gordon, 1992; Hillis & Caramazza, 1991), and some appropriately controlled studies of attribute knowledge in cases with an established category-specific impairment have reported equal difficulty with sensory and functional information (Barbarotto, Capitani, Spinnler, & Trivelli, 1995; Lambon Ralph et al., 1998). In addition, there are a number of studies in which patients have been found to exhibit relatively poor sensory over functional knowledge, without the occurrence of a category-specific deficit for living things (Coltheart et al., 1998; Lambon Ralph et al., 1999; Moss, Tyler, Durranta-Peatfield, & Bunn, 1998).

Some of these formulations have been implemented in connectionist networks, in which category-specific conceptual loss results from either differential "lesioning" of the units representing perceptual and functional features, or from global lesioning in which domain effects are a by-product of differential intercorrelations between the component features. In the model of Farah and McClelland (1991), the semantic features were derived from a series of dictionary definitions, components of which were judged by a panel of undergraduate students to be examples of either sensory or functional knowledge. It is questionable whether an attribute set assembled on this basis accurately reflects the featural composition of concepts within any individual human's semantic memory, and the potential for biases favouring the hypothesis to be tested has been noted by Caramazza and Shelton (1998). McRae, de Sa, and Seidenberg (1997) used a rather more natural method to collect a large set of attributes for living and manmade concepts, and examined their database for evidence of some of the correlational properties referred to earlier. Neither of these studies has, however, presented sets of features corresponding to items in a semantic test battery that can be used to investigate potential differences in knowledge of specific categories in brain-damaged patients (though for a thorough analysis of these issues using a very large feature database, see McRae & Cree, in press).

The motivations for collecting a set of attribute norms, therefore, are threefold: first, to examine the relationship between category structure and feature knowledge; second, to evaluate the assumptions of cognitive models that attempt to explain category-specific semantic impairments in terms of disruption to feature knowledge in the light of an empirically derived corpus of semantic features; and third, to provide a set of living and nonliving concepts that, together with a sample of semantic features varying over theoretically important dimensions such as type of knowledge and distinctiveness, can be used for fine-grained investigations of subjects with semantic memory impairments (see Appendix A).

SUBJECTS, MATERIALS, AND METHODS

Generation of semantic features

The subjects were 20 volunteers from the MRC Cognition and Brain Sciences Unit subject panel. Eleven were female and nine male. Mean age was 67.4 years (SD 3.9), and mean years of education 11.4 (SD 2.0). A payment of £25 was made to each subject on completion of testing.

Subjects were tested in 2 groups of 10 each group attending for 2 sessions, 1 week apart. Data were collected using booklets containing 64 sheets with a standardised format as illustrated in Figure 1, but with a different item heading each sheet. The items had been selected from the Snodgrass and Vanderwart (1980) corpus as stimuli for a battery of tests of semantic memory, and consisted of eight animals native to Britain, eight foreign animals, eight birds, six fruits, two vegetables, eight small manipulable items, eight large non-manipulable items, eight tools, and eight vehicles.

Subjects were given folders containing all 64 sheets, arranged in random order, and asked to work through the folder filling in the blank spaces, beginning with the "Category" field[1]. In order to avoid excessive constraints on the subjects' responses, instructions were minimised, but the following principles were explained, with examples where appropriate:

1. The object of the test was to determine the content of mental representations of familiar items of knowledge.
2. The category chosen for each item should be neither very broad nor very narrow.
3. The attributes should consist of single words or short phrases that could be connected to the word at the top of each page by the word adjoining each blank space.
4. "Is" attributes would tend to be descriptive words (not necessarily of a perceptual kind), "has" attributes to refer to parts of the item, and "can" attributes to the abilities, activities and uses of the item.
5. Attributes should not be pieces of specialised, technical information, nor judgements about the value or aesthetic qualities of an item, but examples of factual knowledge.
6. All the category spaces, and as many as possible of the attribute spaces were to be filled in, with a minimum of two or three per section[2].

[1] The purpose of using a sentence-stem completion method rather than an attribute-listing procedure (favoured by McRae et al., (1997), was to standardise the task as far as possible, both between items and between subjects, without producing excessive constraints on the range of acceptable responses.

[2] Points 4 and 6 were designed to overcome the bias towards sensory attributes inherent in the fact that only one of the three sentence stems ("can…") is more likely to elicit functional than perceptual features.

Elephant

Category ....

is	is ....
is	is ....
is	is ....
has	has ....
has	has ....
has	has ....
can	can ....
can	can ....
can	can ....

Figure 1. *Example of sheet used for the generation of semantic features.*

7. When a page had been completed it should not be returned to later.
8. Two potentially ambiguous items ("glass" and "plug") referred to a container for drinking and an electrical plug, respectively.

Two practice sheets were given, and these were collected and examined to ensure that all subjects had understood the instructions before beginning the test proper. If the responses on any practice sheet indicated that the instructions had not been correctly followed, the errors were explained to the group as a whole without attributing them to any individual. To minimise fatigue, items were presented in 4 blocks of 16, and the subjects were allowed to work for half an hour at a time. Although no formal time limits were set for the task, all subjects completed 12 to 16 sheets per half-hour period. Any unfinished sheets at the end of each block were inserted into an extra block, which was completed at the end.

Nineteen subjects completed the test, while one subject dropped out after the first session and therefore completed just under half of the sheets. The results were collated and entered into a database. Data entry took place in three stages: in the first, responses were divided into individual components of information (e.g., "an apple is red or green" was recoded as "an apple is red" and "an apple is green"). Composite attributes (such as "a horse has four legs") were coded as "a horse has legs" and "a horse has four legs", on the grounds that they contained two separate pieces of information. Responses to a given concept that were identical or had similar meanings were grouped together (e.g., "a lion is ferocious", "a lion is dangerous," and "a lion can kill"). In the second stage a standardised wording was assigned to each such grouping, and a dominance value (the proportion of subjects who generated the attribute for that concept) was calculated. Finally, attribute wordings were standardised across the entire stimulus set (e.g., "an axe can be used to kill someone," "a lorry can run someone over," and "a hammer can be used as a weapon" were all recoded as instances of "…is dangerous")[3].

As far as possible, all the information found on the sheets was preserved in the database, but the following kinds of response were changed: (1) "can" responses indicating attributes that may or may nor be true (e.g., "an apple can be green") were entered as "is" attributes[4]; (2) responses that identified subordinate instances of the item (e.g., "a saw is a fretsaw," or "an aeroplane is a Jumbo jet") were excluded; (3) qualifying expressions were omitted, so that, for instance, "a bicycle is quite fast" became an instance of "a bicycle is fast"; (4) the small number of responses that were highly idiosyncratic or otherwise difficult to classify, such as "a train can evoke happy memories," were excluded.

When data entry was complete, each attribute was designated as an instance of sensory, functional, encyclopaedic, or categorising information, according to the following criteria: attributes classified as sensory were those which could be appreciated in some sensory modality (e.g., "an eagle is large" or "a saw is sharp"); attributes categorised as functional were those which described an action, activity, or use of an item (e.g., "a cat can catch mice," "an owl can fly," or "a suitcase can be carried"); encyclopaedic attributes were considered to be those describing some other type of associative relationship (e.g., "a tiger is found in India"; or "a toaster is kept in the kitchen"); features classed as categorising were those that placed the item in a superordinate category (e.g., "a dog is an animal").

Judgements of prototypicality and familiarity

The 19 subjects who returned complete sets of attribute data in the initial part of the study were

[3] This process of "top-down" standardisation may ultimately have resulted in an underestimate of the distinctive properties, but was necessary because the feature set would otherwise have been dominated by distinctive features with a dominance of .05, making the quantity of usable data very small indeed. Moreover, many of these apparently distinctive features are not distinctive at all (a lorry is not the only vehicle that can run somebody over), and re-wording them to stand for some genuinely shared element that captures most of the sense behind them was felt to be an appropriate intervention.

[4] This manoeuvre runs counter to "classical" theories which assume that concepts are represented only in terms of their necessary and sufficient features (for a discussion, see Smith, & Medin, 1981, pp. 22–60).

contacted 12 months later, and asked to fill in a questionnaire with ratings of their assessments of the familiarity and typicality (considered as members of the 6 basic level categories) of the same 64 items. The format of the questionnaire required typicality judgements to be given on each member of the 6 categories, by assigning it to one of four typicality bands, which ranged from "highly typical" to "very atypical" of its category. Full written instructions, incorporating two completed examples (for categories of sea creatures and items of clothing) were given. Completed forms were received from 18 subjects, and average values of familiarity and prototypicality for each concept were calculated.

DATA ANALYSES

Overall database characteristics

The two vegetables in the category of fruit and vegetables were subsequently removed in order to make this category more homogeneous. The fruit category considered here therefore has only 6 exemplars, and subsequent analyses are based on a set of 62 items, 30 from living and 32 from nonliving categories. In total, 869 unique features were generated to the 62 stimulus words. Many of these responses were associated with more than 1 item, so the total number of concept-feature pairs was rather larger (2969).

The distribution of feature dominance is displayed in Figure 2, where it can be seen that a large number (approaching 300) of the attributes were generated by only one respondent (dominance < .1). In common with McRae et al. (1997), we chose to include in the analysis only those features that had been generated by two or more subjects. In this reduced set of 618 unique features, there were 1656 item-feature pairs, of which 5.5% were sensory, 27.6% functional, 14.7% encyclopaedic, and 7.2% categorising. Table 1 displays the distribution of feature types among each of the six basic level categories.

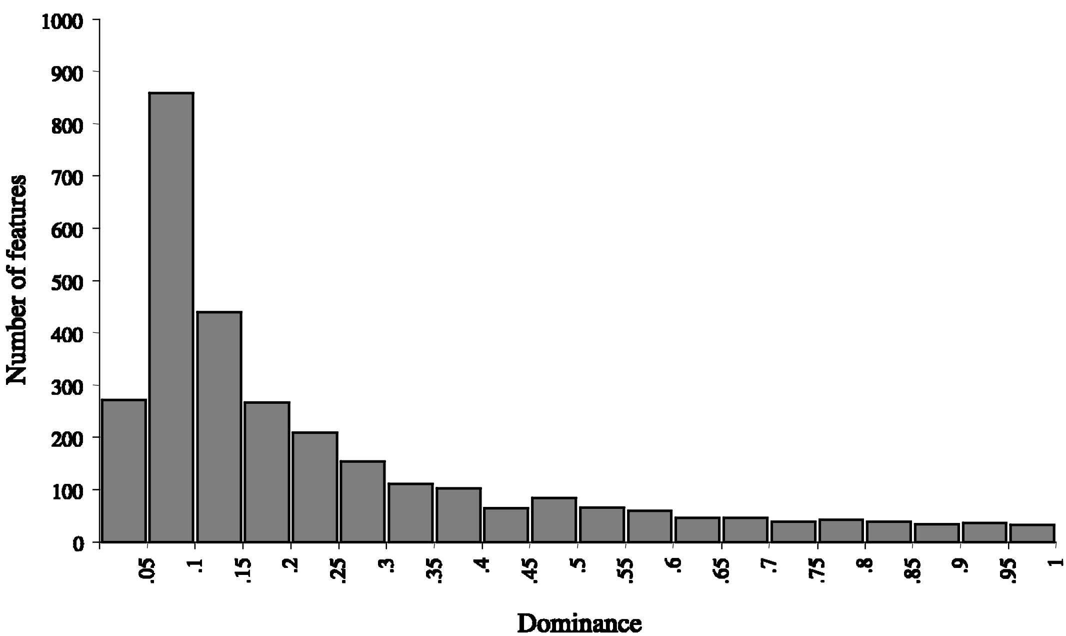


Figure 2. *Distribution of dominance (production frequency) values in the original set of 2969 features.*

Table 1. *Total number of features of each type associated with each of the six basic level categories.*

	Living				*Nonliving*				*Overall*
Feature type	*Animals*	*Birds*	*Fruit*	*Total*	*H'hold*	*Tools*	*Vehicles*	*Total*	*Total*
Categorising	40	12	7	59	38	10	12	60	119
Encyclopaedic	106	40	17	163	23	16	43	82	245
Functional	152	49	26	227	111	45	74	230	457
Sensory	275	110	77	462	205	69	100	374	836
Total	573	211	127	911	377	140	229	746	1657

Validity of the feature approach as a model of category and concept representation

Hierarchical cluster analysis of semantic features

To assess categorical structure within the feature data and compare this with the categories assigned a priori, a hierarchical cluster analysis was performed, using the presence or absence of each feature (excluding categorising features) as the variable of interest.

Three observations can be made from the dendrogram presented in Figure 3. First, the degree of similarity based on these features alone was sufficient to produce clusters of items that corresponded very closely to the a priori category structure without any information about category membership being specified. Second, the earliest clusters to emerge are equivalent to the three broad domains suggested by Caramazza and Shelton (1998)—fruit, animate beings, and inanimate objects—and these quickly divide to produce the most intuitively coherent categories of land-animals, birds, fruit, and vehicles. Third, the biological kinds are generally much more tightly clustered together than are any of the inanimate items except for those in the category of vehicles.

Correlation between rated and computed measures of typicality

Using the available data, it is possible to consider not only the differentiation of categories one from another, but also comparisons of items within individual categories. This suggests an alternative method of examining the validity of the featural approach, namely a comparison of the values of a semantic variable obtained directly from subjects' intuitions, with values derived from a theoretically motivated analysis of the feature data. According to Rosch and Mervis (1975), the typicality of a concept within its category is correlated with a measure of family resemblance, which is based on the degree to which its features are shared with those of other members of its category. The family resemblance metric used in these earlier studies was equivalent to the weighted sum of a concept's features, with the weights denoting the degree to which a feature was shared by other members of the same category. These measures were found to be highly correlated both with independently derived prototypicality ratings and with reaction times in category-concept verification tasks (Rosch, 1973). The present feature data allow this idea to be generalised to a different group of concepts, and across a selection of semantic categories.

In line with the distributed models of semantic organisation outlined in the Introduction, each concept's featural description was considered as a binary vector in a 618-dimensional feature space. The family resemblance measure used by Rosch and Mervis was implemented in the present study by calculating vector centroids for each of the six semantic categories. These were derived by calculating the average values of each element of all the vectors within a category, and were taken to be representative of the average, or most typical, category member. The angle between this vector centroid and each concept vector was assumed, therefore, to reflect its prototypicality within the category. Although the procedure for deriving prototypicality differed from that of Rosch and Mervis, the values obtained were influenced by the same factors: The greater the number of concepts sharing a particular feature, the higher the value of the corresponding element of the vector centroid.

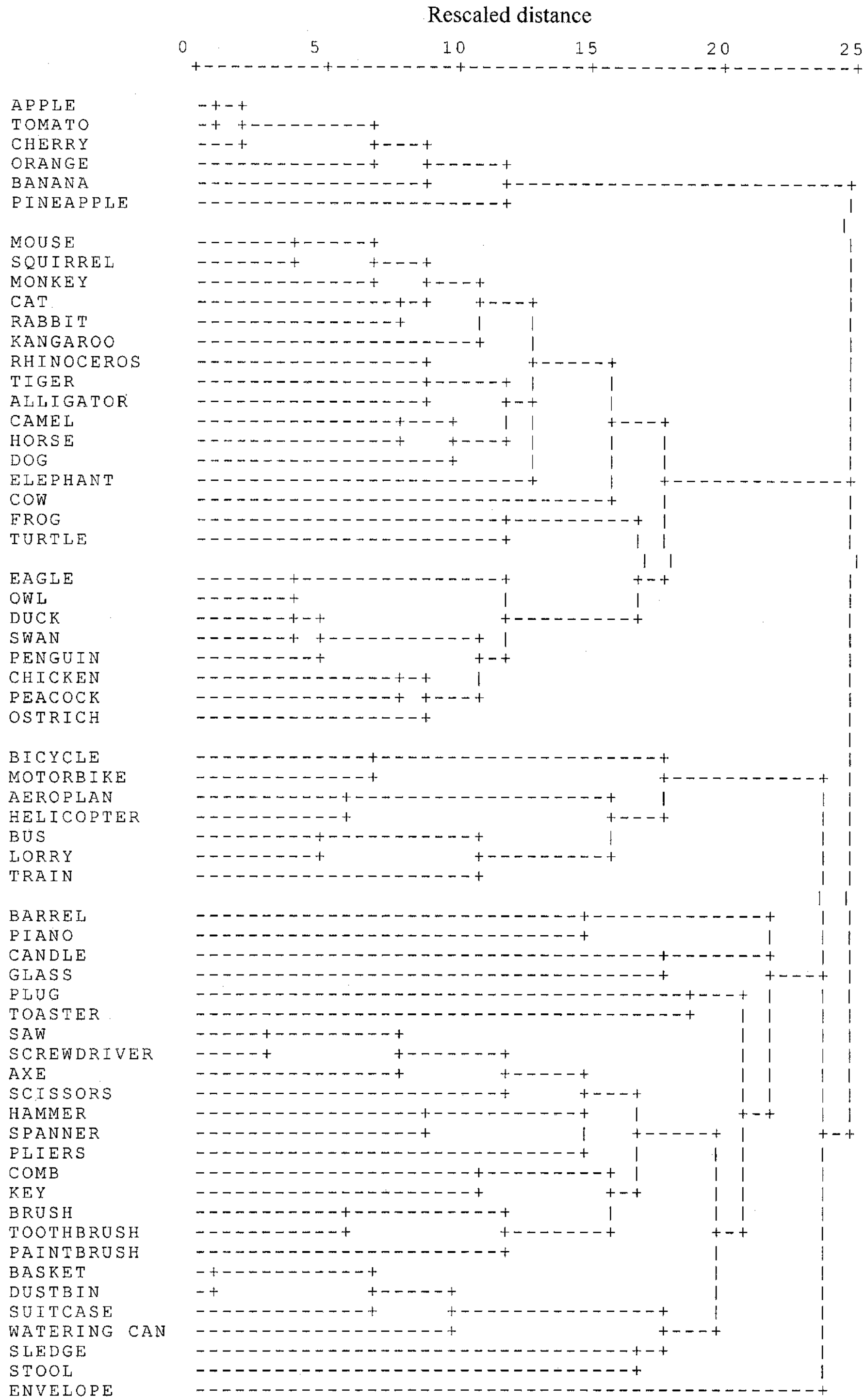


Figure 3. *Dendrogram resulting from hierarchical cluster analysis of binary feature data from the reduced set of 1656 features.*

The angle (or normalised dot product) between each concept vector and its category centroid was calculated for all six semantic categories, and compared in a correlation analysis to the subjects' prototypicality and familiarity ratings. Dot product was significantly correlated with subjects' ratings of familiarity, $r = -.49$, $p < .01$, and typicality, $r = -.38$, $p < .01$. The relationship between typicality and dot product was also examined in a partial correlation analysis (with familiarity entered as covariate) and found to remain significantly negatively correlated, $r = -.41$, $p < .01$. This is consistent with the Rosch model (since smaller values of the dot product indicated greater vector similarity). A correlation of similar magnitude was obtained when the Euclidean distance between the concept vectors and their category centroids were considered, $r = .44$, $p < .01$.

Comment

These preliminary analyses have suggested that concepts can be organised into categories and categories into broader domains of knowledge, based purely on their similarities in terms of attribute structure, a conclusion that was also reached in an earlier, related study (Small, Hart, Nguyen, & Gordon, 1995). Consideration of the similarities alone produced a broad differentiation of concepts into three domains (fruit, animate beings, and artefacts) together with more specific coherent categories (e.g., vehicles). This outcome accords with the idea that, rather than being explicitly encoded, concepts' membership of semantic categories and higher-order domains may "emerge" from the patterns of overlap among the features of their component concepts.

Our results also provide some independent support for the feature approach to semantic memory, insofar as they have endorsed the findings of Rosch and Mervis (1975) concerning the relationship between shared features and rated typicality. The possession of shared features (such as "has wings," "has legs," "lays eggs," etc.) yields a coherent category structure, and the *specificity* of these shared features (e.g., "is sweet" vs. "has legs" vs. "is made of metal") promotes the subdivision into three superordinate domains (fruits, animate beings, and inanimate objects).

Do living and nonliving domains differ with respect to sensory and functional features?

Neuropsychological studies that have demonstrated dissociations between living and nonliving domains in brain-damaged patients have motivated a number of competing theories regarding the key organising principles within semantic memory. We now examine each of these theories in the context of the present feature database.

Warrington and Shallice (1984) proposed that differential performance on living and nonliving items occurs because of the varying importance of sensory and functional knowledge in the cognitive representations of these two domains. This idea can be operationalised in two ways. Like Farah and McClelland (1991), one can consider how the proportions of features of each type may differ between the two domains. Alternatively, one can look at the distinctiveness of individual features. A feature's distinctiveness can be understood as the extent to which it allows a particular concept to be distinguished from other members of the same category. Thus, "has a trunk" is a highly distinctive feature of an elephant, whereas "has a tail" is very nondistinctive; similarly "can be used to knock in nails" is a distinctive, and "has a handle" a nondistinctive feature of a hammer.

It should also be noted that distinctiveness need not be regarded as all-or-nothing; according to the definition just given, it can vary continuously from being diagnostic of a single concept to being shared across an entire category. Critical to the Warrington and Shallice position is the suggestion that the type of feature that enables category coordinate exemplars to be distinguished from one another varies between semantic domains. It is therefore necessary to separate features on the basis of distinctiveness before the distribution of different feature types between semantic domains can be interpreted. To our knowledge, no previous analysis of semantic feature data has given full consideration to this critical factor. The scope of the present data allowed us to consider the distribution of feature types across domains before and after distinctiveness was taken into account.

Do the numbers of sensory and functional features differ between domains?

Farah and McClelland (1991) based their connectionist network on a set of semantic features that had been selected from dictionary definitions of living and manmade items. Although sensory features outnumbered functional in both knowledge domains, the proportions were different in each case: for living items the ratio of sensory to functional features was 7.7:1, whereas for nonliving items it was 1.4:1. The numbers of features of each type contributing to the distributed concept representations were therefore critical to the behaviour of the network when damage was introduced. Caramazza and Shelton (1998) criticised this approach on the grounds that the subjects who performed the selection of features were biased by the instructions against selecting many functional features for living items, since the idea of "function" (in the sense of "what it is *for*") as applied to living things is counterintuitive. They went on to argue that if the subjects had been instructed instead to identify sensory and *nonsensory* information (i.e., including "encyclopaedic" features), then the ratios of these two types of knowledge in each domain would have been equivalent, and the network would have failed to produce the emergent category-specific pattern. These two alternative proposals were considered further by analysing the present feature database, in which nonsensory features had already been classified separately as either "functional" or "encyclopaedic."

The mean numbers of sensory and functional features per item in the living and nonliving subsets are displayed in Figure 4a, and the mean numbers of sensory and nonsensory (i.e., functional + encyclopaedic) features per item are shown in Figure 4b. Adopting a rigorous definition of "functional", which excluded the encyclopaedic properties, the ratio of sensory to functional features for the living set was 2.03:1 and for the nonliving set 1.62:1. A two-way analysis of variance on the raw number of attributes generated yielded significant main effects of feature type, $F(1, 60) = 154.4, p < .001$, and domain, $F(1, 60) = 1.3, p < .01$, together with an interaction, $F(1, 60) = 11.72, p < .01$. Using the Caramazza and Shelton definition of "nonsensory," which collapses across functional and encyclopaedic features, the main effects of feature type, $F(1, 60) = 13.1, p < .01$, and domain, $F(1, 60) = 16.64, p < .001$, persisted, but the interaction disappeared, $F(1, 60) < 1$, due to the larger numbers of encyclopaedic features contributing to the living domain.

Comment

This empirically derived set of semantic attributes has revealed contrasting numbers of sensory and functional features associated with the two conceptual domains, a pattern that is broadly similar to the distribution found by Farah and McClelland, though by no means as striking. This failure to demonstrate a sizeable interaction between domain and feature type is thus more in keeping with the findings of Caramazza and Shelton and, moreover, corroborated the objection levelled by these authors against Farah and McClelland's classification of feature types. In our analysis, inclusion of encyclopaedic features in the set of nonsensory attributes increased the number of functional features in the living domain, and thus largely equated the proportions of each type between the two domains. For a parallel analysis and very similar results, see McRae and Cree (in press).

The claim of Warrington and Shallice, however, was not based entirely on the numbers of features, but on the nature of the *distinguishing* features in each domain, which they claimed would tend to be sensory in the case of living things, and functional in the case of man-made artefacts (Warrington & Shallice, 1984).

Do the numbers of distinctive semantic features vary by knowledge type and by domain?

For the present analysis, the distinctiveness of a feature was considered as a continuous variable, which was simply equal to the proportion of concepts within a category for which the feature in question was generated. Distinctiveness could take a range of values between .125 (characteristic of only one of the eight concepts in the category and thus highly

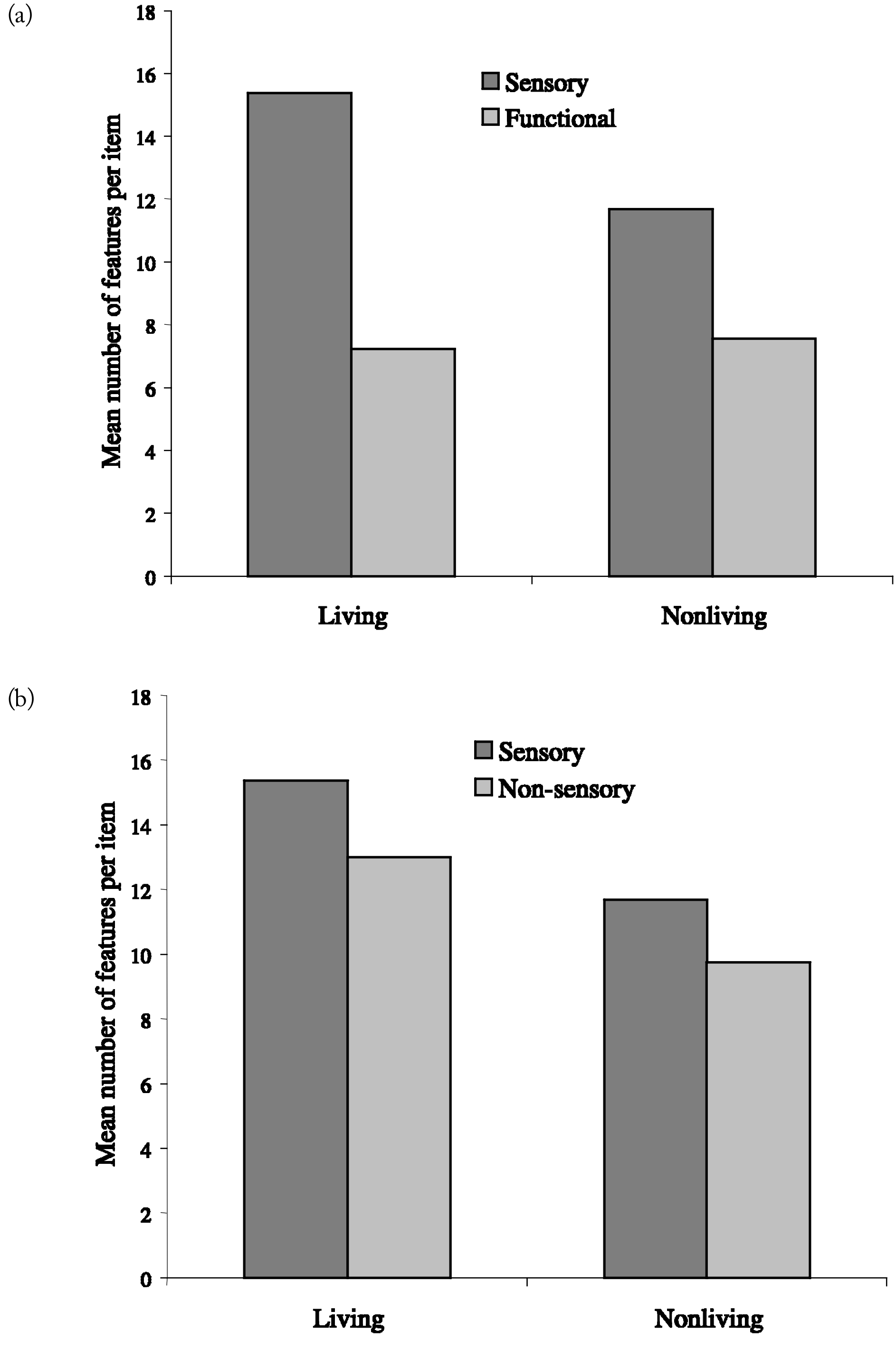


Figure 4. *Mean numbers of features per item in the living and nonliving subsets, split by feature type. Sensory features are compared (a) with functional features, following Farah and McClelland, and (b) with nonsensory features, following Caramazza and Shelton.*

distinctive) and 1.0 (shared by all category members)[5]. For instance, within the category of animals the features "has four legs" and "can walk" are relatively non-distinctive, whereas the features "has a trunk" and "can bark" are so distinctive that they could almost stand alone as descriptive expressions for the exemplars to which they apply. Between these two extremes lie a group of features—such as "has hooves" or "can be used to carry loads"—which pick out smaller subsets without being distinctive of any one exemplar. In its original formulation, the Warrington and Shallice hypothesis would predict that, among the distinctive features, those associated with living things would be predominantly sensory, whereas those associated with artefacts would be predominantly functional.

Figures 5(a)–5(c) show the distributions of distinctiveness values associated with the sensory, functional, and encyclopaedic features, respectively, of the living and nonliving subgroups. It can be seen that among nonliving things there were more distinctive than nondistinctive features of all types. For concepts from the living categories, on the other hand, this same pattern (i.e., more distinctive than shared features) was only true of the encyclopaedic features, whereas the distribution of distinctiveness in the sensory and functional features was U-shaped.

To allow a more formal examination of the distribution of features among types, domains, and levels of distinctiveness, the features were assigned to one of two subgroups: a relatively distinctive subgroup consisted of those features occurring in the descriptions of half or fewer of the category exemplars (i.e., associated with a distinctiveness value of .5 or less), and a relatively shared subgroup consisted of features occurring in the descriptions of more than half of the exemplars within their categories (i.e., associated with a distinctiveness value above .5)[6]. Using this definition of distinctiveness, the mean numbers of distinctive and shared features of each type generated for living and nonliving concepts were examined (see Figure 6).

A three (sensory vs. functional vs. encyclopaedic) by two (distinctive vs. shared) by two (living vs. nonliving) analysis of variance revealed that there were significantly more distinctive than shared features, $F(1, 27) = 30.4, p < .001$, in addition to significant main effects of feature type: sensory > functional > encyclopaedic; $F(2, 54) = 193.1, p < .001$, and domain: living > nonliving; $F(1, 27) = 6.7, p < .05$, already observed. In addition, there were significant interactions between feature type and domain, $F(2, 54) = 11.3, p < .01$, and feature type and distinctiveness, $F(2, 54) = 6.13, p < .01$. The interaction between distinctiveness and domain, and the three-way interaction, however, both fell short of statistical significance.

The distinctive and shared features were examined individually using separate three (feature type) by two (domain) analyses of variance. These revealed that the domain by feature type interaction was significant in both subsets: distinctive; $F(2, 120) = 6.8, p < .01$; shared; $F(2, 120) = 46.03, p < .001$. Post hoc pairwise comparisons showed that, among the shared features (right side of Figure 6), all feature types were significantly more numerous in the living things: sensory; $t(60) = 9.02, p < .001$; functional; $t(60) = 8.69, p < .001$; encyclopaedic; $t(60) = 5.2, p < .001$. By contrast, among the distinctive features (left side of Figure 6) the excess of functional features associated with the nonliving items, and the reverse pattern for the encyclopaedic features, were both significant, $t(60) = 2.04, p < .05$ and $t(60) = 3.41, p < .01$, respectively, but the number of sensory features did not differ significantly between domains, $t(60) = .51, p = .62$.

The differences between conceptual domains with respect to the associated overall proportions of different feature types were found earlier to be influenced by the interpretation chosen to distinguish sensory from functional information. A similar approach was therefore taken using the distinctive and shared feature subsets, with definitions of the sensory-functional distinction based on the same criteria as before (i.e., with and without

[5] Between .17 and 1.0 in the case of fruits, for which there were only six category members.

[6] When a feature is true of exemplars in more than one category, it may be distinctive in one but shared in the other. An example of this is "has wings," which is true of all birds, but of only one vehicle.

encyclopaedic features included in the definition of "functional"). Figure 7(a) displays the mean number of distinctive sensory and functional features generated for living and nonliving categories using the former of these definitions, and Figure 7(b) the same information using the latter definition. Separate two (feature type) by two (domain) analyses of variance were performed for each of these data sets. In the set based on Farah and McClelland (Figure 7(a)), there was a significant overall excess of distinctive sensory over functional features, $F(1, 60) = 35.02, p < .001$, with no main effect of domain, $F(1, 60) = 2.21, p = .14$, and no interaction, $F(1, 60) = 6.04, p = .42$. Using the Caramazza and Shelton definition of sensory and non-sensory features, as reflected in Figure 7(b), there were no significant main effects or interactions, all Fs < 1.

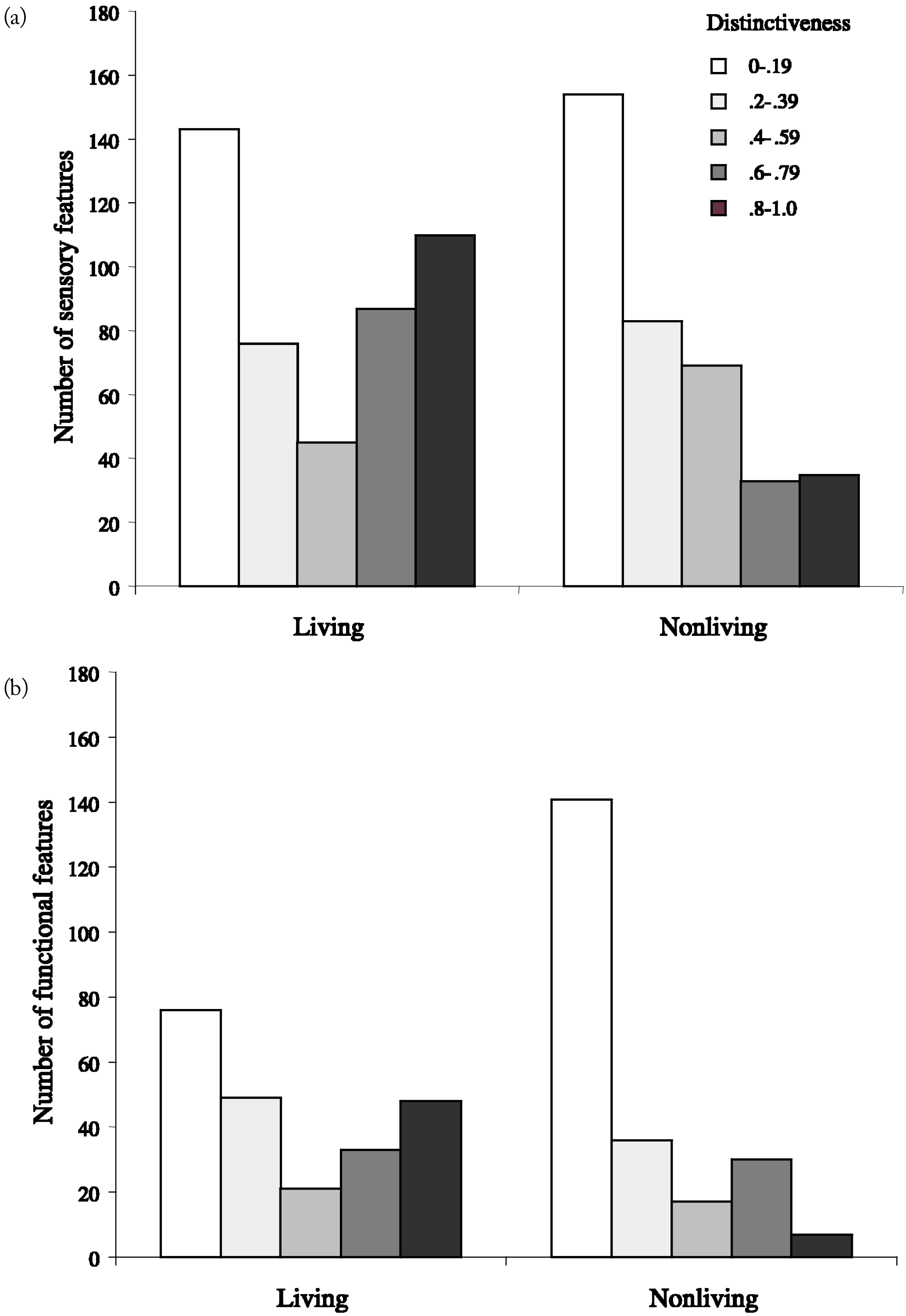
Comment

These analyses have confirmed that, as suggested by Warrington and Shallice (1984), statistically reliable differences exist between the proportions of different feature types associated with concepts in the living and nonliving domains, and that these differences are influenced by feature distinctiveness. Of the individual comparisons, however, the only finding that is predicted by the Warrington and Shallice hypothesis is the greater number of distinctive functional features in the nonliving subset; the expected complementary difference (i.e., an excess of distinctive sensory features associated with concepts in the living domain) was not found, though there was an excess of *shared* sensory features associated with concepts in the living domain. In general, however, the prediction of Warrington and McCarthy (1987) that visual features are crucial for distinguishing among living things, and therefore that damage to "visual semantics" should result in a category-specific deficit, has not been upheld. In fact, the interaction observed in the distinctive feature subset, between feature type and conceptual domain, was critically dependent on the distribution of *encyclopaedic* features, and was not apparent when these features were excluded from the analysis, nor when they were combined with the functional features (following Caramazza and Shelton). The significantly greater number of distinctive encyclopaedic features associated with concepts in the living domain is a finding that is not predicted by any theoretical model known to us.

Are there differences in the degree to which the features of living and nonliving things are intercorrelated?

A number of recent papers have emphasised the potential influence of another factor within feature-based approaches to semantic memory, namely the intercorrelation of feature-pairs across concepts (Devlin et al., 1998; Durrant-Peatfield et al., 1997; Gonnerman et al., 1997; Moss, Tyler, & Jennings, 1997). The principal notion underlying such approaches is that if two or more features tend to co-occur in the description of various concepts then this statistical fact will have significant consequences for the semantic system under both normal and impaired circumstances (McRae et al., 1997). Several investigators have demonstrated the effect of different degrees of feature-intercorrelation on the performance of computational models of semantic memory. Typically, if a concept includes a large number of intercorrelated features then (1) under normal circumstances, the full conceptual representation is more readily activated (McRae et al., 1997), and (2) under mild degrees of damage, the intercorrelated features are less vulnerable than those lacking intercorrelational "support" (Devlin et al., 1998).

McRae et al. noted that within their feature database for 190 different concepts, intercorrelations were generally low (i.e., the distribution of correlation coefficients for all the possible feature-pairings was strongly skewed) but that in general the intercorrelations were higher for the living than nonliving concepts. Figure 8 shows the distribution of intercorrelations between pairs of attributes generated for the living and nonliving concepts in the present database. Despite its smaller size, this database produces a pattern similar to that described by McRae et al. First of all, the absolute value of Spearman's correlation across concepts (a formal measure of the number of concepts in which pairs of features are either both present or both


(a)
Number of sensory features
180
160
140
120
100
80
60
40
20
0
Distinctiveness
0-.19
.2-.39
.4-.59
.6-.79
.8-1.0
Living
Nonliving
(b)
Number of functional features
180
160
140
120
100
80
60
40
20
0
Living
Nonliving

(c)

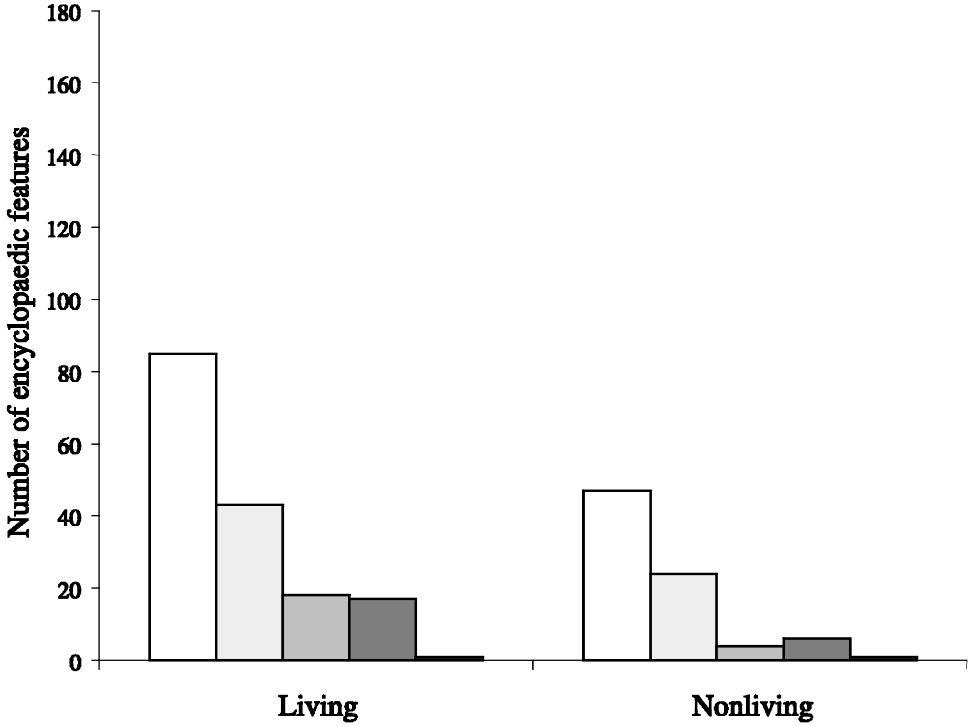


Figure 5. *Distribution of distinctiveness values in the subsets of (a) sensory, (b) functional, and (c) encyclopaedic features.*

absent) for the vast majority of feature pairs was extremely small. Second, the values for the features of living things were slightly higher than those of nonliving: the mean correlation coefficient for living feature pairs was .13 (SD =.16), and for nonliving feature pairs it was .10 (SD =.17), a difference that was statistically significant given the large number of possible feature pairings (Mann-Whitney, $p < .001$). It is important, however, to view this significant difference between intercorrelations for the two domains in terms of the critical values for the correlation coefficient ($R_{critical}$). For the features of living items, N=30, $R_{critical}$ =.36, whereas for features of nonliving items, N=32, $R_{critical}$ =.35 (α =.05 in both cases). It is clear, therefore, that the vast majority (90%) of these intercorrelations are not statistically significant.

Two approaches have utilised this apparently different degree of intercorrelation for features of living and nonliving concepts to explain patterns of category-specific semantic deficits. These two approaches differ in terms of the feature types that are presumed to participate in intercorrelations, and make contrasting predictions about the emergence and progression of category-specific effects.

Feature intercorrelation is more characteristic of living things

Devlin et al. (1998) reported results from a computational model of conceptual knowledge in which, with mild degrees of simulated generalised damage, the greater number of intercorrelated features for living things resulted in a relatively better performance on living than on nonliving items. As the level of damage was increased, however, the intercorrelated features showed a tendency to "drop out" together, resulting in relatively better performance for the nonliving items (see Devlin et al., 1998, Figure 4, p. 87). This cross-over in the relationship between severity and the direction of the category advantage has also been observed in a group of

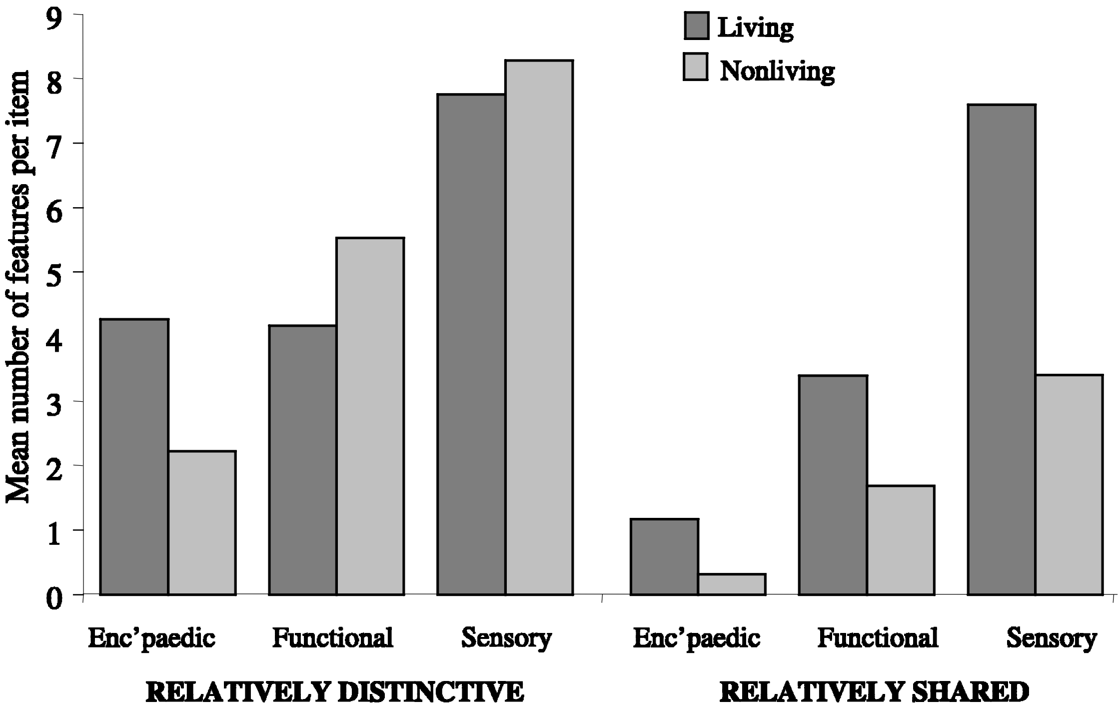


Figure 6. *Comparative distributions of the relatively distinctive and relatively shared features split by feature type and by semantic domain.*

patients with DAT (Gonnerman et al., 1997), though the pattern could not be replicated in a larger cross-sectional study (Garrard et al., 1998).

Detailed neuropsychological investigation has provided little support for this approach (for details see Garrard et al., 1998; Lambon Ralph et al., 1998) and it is further challenged by reports of category effects persisting in the same direction in patients who recover from acute brain injury (e.g., Hillis & Caramazza, 1991). Analysis of our feature database, however, is relevant to its empirical foundations. It was noted earlier that there were more shared features for living than for nonliving things. Shared features will tend to be highly intercorrelated with each other. For example the features *can see*, *can hear*, *has eyes*, *has ears* are not only shared across many of the concepts within a category, they also tend to co-occur within representations of each of these concepts. This raises the possibility that the higher number of intercorrelated features for living concepts may be a by-product of the larger number of shared features in that domain.

Given that the majority of feature pairs were not significantly intercorrelated, the following dependent measure was used. For each feature we calculated the proportion of all possible pairings that resulted in statistically significant values of Spearman's correlation coefficient. The mean of these proportions, split by domain and distinctiveness, is shown in Figure 9. A two (shared vs. distinctive) by two (living vs. nonliving) analysis of variance revealed significant main effects of feature distinctiveness, $F(1, 1534) = 16.9, p < .001$, and of semantic domain, $F(1, 1534) = 125.9, p < .001$, and a significant interaction, $F(1, 1534) = 33.4, p < .001$. The interaction clearly results from a higher proportion of significant intercorrelations among the shared than the distinctive features associated with living concepts, $t = 8.73, p < .001$, a difference that was not present in the nonliving domain, $t = -.78$, n.s.

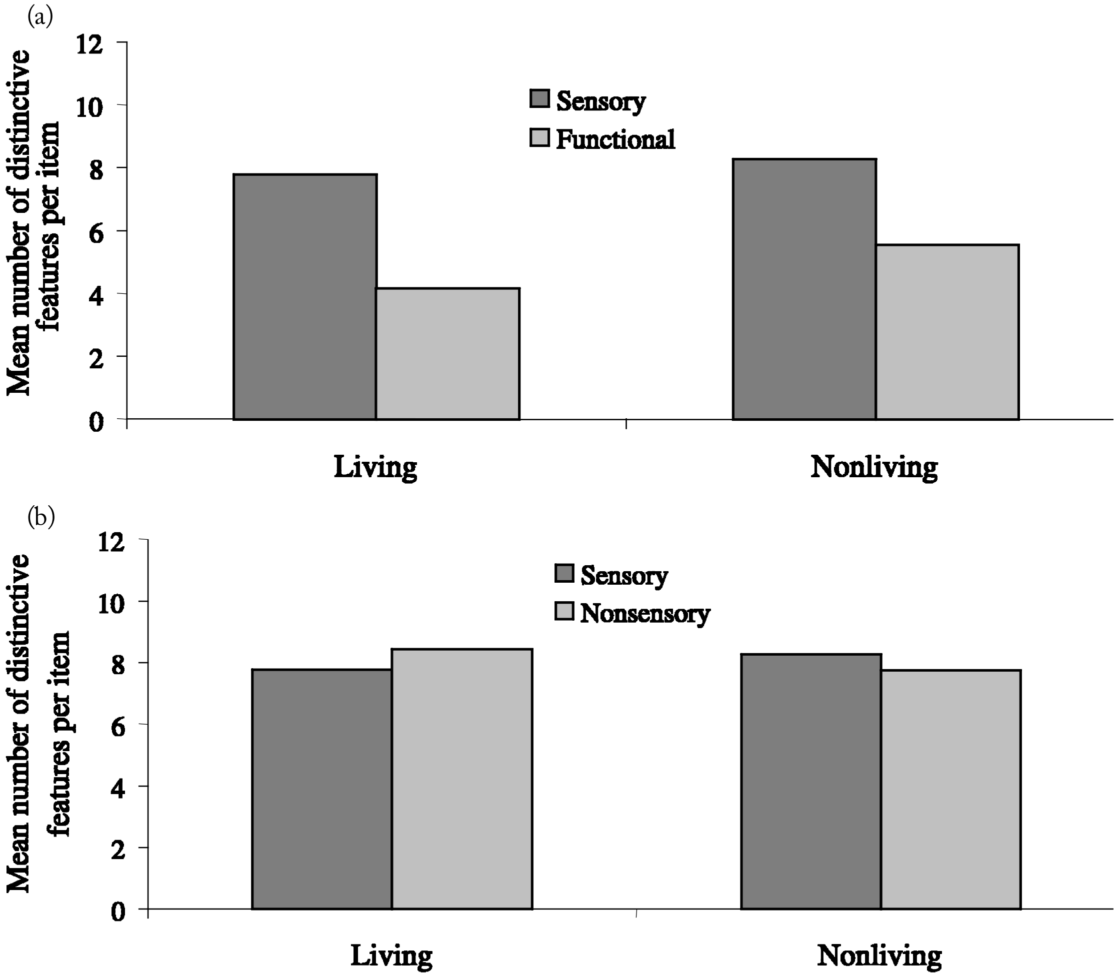


Figure 7. *Mean numbers of distinctive features per item in the living and nonliving subsets, split by feature type. Sensory features are compared (a) with functional features, following Farah and McClelland, and (b) with nonsensory features, following Caramazza and Shelton.*

Intercorrelations exist between the structural and functional features of nonliving things, and among the shared features of living things

Moss, Tyler, and colleagues have suggested an alternative role for intercorrelations in the production of category-specific deficits (Durrant-Peatfield et al., 1997; Moss et al., 1998; Moss & Tyler, in press). Unlike Devlin et al. (1998) and McRae et al. (1997), Moss and Tyler have emphasised the importance of two specific types of intercorrelation. For living things the shared functional features (e.g., can see, can hear, can run, etc.) and shared perceptual features (e.g., has eyes, has ears, has legs) are highly intercorrelated, but the distinctive features are much less so. For artefacts, the pattern is reversed: Building upon previous notions of form-function relationships (Caramazza et al., 1990; De Renzi & Lucchelli, 1994), Moss et al. (1998) suggested that artefact concepts have strong correlations between pairs of individual, distinctive perceptual and functional properties (e.g., the properties of being sharp and being used for cutting), but fewer, and more weakly intercorrelated, shared features.

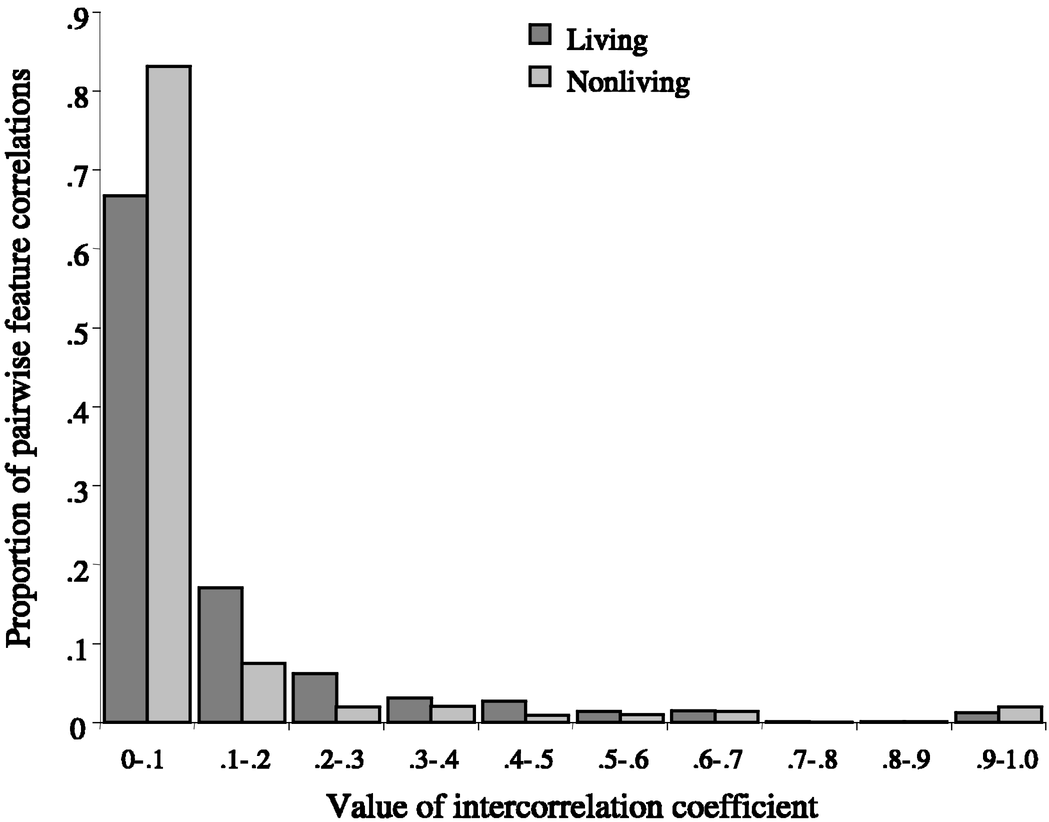


Figure 8. *Distribution of values of Spearman's correlation coefficient for all pairwise combinations of features, excluding categorising features, in the reduced set.*

Although this account, like that of Devlin et al., (1998), predicts a relationship between severity and category advantage, the direction of the predicted relationship is in fact reversed: With mild degrees of damage, unique identification will be best preserved for nonliving concepts due to the presence of the strong form-function intercorrelations among the distinctive features of these items. With more severe impairments, however, the category advantage reverses because the living concepts are supported to a greater degree by the shared, intercorrelated attributes.

We have already reported the distribution of shared and distinctive sensory and functional features in the present feature database for living and nonliving domains. These analyses of feature intercorrelations can now be extended to address the stated hypothesis. As this proposal does not make any predictions with regard to "encyclopaedic" knowledge, these features were excluded from the analyses. Figure 10 shows the proportion of feature correlations that reached significance, split by domain, distinctiveness, and correlation type—i.e., *between* feature types (sensory with functional) or *within* feature type (sensory with sensory and functional with functional). We shall refer to the former as "intercorrelations" and to the latter as "intracorrelations".

A two (living vs. nonliving) by two (distinctive vs. shared) by two (intracorrelation vs. intercorrelation) analysis of variance revealed a significant three-way interaction, $F(1, 1290) = 14.4, p < .001$, which was analysed further using separate two-way analyses of variance for the living and nonliving domains. For living concepts, the proportion of significant intercorrelations was greater for

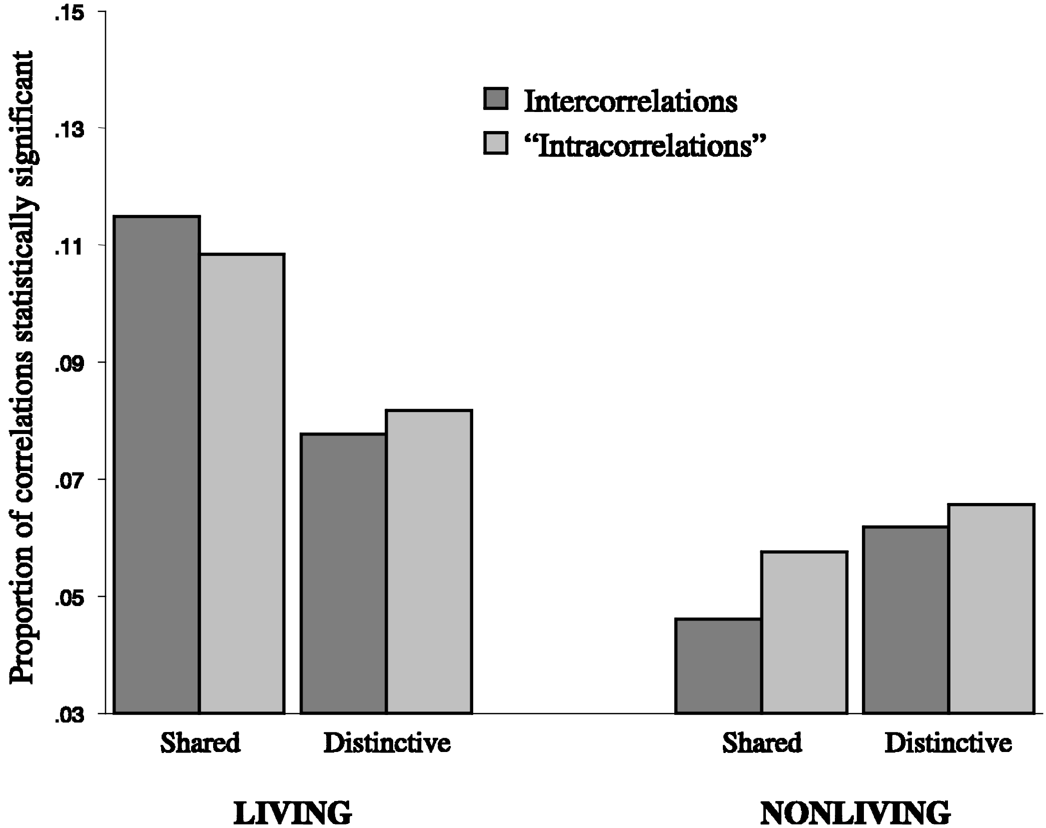


Figure 9. *Mean proportions of the shared and distinctive features of living and nonliving items associated with statistically significant correlations.*

shared than distinctive features, $F(1, 687) = 89.7, p < .001$, but there was no effect of correlation type, $F(1, 687) < 1$. There was a small but significant interaction between distinctiveness and correlation type, $F(1, 687) = 9.7, p = .002$. For nonliving concepts, the overall proportion of significant intercorrelations was higher for the distinctive than for the shared features, $F(1, 603) = 1.0, p = .02$, and for the intracorrelations than for the intercorrelations $F(1, 603) = 23.2, p < .001$. The interaction was also significant, $F(1, 603) = 5.7, p = .02$.

Comment

These results indicate that, even in the absence of encyclopaedic attributes, the overall proportion of significant feature correlations was very small. Although the model proposed by Moss et al. predicted that the shared features of living concepts should be more highly correlated, other details of their hypothesis are not supported by the present data. For living things, it is true that the shared features are more likely to be correlated with other features, but the distinctive features of living things are also more correlated than *any* of the features of the nonliving concepts. Finally, although there is a slight excess of correlation among the distinctive features in the nonliving domain, the intracorrelations are more, rather than less, numerous than the putatively more important (perceptual-functional) intercorrelations.

GENERAL DISCUSSION

The data reported here consist of a set of concept properties collected from a group of normal volun-

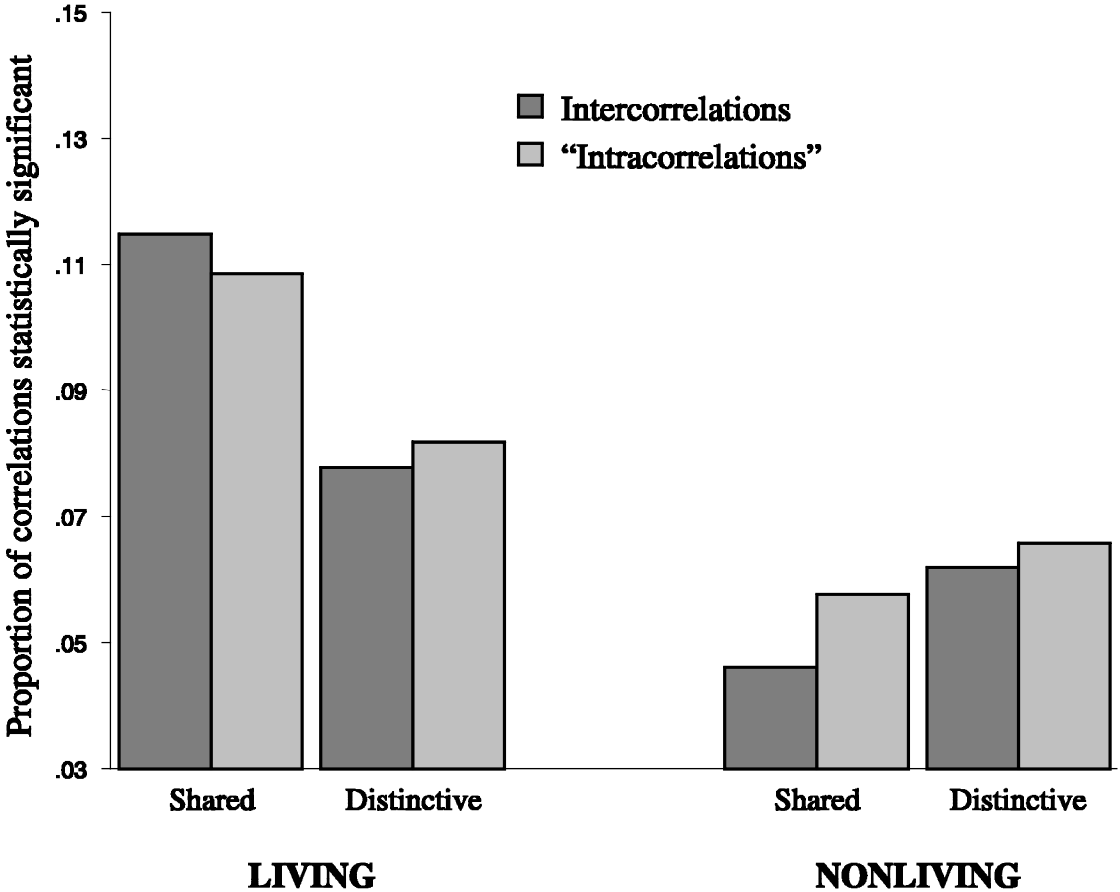


Figure 10. *Mean proportions of the shared and distinctive features of living and nonliving items associated with statistically significant correlations, split by domain and by intercorrelation type:* intercorrelations *refer to pairings between features of different types (i.e., sensory with functional), and* intracorrelations *to pairings between features of the same type (i.e., sensory with sensory or functional with functional).*

teers in a manner that was designed to permit examination of claims about the structure of semantic knowledge. Analyses of these properties have upheld the usefulness of the feature-based approach to semantic knowledge, as well as the idea that broad conceptual domains may emerge simply from the similarity in feature structure among groups of concepts. Our results support the notion that such emergent domains may manifest as a distinction between living and nonliving items—an idea that is central to distributed theories of semantic knowledge. It therefore seems unnecessary, on theoretical grounds alone, to assume that a separate coding mechanism is required for category and domain membership, whether this coding reflects learning or evolutionary, neural adaptations. Theoretical redundancy, however, does not preclude the existence of an organising principle in the brain, and Caramazza and Shelton (1998) have made a convincing case, on empirical grounds, for the existence of regional neural systems specialised for the recognition of three broad semantic domains—animals, plant life, and artefacts. Nevertheless, to assume on the basis of one case that this mechanism explains all category-specific phenomena would be premature. This note of caution is emphasised by the results of our analyses.

Another interesting aspect of the feature database was the degree of accordance it showed with more intuitive assessments of category and concept structure. Not only was there a familiar variation in coherence for different collections of exemplars (for example, living things were more tightly clustered than most nonliving entities), but the rated typicality of each exemplar was also significantly correlated with the angle—or distance—between the featural representation of the exemplar and the category centroid, or "average exemplar".

The data were also analysed along the lines of contemporary theoretical models of semantic organisation that have been proposed to explain patterns of category-specific semantic impairments. Such models have variously emphasised the role of feature type (perceptual, functional, and encyclopaedic), feature distinctiveness, and feature intercorrelation in the representations of living and nonliving concepts.

The raw numbers of features of each type were found to be distributed between the two conceptual domains in rather different proportions: Although sensory features were the most numerous in both, the disparity was relatively greater for living than for nonliving concepts. This pattern of results loosely resembles that described by Farah and McClelland (1991), though the contrast between the two sensory:functional ratios was less marked, and would probably not have been large enough to produce category-specific deficits if incorporated into a similar connectionist network. Moreover, the observed difference was highly dependent on the role assigned to features that had been classified as encyclopaedic, as pointed out by Caramazza and Shelton (1998).

When distinctiveness was taken into account, a striking asymmetry appeared between the shared and distinctive features: Although more distinctive features of all types were associated with nonliving concepts (see also McRae & Cree, in press), this pattern was evident only among the encyclopaedic features of living things; for the sensory and functional subsets the numbers of shared and distinctive features were approximately equal. This is an important result, as it apparently runs counter to the hypothesis (never previously tested directly) that visual features are crucial for distinguishing among living things (Warrington & McCarthy, 1987).

The analyses relating to feature intercorrelation showed that few feature combinations participated in statistically significant intercorrelations, and that these were largely made up of intercorrelations among shared features. This finding also characterises the semantic feature data reported by McRae et al. (1997). Even allowing for the possibility that these empirically derived data are unrepresentative of semantic feature knowledge in its entirety (an issue that is given more detailed consideration later), it is difficult to see how the influence of this subset of features alone could produce category dissociations of the magnitude of those described in the neuropsychological literature. The critical observation in the studies of both Durrant-Peatfield et al. (1997) and Devlin et al. (1998) was that the advantage evinced by the system switched from one domain to the other when a substantial overall level of damage had accumulated. This pattern has rarely been observed in longitudinal or cross-sectional studies of patients with progressive neurodegenerative disorders; and category advantages persisting after resolution of an acute lesion and overall improvement in the linguistic deficit have also been reported (Hillis & Caramazza, 1991). The relative paucity of these internal relationships in the present sample of semantic feature knowledge might go some way to explaining the rather unimpressive evidence, both computational and neuropsychological, for predictable patterns in the relationship between severity of damage and direction of category advantage.

Consideration of the distinctiveness of features in living and nonliving domains may be relevant to explaining certain aspects of the category-specific behavioural data. First, the cases reported as showing a significant advantage for nonliving categories are much more numerous than those with the reverse dissociation, but the origin of this inequality has never been satisfactorily explained: It is certainly not due to the relative incidences of the causative lesion, since left middle cerebral artery (MCA) territory infarction (the commonest reported underlying pathology in cases with an advantage for living items) is much more common than Herpes simplex virus encephalitis (HSVE), which is the modal aetiology in cases with an advantage for artefacts. The present data suggest a possible explanation in the much higher proportion of distinctive relative to shared features of all attribute types associated with artefacts (see Figure 6); since partial, nonselective loss of knowledge would tend to maintain a balance favouring distinctive information about nonliving items, performance on tasks such as object naming—which presumably relies on the appreciation of distinctive information—should be relatively more robust to damage for artefact than for natural kinds.

A recent finding that is difficult to accommodate within the Warrington and Shallice hypothesis is that patients with progressive focal temporal lobe atrophy and the syndrome of semantic dementia suffer a disproportionately severe loss of knowledge of visual attributes, yet the majority of these patients exhibit little, if any, cross-domain difference in their performance on semantic tests (Lambon Ralph, Graham, Patterson, & Hodges, 1999). It remains to be seen whether those semantic dementia patients who *do* manifest a nonliving advantage can also be shown to have a disproportionate deficit in encyclopaedic knowledge—a pattern that, according to the results presented in this paper, could contribute to such a dissociation.

We were also able to analyse our feature database in respect of three recent claims about the importance of intercorrelations between different types of semantic attribute (Devlin et al., 1998; McRae et al., 1997; Moss et al., 1998). Like McRae et al. we found (1) that most intercorrelations are extremely small (and nonsignificant) and (2) that the intercorrelations were somewhat higher for living than nonliving domains. Once the features are split by distinctiveness, it is clear that the main difference between domains is carried by the presence of a greater proportion of significant intercorrelations for the shared features of living things. This would appear to agree with the obvious intuition that features such as "has eyes," "has ears," "can see," and "can hear" are not only shared across concepts but also intercorrelated. In contrast to the hypothetical structure proposed by Moss, Tyler, and colleagues, however, the degree of intercorrelation among the distinctive features of living things is no less than among any of the features of nonliving things. Moreover, nonliving concepts do not appear to be dominated by a large proportion of significant distinctive, form-function correlations.

One difficulty with the present data is that they do not suggest a means of explaining the origin of advantages for natural kinds over artefacts. That such patterns have their origin in the nature of semantic organisation is no longer widely questioned, though insufficiently stringent control of the contribution of the age of acquisition and imageability of the compared concepts may produce an exaggerated difference favouring living categories (as children tend to learn animal names before those of artefacts; McKenna & Parry, 1994). If this is the case, then the size of the advantages in some reported cases might in reality be even smaller than the data suggest. This raises the possibility that contributions from the small but statistically significant domain differences in intercorrelational properties that were observed in the present data might be important in causing an advantage for the domain of living things when there is widespread damage to the semantic system. The feature norms provided in Appendix A constitute a corpus of attribute knowledge that will allow these and similar issues to be addressed directly in studies of both normal and brain-damaged individuals.

Any interpretation of these results must, of course, be viewed in the context of a relative paucity of data. With respect to the sum total of semantic knowledge acquired over an average lifetime, a sample of 62 concrete items is somewhat trifling. Moreover, the analyses described here have been based on a limited corpus of semantic features, while the true extent of attribute knowledge associated with even one of these items is potentially almost infinite. The items were, however, chosen to represent a distinction that is known to be important in the organisation of semantic knowledge, and to allow a series of specific theoretical claims to be examined. These limitations are perhaps most important when considering the properties of features that are shared among a large number of category members, since it is within this subset of features that correlational structure is most likely to exist. In this regard it is important to note that the subjects in the present study were not explicitly instructed to generate either distinctive or shared information. Although in the absence of such instructions, subjects would probably tend to produce relatively distinctive information, the present results show that shared information was also generated, suggesting a more even sampling across a range of distinctiveness values. This lends some justification to the generalisation of the trends observed in these data to the domain of semantic knowledge as a whole.

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APPENDIX A

Feature norms

	Feature type	Dominance	Distinctiveness	Proportion of all inter-correlations significant
Aeroplane				
is a aircraft	c	.28	.25	
is a vehicle	c	.78	1.00	
is large	s	.53	.63	.07
is made of metal	s	.42	.88	.04
is fast	s	.33	.88	.08
can make a noise	s	.32	.75	.08
has cockpit	s	.32	.25	.09
has fuselage	s	.32	.25	.09
has propellor	s	.32	.13	.06
has seat	s	.32	.88	.06
has tailplane	s	.32	.13	.06
has rudder	s	.21	.13	.06
has controls	s	.11	.25	.12
has flap	s	.11	.13	.09
can fly	f	.94	.25	.09
carry passengers	f	.67	.50	.17
can land	f	.47	.25	.09
can taxi	f	.32	.13	.06
can crash	f	.28	.13	.06
can take off	f	.26	.13	.06
is useful	f	.26	.75	.01
can drop bombs	f	.11	.13	.06
can fight	f	.11	.13	.06
is powerful	f	.11	.38	.15
has engine	e	.84	.75	.24
is expensive	e	.22	.25	.13
has pilot	e	.21	.25	.09
is fuel-driven	e	.11	.13	.06

	Feature type	Dominance	Distinctiveness	Proportion of all inter-correlations significant
Alligator				
is a reptile	c	.32	.19	
is a amphibian	c	.53	.13	
is a animal	c	.58	.88	
has tail	s	.84	.81	.11
has teeth	s	.79	.56	.10
has skin	s	.63	.44	.10
has large mouth	s	.47	.13	.08
has mouth	s	.47	.19	.11
has scales	s	.47	.06	.07
has legs	s	.42	.88	.12
has body	s	.32	.31	.14
has eyes	s	.32	1.00	.13
has long tail	s	.26	.25	.11
has sharp teeth	s	.21	.38	.19
has four legs	s	.21	.13	.08
is large	s	.21	.63	.06
has feet	s	.16	.44	.06
is long	s	.16	.06	.06
has head	s	.11	.38	.04
has large teeth	s	.11	.06	.07
has powerful tail	s	.11	.13	.07
has four feet	s	.11	.06	.07
has short legs	s	.11	.06	.07
is fast	s	.11	.63	.08
can swim	f	.74	.25	.04
can bite	f	.37	.31	.17
can eat	f	.32	.94	.11
can walk	f	.26	.75	.08
can lay eggs	f	.16	.19	.05
can dive	f	.11	.06	.10
can hide	f	.11	.19	.08
can run	f	.11	.88	.12
is dangerous	e	.79	.25	.05
is carnivorous	e	.32	.19	.14
is found near water	e	.26	.25	.04
is wild	e	.26	.75	.09
can eat people	e	.16	.06	.07
has tough skin	e	.16	.13	.09
can eat fish	e	.11	.06	.06
is found in America	e	.11	.06	.07
is strong	e	.11	.31	.21

	Feature type	Dominance	Distinctiveness	Proportion of all intercorrelations significant
Apple				
is a fruit	c	1.00	1.00	
has pips	s	.95	.67	.15
has skin	s	.74	1.00	.10
is round	s	.74	.67	.13
has stalk	s	.68	.67	.15
has flesh	s	.63	1.00	.22
has core	s	.53	.33	.10
is red	s	.37	.50	.10
is green	s	.37	.33	.11
is sweet	s	.37	1.00	.22
has leaves	s	.32	.83	.19
is hard	s	.32	.33	.09
is juicy	s	.32	.83	.18
is coloured	s	.16	.17	.09
is sour	s	.16	.17	.08
has white flesh	s	.11	.33	.10
is small	s	.11	.50	.02
is edible	f	.84	1.00	.10
be cooked	f	.68	.83	.17
can fall	f	.32	.33	.10
can be picked	f	.16	.67	.15
can ripen	f	.16	.50	.13
can rot	f	.16	.17	.08
can be bought	f	.11	.17	.08
can be sold	f	.11	.17	.08
can grow	e	.53	.50	.13
is found on trees	e	.21	.50	.11
can be preserved	e	.11	.17	.08
has maggots	e	.11	.17	.08
Axe				
is a implement	c	.11	.13	
is a tool	c	.84	1.00	
has handle	s	.89	.88	.03
is sharp	s	.79	.50	.06
is made of metal	s	.74	.88	.04
has blade	s	.63	.50	.06
has head	s	.63	.38	.14
is heavy	s	.63	.38	.01
is made of wood	s	.26	.63	.01
can cut	f	.61	.50	.09
can fell trees	f	.37	.13	.02
can split	f	.21	.13	.02
can be thrown	f	.16	.13	.02
can be sharpened	f	.11	.38	.06
is dangerous	e	.47	.50	.11

	Feature type	Dominance	Distinctiveness	Proportion of all intercorrelations significant
Banana				
is a fruit	c	1.00	1.00	
has skin	s	.95	1.00	.10
is yellow	s	.95	.33	.08
has flesh	s	.63	1.00	.22
is curved	s	.42	.17	.06
is soft	s	.42	.33	.10
has taste	s	.26	.17	.06
is long	s	.26	.17	.06
has pips	s	.21	.67	.15
has smell	s	.21	.17	.06
is green	s	.21	.33	.11
has leaves	s	.16	.83	.19
has stalk	s	.16	.67	.15
is sweet	s	.16	1.00	.22
has white flesh	s	.11	.33	.10
is thin	s	.11	.17	.06
is edible	f	.74	1.00	.10
can be cooked	f	.47	.83	.17
can ripen	f	.26	.50	.13
is found in tropics	e	.37	.17	.06
is found in salads	e	.11	.17	.06
is found on trees	e	.11	.50	.11
Barrel				
is a container	c	.75	.44	
is made of wood	s	.65	.31	.01
is round	s	.65	.44	.03
has lid	s	.60	.31	.12
has bands	s	.55	.06	.02
has tap	s	.55	.06	.02
is made of metal	s	.55	.56	.04
has base	s	.50	.38	.14
has staves	s	.35	.06	.02
has sides	s	.25	.06	.02
is heavy	s	.25	.19	.01
is large	s	.15	.31	.07
can hold liquid	f	.50	.12	.06
can roll	f	.40	.12	.04

	Feature type	Dominance	Distinctiveness	Proportion of all intercorrelations significant
Basket				
is a container	c	.37	.44	
is a household item	c	.37	.75	
has handle	s	1.00	.50	.03
is made of cane	s	.79	.06	.03
is woven	s	.47	.06	.03
is hollow	s	.26	.25	.11
has base	s	.21	.38	.14
has body	s	.21	.25	.20
has lid	s	.21	.31	.12
is light	s	.21	.44	.02
is made of plastic	s	.21	.50	.03
is small	s	.21	.69	.03
is made of wood	s	.16	.31	.01
has wheel	s	.11	.19	.09
is large	s	.11	.31	.07
is made of fabric	s	.11	.12	.09
is round	s	.11	.44	.03
can be filled	f	.84	.25	.11
can be carried	f	.42	.56	.04
can hold shopping	f	.32	.06	.03
is useful	f	.32	.75	.01
can be emptied	f	.16	.19	.09
has pocket	e	.11	.12	.09

	Feature type	Dominance	Distinctiveness	Proportion of all intercorrelations significant
Bicycle				
is a vehicle	c	1.00	1.00	
has wheel	s	.94	.75	.09
has seat	s	.72	.88	.06
is made of metal	s	.67	.88	.04
has handlebar	s	.56	.25	.09
has pedal	s	.50	.25	.09
has light	s	.39	.38	.12
has tyre	s	.33	.25	.09
has chain	s	.28	.12	.05
is fast	s	.28	.88	.08
has frame	s	.22	.12	.09
is light	s	.22	.12	.02
is unstable	s	.22	.38	.12
has spokes	s	.11	.12	.05
is coloured	s	.11	.38	.04
can be ridden	f	.67	.25	.09
has brakes	f	.50	.38	.12
can be pushed	f	.22	.12	.05
is manoeuvrable	f	.22	.12	.05
can be raced	f	.17	.12	.05
can move	f	.17	.75	.23
is powered by rider	f	.17	.12	.05
is useful	f	.17	.75	.01
can be bought	f	.11	.12	.01
can carry passengers	f	.11	.12	.05
can freewheel	f	.11	.12	.05
is non-polluting	f	.11	.12	.05
has gears	e	.33	.38	.12
Brush				
is a household item	c	.45	.75	
is a tool	c	.60	.50	
has bristles	s	.90	.12	.07
has handle	s	.90	.50	.03
has head	s	.45	.19	.14
is hard	s	.40	.44	.02
is made of wood	s	.35	.31	.01
is long and/or thin	s	.25	.25	.02
is soft	s	.25	.19	.09
is made of plastic	s	.20	.50	.03
is small	s	.15	.69	.03
can sweep	f	.65	.06	.02
can clean	f	.60	.12	.05
can smooth hair	f	.30	.06	.02
can apply paint	f	.25	.06	.02
is hand held	f	.25	.06	.02
is useful	f	.20	.75	.01
is found in the garden	e	.20	.12	.06

	Feature type	Dominance	Distinctiveness	Proportion of all intercorrelations significant
Bus				
is a vehicle	c	1.00	1.00	
has wheel	s	.79	.75	.09
has seat	s	.74	.88	.06
is large	s	.58	.62	.07
is made of metal	s	.37	.88	.04
has decks	s	.32	.12	.07
has window	s	.32	.50	.19
is coloured	s	.32	.38	.04
is roomy	s	.16	.12	.07
is fast	s	.11	.88	.08
can make a noise	s	.11	.75	.08
has body	s	.11	.25	.20
has cab	s	.11	.25	.11
has door	s	.11	.25	.11
can carry passengers	f	.78	.50	.17
can move	f	.37	.75	.23
can stop	f	.32	.38	.13
can break down	f	.17	.12	.07
can reverse	f	.16	.38	.14
can run on roads	f	.16	.12	.07
can follow a route	f	.11	.12	.07
can start	f	.11	.12	.07
is powerful	f	.11	.38	.15
has driver	e	.74	.38	.14
has engine	e	.63	.75	.24
has conductor	e	.26	.12	.07
has stairs	e	.26	.12	.07
has brakes	e	.16	.25	.11
has fare	e	.11	.12	.07
is polluting	e	.11	.25	.11
is powered by diesel	e	.11	.38	.14
is powered by petrol	e	.11	.38	.13
is public	e	.11	.12	.07

	Feature type	Dominance	Distinctiveness	Proportion of all intercorrelations significant
Camel				
is a mammal	c	.11	.50	
is a vehicle	c	.16	.06	
is a animal	c	.95	.88	
has humps	s	.79	.06	.08
has legs	s	.68	.88	.12
has four legs	s	.53	.94	.13
is large	s	.53	.62	.06
has tail	s	.42	.81	.11
has fur	s	.37	.69	.11
has hooves	s	.26	.19	.11
has ears	s	.21	.69	.09
has long neck	s	.21	.06	.07
has neck	s	.21	.06	.07
has eyes	s	.16	1.00	.13
has large mouth	s	.16	.12	.08
has mouth	s	.16	.19	.11
has small tail	s	.16	.25	.14
has smell	s	.16	.12	.06
is brown	s	.16	.50	.05
is fast	s	.11	.62	.08
can be ridden	f	.58	.19	.12
can carry	f	.58	.19	.14
can run	f	.47	.88	.12
can walk	f	.47	.75	.08
can spit	f	.26	.06	.08
can eat	f	.21	.94	.11
can kneel	f	.21	.06	.08
can bite	f	.20	.31	.17
can sit	f	.16	.06	.08
is useful	f	.16	.12	.07
can drink	f	.11	.12	.10
can store water	e	.58	.06	.08
is found in desert	e	.47	.06	.08
is bad temepered	e	.37	.06	.08
is herbivorous	e	.16	.25	.15
is domesticated	e	.11	.38	.05
is found in Africa	e	.11	.19	.11
is found in Australia	e	.11	.12	.06
is strong	e	.11	.31	.21
is wild	e	.11	.75	.09

	Feature type	Dominance	Distinctiveness	Proportion of all intercorrelations significant
Candle				
is lighting	c	.42	.06	
is a household item	c	.47	.75	
is wax	s	.79	.06	.07
has wick	s	.74	.06	.07
is coloured	s	.37	.44	.04
is long and/or thin	s	.37	.25	.02
has smell	s	.26	.06	.07
is round	s	.26	.44	.03
has stem	s	.21	.12	.11
is white	s	.16	.19	.15
has head	s	.16	.19	.14
is small	s	.16	.69	.03
has flame	s	.11	.06	.07
is shiny	s	.11	.06	.09
is smooth	s	.11	.12	.11
can give light	f	.74	.06	.07
can be lit	f	.53	.06	.07
can burn	f	.32	.12	.11
can go out	f	.32	.06	.07
can stand	f	.26	.06	.07
can be carried	f	.16	.56	.04
can melt	f	.16	.06	.07
can be bought	f	.11	.25	.01
can be moved	f	.11	.12	.08
can ignite	f	.11	.06	.07
can seal	f	.11	.06	.07
can smoke	f	.11	.06	.07
is found in church	e	.16	.06	.07
is found in a holder	e	.11	.06	.07
is cheap	e	.11	.06	.07
is found on birthday cake	e	.11	.06	.07
is long lasting	e	.11	.06	.07

	Feature type	Dominance	Distinctiveness	Proportion of all intercorrelations significant
Cat				
is a pet	c	.20	.19	
is a animal	c	.90	.88	
has fur	s	.90	.69	.11
has tail	s	.70	.81	.11
has legs	s	.55	.88	.12
has four legs	s	.50	.94	.13
has claws	s	.45	.31	.04
can miaow	s	.35	.06	.04
has ears	s	.35	.69	.09
has whiskers	s	.30	.19	.06
has eyes	s	.25	1.00	.13
has teeth	s	.25	.56	.10
is small	s	.20	.50	.02
has pointed ears	s	.15	.12	.04
is coloured	s	.15	.12	.09
is soft	s	.15	.19	.10
can purr	f	.60	.06	.04
can jump	f	.50	.56	.09
can scratch	f	.45	.06	.03
can climb	f	.35	.31	.13
can run	f	.35	.88	.12
can eat	f	.20	.94	.11
can see	f	.20	.25	.10
can see in the dark	f	.15	.06	.04
can walk	f	.15	.75	.08
is predator	e	.65	.19	.12
is domesticated	e	.55	.38	.05
Cherry				
is a fruit	c	1.00	1.00	
has pip	s	.95	.17	.04
is red	s	.85	.50	.10
has stalk	s	.70	.67	.15
has skin	s	.65	1.00	.10
is sweet	s	.65	1.00	.22
has flesh	s	.55	1.00	.22
is round	s	.55	.67	.13
is juicy	s	.30	.83	.18
is small	s	.30	.50	.02
is found in bunches	s	.25	.17	.04
has leaves	s	.20	.83	.19
is shiny	s	.15	.17	.04
is edible	f	.65	1.00	.10
can be cooked	f	.50	.83	.17
can be picked	f	.40	.67	.15
is found in trees	e	.25	.17	.06

	Feature type	Dominance	Distinctiveness	Proportion of all inter-correlations significant
Chicken				
is a animal	c	.15	.50	
is a bird	c	.90	1.00	
has feathers	s	.80	1.00	.07
has beak	s	.55	1.00	.07
has legs	s	.55	.75	.12
has wings	s	.35	1.00	.07
has two legs	s	.35	.62	.13
is small	s	.35	.38	.02
has crest	s	.30	.25	.05
can make a noise	s	.20	.62	.03
has eyes	s	.20	.75	.13
has feet	s	.20	.75	.06
has scaley legs	s	.15	.12	.02
is brown	s	.15	.25	.05
can lay eggs	f	.80	1.00	.05
is edible	f	.65	.38	.10
can cluck	f	.30	.12	.02
can eat	f	.30	.62	.11
can fly	f	.30	.75	.14
can scratch	f	.20	.12	.03
can peck	f	.15	.12	.02
can run	f	.15	.38	.12
is domesticated	e	.55	.25	.05
is found on farms	e	.30	.25	.05
Comb				
is a household item	c	.25	.75	
is a toiletry	c	.30	.12	
is a tool	c	.35	.50	
has teeth	s	1.00	.12	.06
is made of plastic	s	.65	.50	.03
is small	s	.30	.69	.03
has back	s	.25	.12	.06
is made of metal	s	.25	.56	.04
has handle	s	.20	.50	.03
is coloured	s	.20	.44	.04
is hard	s	.15	.44	.02
is long and/or thin	s	.15	.25	.02
can tidy hair	f	.80	.06	.01
is useful	f	.30	.75	.01
can be put in pocket	f	.20	.06	.01
can be broken	f	.15	.19	.09
can be carried	f	.15	.56	.04
can be played	f	.15	.12	.07

	Feature type	Dominance	Distinctiveness	Proportion of all inter-correlations significant
Cow				
is a mammal	c	.16	.50	
is a ruminant	c	.26	.06	
is a animal	c	1.00	.88	
has udder	s	.74	.06	.04
has four legs	s	.47	.94	.13
can moo	s	.37	.06	.04
is large	s	.37	.62	.06
has eyes	s	.26	1.00	.13
has cloven hooves	s	.16	.06	.04
has ears	s	.16	.69	.09
has fur	s	.16	.69	.11
is black	s	.16	.06	.06
is brown	s	.16	.50	.05
has teats	s	.11	.06	.04
has tongue	s	.11	.12	.06
can be milked	f	.84	.06	.04
is edible	f	.37	.31	.10
can breed	f	.26	.56	.07
can chew	f	.26	.19	.07
can eat	f	.26	.94	.11
can walk	f	.26	.75	.08
is useful	f	.21	.12	.07
can run	f	.16	.88	.12
is found on farms	e	.47	.06	.05
can eat grass	e	.26	.12	.07
is docile	e	.26	.12	.07
is domesticated	e	.26	.38	.05
has valuable skin	e	.11	.06	.04

	Feature type	Dominance	Distinctiveness	Proportion of all inter-correlations significant
Dog				
is a mammal	c	.16	.50	
is a pet	c	.84	.19	
is a animal	c	1.00	.88	
has legs	s	.79	.88	.12
has four legs	s	.68	.94	.13
has tail	s	.68	.81	.11
can bark	s	.58	.06	.08
has ears	s	.47	.69	.09
has teeth	s	.32	.56	.10
has eyes	s	.26	1.00	.13
has fur	s	.26	.69	.11
can make a noise	s	.21	.19	.03
has head	s	.21	.38	.04
has nose	s	.16	.12	.09
has sharp teeth	s	.16	.38	.19
has mouth	s	.11	.19	.11
has wet nose	s	.11	.06	.08
is coloured	s	.11	.12	.09
is fast	s	.11	.62	.08
is in different sizes	s	.11	.06	.08
is large	s	.11	.62	.06
is small	s	.11	.50	.02
can eat	f	.74	.94	.11
can run	f	.58	.88	.12
can bite	f	.47	.31	.17
can jump	f	.32	.56	.09
can be trained	f	.26	.25	.17
can wag tail	f	.26	.06	.08
can guard	f	.21	.06	.08
can guide	f	.21	.06	.08
can walk	f	.21	.75	.08
can be bought	f	.11	.06	.08
can beg	f	.11	.06	.08
can drink	f	.11	.12	.10
can play	f	.11	.06	.08
can pull	f	.11	.19	.12
can sleep	f	.11	.06	.08
is domesticated	e	.47	.38	.05
is friendly	e	.47	.12	.11
has good sense of smell	e	.16	.06	.08
is carnivorous	e	.11	.19	.14
is intelligent	e	.11	.12	.10
is predator	e	.11	.19	.12
is wild	e	.11	.75	.09

	Feature type	Dominance	Distinctiveness	Proportion of all inter-correlations significant
Duck				
is a bird	c	.90	1.00	
has feathers	s	.85	1.00	.07
has beak	s	.70	1.00	.07
has feet	s	.70	.75	.06
has webbed feet	s	.65	.38	.10
has wings	s	.60	1.00	.07
can quack	s	.40	.12	.02
has legs	s	.35	.75	.12
is coloured	s	.35	.25	.09
has tail	s	.20	.38	.11
can make a noise	s	.15	.62	.03
has eyes	s	.15	.75	.13
is small	s	.15	.38	.02
can swim	f	.90	.38	.04
can fly	f	.85	.75	.14
is edible	f	.63	.38	.10
can dive	f	.60	.38	.10
can lay eggs	f	.40	1.00	.05
can walk	f	.25	.75	.08
is found near water	e	.45	.38	.04
is wild	e	.25	.62	.09
is domestic	e	.15	.12	.02
Dustbin				
is a container	c	.50	.44	
is a household item	c	.55	.75	
has lid	s	.95	.31	.12
is made of metal	s	.75	.56	.04
has handle	s	.70	.50	.03
is made of plastic	s	.65	.50	.03
is round	s	.40	.44	.03
has wheel	s	.35	.19	.09
is large	s	.25	.31	.07
is hollow	s	.20	.25	.11
has base	s	.15	.38	.14
can hold rubbish	f	.60	.06	.02
can be filled	f	.50	.25	.11
can be emptied	f	.45	.19	.09
is useful	f	.30	.75	.01
can be carried	f	.25	.56	.04
can be moved	f	.20	.12	.08
can roll	f	.15	.12	.04
has lining	e	.15	.06	.02

	Feature type	Dominance	Distinctiveness	Proportion of all intercorrelations significant
Eagle				
is a bird	c	1.00	1.00	
has claws	s	.89	.25	.04
has wings	s	.89	1.00	.07
has beak	s	.78	1.00	.07
has feathers	s	.67	1.00	.07
is large	s	.44	.62	.06
has legs	s	.32	.75	.12
has large wings	s	.28	.25	.07
has feet	s	.22	.75	.06
has two legs	s	.22	.62	.13
has eyes	s	.17	.75	.13
has hooked beak	s	.17	.12	.06
is golden	s	.16	.12	.06
is grey	s	.11	.12	.09
can fly	f	.89	.75	.14
can swoop	f	.39	.25	.08
can lay eggs	f	.28	1.00	.05
can hover	f	.22	.12	.06
can reproduce	f	.22	.25	.07
can carry	f	.17	.12	.14
can walk	f	.11	.75	.08
is predator	e	.89	.25	.12
is carnivorous	e	.78	.25	.14
has good eyesight	e	.67	.25	.10
is dangerous	e	.33	.50	.05
has nest	e	.28	.38	.12
is wild	e	.28	.62	.09
is found in mountains	e	.22	.12	.06
is rare	e	.22	.12	.08
is protected	e	.11	.12	.06
is strong	e	.11	.12	.21

	Feature type	Dominance	Distinctiveness	Proportion of all intercorrelations significant
Elephant				
is a mammal	c	.15	.50	
is a animal	c	1.00	.88	
has trunk	s	.90	.06	.08
is large	s	.90	.62	.06
has ears	s	.60	.69	.09
has tusks	s	.60	.06	.08
is grey	s	.60	.19	.09
has large ears	s	.55	.12	.09
has legs	s	.45	.88	.12
has feet	s	.40	.44	.06
has skin	s	.40	.44	.10
has tail	s	.40	.81	.11
has four legs	s	.35	.94	.13
has thick skin	s	.30	.12	.08
has large feet	s	.30	.06	.08
is heavy	s	.30	.25	.15
has eyes	s	.20	1.00	.13
has small tail	s	.20	.25	.14
is slow	s	.20	.12	.08
has ivory tusks	s	.15	.06	.08
can trumpet	f	.45	.06	.08
can be ridden	f	.35	.19	.12
can pull	f	.35	.19	.12
can be trained	f	.25	.25	.17
can carry	f	.25	.19	.14
can spray	f	.25	.06	.08
can breed	f	.20	.56	.07
can trample	f	.20	.06	.08
can walk	f	.20	.75	.08
can pick things up	f	.15	.06	.08
can run	f	.15	.88	.12
is strong	e	.50	.31	.21
is wild	e	.35	.75	.09
is vegetarian	e	.25	.50	.09
is found India	e	.20	.06	.08
is dangerous	e	.15	.25	.05
is found in a zoo	e	.15	.19	.08
is found in Africa	e	.15	.19	.11
is gregarious	e	.15	.12	.09
is herbivorous	e	.15	.25	.15

	Feature type	Dominance	Distinctiveness	Proportion of all intercorrelations significant
Envelope				
is a container	c	.15	.44	
is stationery	c	.20	.06	
has gummed edge	s	.80	.06	.05
has flap	s	.70	.06	.09
is made of paper	s	.65	.06	.05
is square	s	.30	.31	.16
is in different sizes	s	.25	.12	.10
is white	s	.25	.19	.15
has front	s	.20	.06	.05
is brown	s	.20	.12	.09
is flat	s	.20	.06	.05
has back	s	.15	.12	.06
has fold	s	.15	.06	.05
has window	s	.15	.06	.19
is light	s	.15	.44	.02
can hold a letter	f	.85	.06	.05
can be posted	f	.60	.06	.05
can be stamped	f	.55	.06	.05
can be addressed	f	.45	.06	.05
can be stuck down	f	.25	.06	.05
is useful	f	.20	.75	.01
can be delivered	f	.15	.06	.05
Frog				
is a reptile	c	.15	.19	
is an animal	c	.50	.12	
is an amphibian	c	.55	.06	
has eyes	s	.55	1.00	.13
has skin	s	.50	.44	.10
is green	s	.40	.06	.11
is slimy	s	.40	.06	.03
has four legs	s	.35	.94	.13
has feet	s	.25	.44	.06
has spots	s	.25	.06	.03
is small	s	.25	.50	.02
has tongue	s	.20	.12	.06
has webbed feet	s	.20	.06	.10
has bulging eyes	s	.15	.06	.03
can jump	f	1.00	.56	.09
can swim	f	.80	.25	.04
can eat	f	.45	.94	.11
can croak	f	.40	.06	.03
can spawn	f	.30	.06	.03
can breed	f	.20	.56	.07
is edible	f	.20	.31	.10
can lay eggs	f	.15	.19	.05
can eat insects	e	.50	.06	.03
is found in gardens	e	.20	.06	.03
is found near water	e	.20	.25	.04

	Feature type	Dominance	Distinctiveness	Proportion of all intercorrelations significant
Glass				
is a tool	c	.12	.50	
is a container	c	.35	.44	
is a household item	c	.47	.75	
is transparent	s	.76	.06	.04
has base	s	.65	.38	.14
has bowl	s	.41	.06	.04
has stem	s	.41	.12	.11
is round	s	.24	.44	.03
is small	s	.24	.69	.03
has rim	s	.18	.06	.04
is different shapes	s	.18	.06	.04
is hard	s	.18	.44	.02
is open-topped	s	.18	.06	.04
is smooth	s	.18	.12	.11
is coloured	s	.12	.44	.04
is decorative	s	.12	.06	.04
is light	s	.12	.44	.02
can be broken	f	.65	.19	.09
can hold liquid	f	.59	.12	.06
can be drunk from	f	.53	.06	.04
can be bought	f	.12	.25	.01
can be cut	f	.12	.12	.08
can be washed	f	.12	.12	.07
can cut	f	.12	.06	.09
is useful	f	.12	.75	.01
Hammer				
is a tool	c	.95	1.00	
has handle	s	.95	.88	.03
has head	s	.95	.38	.14
is made of wood	s	.79	.62	.01
is made of metal	s	.74	.88	.04
is heavy	s	.53	.38	.01
has claw	s	.37	.12	.03
can make a noise	s	.21	.12	.08
is hard	s	.21	.38	.02
has face	s	.16	.12	.03
is long and/or thin	s	.11	.38	.02
can knock in nails	f	.89	.12	.03
can pull nails	f	.47	.12	.03
can flatten surfaces	f	.26	.12	.03
is handheld	f	.26	.88	.03
can break things	f	.16	.12	.03
is dangerous	e	.16	.50	.11
is found in the house	e	.16	.12	.03
is found in the workshop	e	.11	.12	.03

	Feature type	Dominance	Distinctiveness	Proportion of all intercorrelations significant
Helicopter				
is a machine	c	.17	.12	
is a aircraft	c	.44	.25	
is a vehicle	c	.50	1.00	
has rotor	s	1.00	.12	.05
can make a noise	s	.50	.75	.08
has cockpit	s	.28	.25	.09
has wheel	s	.28	.75	.09
has skids	s	.22	.12	.05
is made of metal	s	.22	.88	.04
has fuselage	s	.17	.25	.09
has seat	s	.17	.88	.06
has window	s	.17	.50	.19
is large	s	.17	.62	.07
has controls	s	.11	.25	.12
can fly	f	.83	.25	.09
can hover	f	.67	.12	.05
can carry passengers	f	.33	.50	.17
can land	f	.22	.25	.09
can take off / land vertical	f	.22	.12	.05
can lower	f	.11	.12	.05
can rise	f	.11	.12	.05
is useful	f	.11	.75	.01
has engine	e	.50	.75	.24
has pilot	e	.28	.25	.09
can be used by forces	e	.17	.12	.05
can be used for observation	e	.11	.12	.05

	Feature type	Dominance	Distinctiveness	Proportion of all intercorrelations significant
Horse				
is a mammal	c	.16	.50	
is a animal	c	1.00	.88	
has legs	s	.79	.88	.12
has four legs	s	.74	.94	.13
has tail	s	.68	.81	.11
has mane	s	.47	.06	.07
is large	s	.47	.62	.06
has hooves	s	.32	.19	.11
has teeth	s	.32	.56	.10
has eyes	s	.26	1.00	.13
has fur	s	.26	.69	.11
has ears	s	.21	.69	.09
has head	s	.21	.38	.04
is brown	s	.21	.50	.05
is fast	s	.21	.62	.08
is heavy	s	.21	.25	.15
has body	s	.16	.31	.14
can neigh	s	.11	.06	.07
has skin	s	.11	.44	.10
is dappled	s	.11	.06	.07
is white	s	.11	.06	.06
can pull	f	.58	.19	.12
can be ridden	f	.42	.19	.12
can jump	f	.37	.56	.09
can be raced	f	.32	.06	.07
can trot	f	.32	.06	.07
can walk	f	.32	.75	.08
can gallop	f	.26	.06	.07
can run	f	.26	.88	.12
can be trained	f	.16	.25	.17
can bite	f	.16	.31	.17
can eat	f	.16	.94	.11
can be shod	f	.11	.06	.07
can carry	f	.11	.19	.14
can kick	f	.11	.06	.06
is herbivorous	e	.32	.25	.15
is vegetarian	e	.26	.50	.09
is domesticated	e	.21	.38	.05
is strong	e	.16	.31	.21
can eat grass	e	.11	.12	.07
has strong teeth	e	.11	.12	.07
is friendly	e	.11	.12	.11

	Feature type	Dominance	Distinctiveness	Proportion of all inter-correlations significant
Kangaroo				
is a marsupial	c	.60	.06	
is a animal	c	.90	.88	
has legs	s	.85	.88	.12
has large hind legs	s	.60	.12	.07
has pouch	s	.60	.06	.04
has fur	s	.50	.69	.11
is brown/grey	s	.45	.06	.04
has small front legs	s	.40	.06	.04
is large	s	.40	.62	.06
has ears	s	.35	.69	.09
has tail	s	.25	.81	.11
is fast	s	.25	.62	.08
has feet	s	.20	.44	.06
has powerful tail	s	.20	.12	.07
is upright	s	.20	.06	.04
has eyes	s	.15	1.00	.13
has four legs	s	.15	.94	.13
has head	s	.15	.38	.04
has large feet	s	.15	.06	.04
can jump	f	.70	.56	.09
can eat	f	.30	.94	.11
can carry young	f	.25	.06	.04
is edible	f	.20	.31	.10
can breed	f	.15	.56	.07
can run	f	.15	.88	.12
can see	f	.15	.25	.10
is found in Australia	e	.50	.12	.06
is vegetarian	e	.40	.50	.09
is wild	e	.40	.75	.09
is found in a zoo	e	.30	.19	.08

	Feature type	Dominance	Distinctiveness	Proportion of all inter-correlations significant
Key				
is a household item	c	.35	.75	
is a tool	c	.45	.50	
is made of metal	s	.90	.56	.04
has teeth	s	.55	.12	.06
has handle	s	.35	.50	.03
is small	s	.35	.69	.03
is hard	s	.21	.44	.02
has pattern	s	.20	.06	.04
has shaft/stem	s	.20	.06	.04
has hole	s	.15	.06	.04
can open doors	f	.85	.06	.04
can lock doors	f	.65	.06	.04
can be turned	f	.35	.06	.04
can be hung on a ring	f	.25	.06	.04
can be inserted	f	.20	.12	.08
can be lost	f	.20	.12	.09
can be carried	f	.15	.56	.04
can be copied	f	.15	.06	.04
can be cut	f	.15	.12	.08
can start cars	f	.15	.06	.04
is useful	f	.15	.75	.01
is unique	e	.20	.06	.04

	Feature type	Dominance	Distinctiveness	Proportion of all inter-correlations significant
Lorry				
is a vehicle	c	.94	1.00	
has wheel	s	.89	.75	.09
is large	s	.72	.62	.07
has cab	s	.56	.25	.11
can make a noise	s	.22	.75	.08
has trailer	s	.22	.12	.07
has body	s	.17	.25	.20
has light	s	.17	.38	.12
is articulated	s	.17	.12	.07
is fast	s	.17	.88	.08
is heavy	s	.17	.12	.01
is made of metal	s	.17	.88	.04
has door	s	.11	.25	.11
has platform	s	.11	.12	.07
has window	s	.11	.50	.19
is hard	s	.11	.12	.02
can carry goods	f	.94	.38	.12
can be loaded	f	.50	.12	.07
can move	f	.17	.75	.23
can reverse	f	.17	.38	.14
can stop	f	.11	.38	.13
can tip	f	.11	.12	.09
is useful	f	.11	.75	.01
has engine	e	.72	.75	.24
has driver	e	.39	.38	.14
is powered by diesel	e	.33	.38	.14
has brakes	e	.17	.25	.11
is polluting	e	.17	.25	.11
has gears	e	.11	.38	.12
has license	e	.11	.12	.07
is dangerous	e	.11	.12	.11
is expensive	e	.11	.25	.13
is powered by petrol	e	.11	.38	.13
is strong	e	.11	.12	.11

	Feature type	Dominance	Distinctiveness	Proportion of all inter-correlations significant
Monkey				
is a primate	c	.25	.06	
is a animal	c	1.00	.88	
has tail	s	.75	.81	.11
has fur	s	.70	.69	.11
has legs	s	.50	.88	.12
has arms	s	.30	.06	.06
has teeth	s	.25	.56	.10
is small	s	.25	.50	.02
has hands	s	.20	.06	.06
has long tail	s	.20	.25	.11
has two legs	s	.20	.06	.06
can make a noise	s	.15	.19	.03
has eyes	s	.15	1.00	.13
has feet	s	.15	.44	.06
has four legs	s	.15	.94	.13
has long arms	s	.15	.06	.06
has sharp teeth	s	.15	.38	.19
is brown	s	.15	.50	.05
can climb	f	.55	.31	.13
can jump	f	.40	.56	.09
can swing	f	.40	.06	.06
can breed	f	.25	.56	.07
can chatter	f	.25	.06	.06
can run	f	.25	.88	.12
can grasp	f	.20	.12	.08
can eat	f	.15	.94	.11
is agile	f	.15	.25	.12
is found in trees	e	.40	.12	.06
is wild	e	.40	.75	.09
is intelligent	e	.30	.12	.10
is vegetarian	e	.30	.50	.09
is found in zoos	e	.20	.12	.08
is mischeivous	e	.20	.06	.06
can eat fruit	e	.15	.06	.06
is gregarious	e	.15	.12	.09

	Feature type	Dominance	Distinctiveness	Proportion of all intercorrelations significant
Motorbike				
is a vehicle	c	.95	1.00	
has wheel	s	.95	.75	.09
is fast	s	.79	.88	.08
has handlebar	s	.53	.25	.09
has light	s	.53	.38	.12
has seat	s	.53	.88	.06
can make a noise	s	.42	.75	.08
has tank	s	.42	.12	.05
is made of metal	s	.42	.88	.04
is unstable	s	.37	.38	.12
has tyre	s	.26	.25	.09
is coloured	s	.21	.38	.04
has sidecar	s	.16	.12	.05
has indicator	s	.11	.12	.05
has pannier	s	.11	.12	.05
has pedal	s	.11	.25	.09
has speedometer	s	.11	.12	.05
is manoevrable	f	.42	.12	.05
can race	f	.32	.12	.05
has brakes	f	.21	.38	.12
can stop	f	.16	.38	.13
can move	f	.11	.75	.23
has engine	e	.63	.75	.24
is powered by petrol	e	.42	.38	.13
is economical	e	.26	.12	.05
has gears	e	.21	.38	.12

	Feature type	Dominance	Distinctiveness	Proportion of all intercorrelations significant
Mouse				
is a pet	c	.21	.19	
is a rodent	c	.32	.12	
is a animal	c	.84	.88	
has tail	s	.84	.81	.11
is small	s	.79	.50	.02
has fur	s	.68	.69	.11
has long tail	s	.53	.25	.11
has whiskers	s	.47	.19	.06
has legs	s	.42	.88	.12
has teeth	s	.32	.56	.10
has ears	s	.26	.69	.09
has eyes	s	.26	1.00	.13
has four legs	s	.26	.94	.13
is brown	s	.21	.50	.05
is fast	s	.21	.62	.08
is grey	s	.21	.19	.09
has sharp teeth	s	.16	.38	.19
can squeak	s	.11	.06	.06
has smell	s	.11	.12	.06
is soft	s	.11	.19	.10
can chew	f	.47	.19	.07
can run	f	.47	.88	.12
can climb	f	.26	.31	.13
can breed	f	.21	.56	.07
can eat	f	.16	.94	.11
can hide	f	.16	.19	.08
can be caught	f	.11	.06	.06
can smell	f	.11	.06	.06
is a pest	e	.53	.19	.08
has good eyesight	e	.16	.12	.10
is found in houses	e	.16	.06	.06
has nest	e	.11	.12	.12
is nocturnal	e	.11	.06	.04
is wild	e	.11	.75	.09

	Feature type	Dominance	Distinctiveness	Proportion of all intercorrelations significant
Orange				
is a fruit	c	1.00	1.00	
has pips	s	.85	.67	.15
is juicy	s	.85	.83	.18
has skin	s	.80	1.00	.10
has segments	s	.60	.17	.04
is orange	s	.60	.17	.04
has flesh	s	.45	1.00	.22
is round	s	.45	.67	.13
is sweet	s	.45	1.00	.22
has pith	s	.35	.17	.04
is edible	f	.85	1.00	.10
can be cooked	f	.15	.83	.17
is found in the tropics	e	.15	.33	.07
is found on trees	e	.15	.50	.11
Ostrich				
is a animal	c	.15	.50	
is a bird	c	.80	1.00	
has legs	s	.90	.75	.12
has feathers	s	.85	1.00	.07
has long legs	s	.60	.12	.03
has neck	s	.55	.25	.07
is large	s	.55	.62	.06
has long neck	s	.50	.25	.07
has wings	s	.45	1.00	.07
is fast	s	.40	.12	.08
has head	s	.35	.38	.04
has two legs	s	.35	.62	.13
has beak	s	.30	1.00	.07
has eyes	s	.25	.75	.13
has small head	s	.25	.12	.06
has long feathers	s	.15	.12	.03
has tail	s	.15	.38	.11
can run	f	.85	.38	.12
is edible	f	.60	.38	.10
can kick	f	.40	.12	.06
can lay eggs	f	.40	1.00	.05
is flightless	f	.35	.12	.03
can eat	f	.20	.62	.11
can walk	f	.20	.75	.08
can bury head	f	.15	.12	.03
is found on farms	e	.45	.25	.05
is dangerous	e	.30	.50	.05
is wild	e	.25	.62	.09
is vegetarian	e	.15	.12	.09

	Feature type	Dominance	Distinctiveness	Proportion of all intercorrelations significant
Owl				
is a bird	c	1.00	1.00	
has feathers	s	.80	1.00	.07
has beak	s	.70	1.00	.07
can make a noise	s	.60	.62	.03
has claws	s	.55	.25	.04
can hoot	s	.50	.12	.04
has wings	s	.45	1.00	.07
has eyes	s	.35	.75	.13
has large eyes	s	.25	.12	.06
has feet	s	.20	.75	.06
is brown	s	.20	.25	.05
is large	s	.20	.62	.06
has ears	s	.15	.12	.09
has head	s	.15	.38	.04
has two legs	s	.15	.62	.13
is silent	s	.15	.12	.04
can fly	f	.85	.75	.14
can eat	f	.25	.62	.11
can lay eggs	f	.15	1.00	.05
can swoop	f	.15	.25	.08
is nocturnal	e	.80	.12	.04
is predator	e	.75	.25	.12
has good eyesight	e	.55	.25	.10
can eat animals	e	.35	.12	.04
is carnivorous	e	.30	.25	.14
is dangerous	e	.25	.50	.05
has nest	e	.20	.38	.12
is found in trees	e	.15	.12	.06
is wild	e	.15	.62	.09

	Feature type	Dominance	Distinctiveness	Proportion of all intercorrelations significant
Paintbrush				
is a tool	c	.72	1.00	
has bristles	s	1.00	.12	.07
has handle	s	.94	.88	.03
is made of wood	s	.50	.62	.01
is in different sizes	s	.33	.25	.10
is soft	s	.22	.12	.09
has metal band	s	.11	.12	.03
is made of plastic	s	.11	.25	.03
is small	s	.11	.50	.03
can spread paint	f	.67	.12	.03
can be cleaned	f	.33	.12	.03
is handheld	f	.22	.88	.03
is useful	f	.17	.75	.01
can be used to clean things	f	.15	.12	.03
can be bought	f	.11	.25	.01
can be stored	f	.11	.12	.03
is used by artists	e	.28	.12	.03
is used by decorators	e	.22	.12	.03
Peacock				
is a bird	c	.95	1.00	
is domesticated	e	.15	.25	.05
can lay eggs	f	.25	1.00	.05
can run	f	.30	.38	.12
can walk	f	.30	.75	.08
can fly	f	.50	.75	.14
has head	s	.15	.38	.04
has crest	s	.20	.25	.05
has large tail	s	.25	.12	.02
has wings	s	.25	1.00	.07
has two legs	s	.30	.12	.06
has beak	s	.35	1.00	.07
is large	s	.35	.62	.06
can screech	s	.40	.12	.02
has tail	s	.50	.38	.11
is coloured	s	.50	.25	.09
can fan tail	s	.55	.12	.02
has legs	s	.55	.75	.12
is decorative	s	.55	.12	.02
has feathers	s	.60	1.00	.07
can make a noise	s	.90	.62	.03

	Feature type	Dominance	Distinctiveness	Proportion of all intercorrelations significant
Penguin				
is a animal	c	.15	.50	
is a bird	c	.85	1.00	
has feet	s	.75	.75	.06
is black	s	.70	.25	.06
has beak	s	.55	1.00	.07
is white	s	.55	.25	.06
has feathers	s	.50	1.00	.07
has webbed feet	s	.50	.38	.10
is upright	s	.40	.12	.04
has flippers	s	.35	.12	.05
has wings	s	.35	1.00	.07
is small	s	.15	.38	.02
can swim	f	.90	.38	.04
can walk	f	.80	.75	.08
can eat	f	.75	.62	.11
can lay eggs	f	.45	1.00	.05
can dive	f	.20	.38	.10
can eat fish	e	.70	.12	.06
is found in cold climate	e	.55	.12	.03
is found near water	e	.30	.38	.04
is found in groups	e	.15	.12	.03
Piano				
is a musical instrument	c	.84	.06	
has keys	s	.79	.06	.05
has pedals	s	.68	.06	.05
has lid	s	.58	.31	.12
is made of wood	s	.58	.31	.01
is large	s	.47	.31	.07
can make a noise	s	.32	.06	.08
has legs	s	.32	.12	.07
has black keys	s	.26	.06	.05
is grand	s	.26	.06	.05
is made of ivory	s	.26	.06	.05
has frame	s	.21	.06	.09
is heavy	s	.21	.19	.01
is upright	s	.21	.06	.05
has case	s	.16	.06	.05
has feet	s	.11	.06	.05
has music-stand	s	.11	.06	.05
is made of metal	s	.11	.56	.04
is soft	s	.11	.19	.09
can be played	f	.84	.12	.07
can be tuned	f	.37	.06	.05
can be polished	f	.16	.12	.07
has hammer	e	.21	.06	.05
is expensive	e	.21	.06	.13

	Feature type	Dominance	Distinctiveness	Proportion of all intercorrelations significant
Pineapple				
is a fruit	c	1.00	1.00	
has skin	s	.70	1.00	.10
is sweet	s	.70	1.00	.22
has leaves	s	.65	.83	.19
has flesh	s	.60	1.00	.22
is juicy	s	.60	.83	.18
has rough skin	s	.40	.17	.06
has spikes	s	.40	.17	.06
is yellow	s	.40	.33	.08
has core	s	.35	.33	.10
is hard	s	.25	.33	.09
is oval/round	s	.25	.17	.06
has yellow flesh	s	.20	.17	.06
has spikey leaves	s	.15	.17	.06
is large	s	.15	.17	.06
is edible	f	.85	1.00	.10
can be cut	f	.40	.17	.06
can be peeled	f	.25	.17	.06
can be picked	f	.15	.67	.15
is found in the tropics	e	.40	.33	.07
can grow	e	.35	.50	.13
is found in tins	e	.30	.33	.08
Pliers				
is a tool	c	1.00	1.00	
has handle	s	.95	.88	.03
is made of metal	s	.84	.88	.04
has jaw	s	.63	.12	.03
has hinge	s	.37	.25	.06
is hard	s	.32	.38	.02
has notch	s	.21	.12	.03
is small	s	.11	.50	.03
can grip	f	.63	.12	.03
can pull	f	.47	.12	.08
can cut	f	.37	.50	.09
can squeeze	f	.32	.12	.03
can turn	f	.32	.25	.05
is handheld	f	.21	.88	.03
can bend	f	.16	.12	.03
can open and close	f	.16	.12	.07
is useful	f	.16	.75	.01
is used in metalwork	e	.21	.25	.05
is found in a toolbox	e	.16	.12	.03

	Feature type	Dominance	Distinctiveness	Proportion of all intercorrelations significant
Plug				
is a appliance	c	.11	.06	
is a household item	c	.11	.75	
is a tool	c	.21	.50	
is a electrical item	c	.68	.12	
has pin	s	.95	.06	.05
is made of plastic	s	.63	.50	.03
has fuse	s	.58	.06	.05
has wires	s	.58	.12	.09
is made of metal	s	.47	.56	.04
has cable	s	.37	.06	.05
is small	s	.28	.69	.03
has cover	s	.26	.06	.05
has screws	s	.26	.06	.05
is white	s	.21	.19	.15
has terminals	s	.16	.06	.05
has cable grip	s	.11	.06	.05
is coloured	s	.11	.44	.04
is square	s	.11	.31	.16
can conduct electricity	f	.53	.06	.05
can be inserted	f	.42	.12	.08
can earth	f	.28	.06	.05
is useful	f	.26	.75	.01
can be connected	f	.21	.06	.05
can be pulled	f	.21	.06	.09
can be broken	f	.16	.19	.09
is insulated	f	.16	.06	.05
can be bought	f	.11	.25	.01
is dangerous	e	.26	.06	.11

	Feature type	Dominance	Distinctiveness	Proportion of all intercorrelations significant
Rabbit				
is a mammal	c	.11	.50	
is a animal	c	.95	.88	
has long ears	s	1.00	.06	.07
has fur	s	.79	.69	.11
has tail	s	.79	.81	.11
has large ears	s	.68	.12	.09
has legs	s	.68	.88	.12
has small tail	s	.53	.25	.14
has four legs	s	.47	.94	.13
has eyes	s	.37	1.00	.13
is small	s	.37	.50	.02
is fast	s	.26	.62	.08
has whiskers	s	.16	.19	.06
has white tail	s	.16	.06	.07
is brown	s	.16	.50	.05
can squeal	s	.11	.06	.07
has body	s	.11	.31	.14
has claws	s	.11	.31	.04
has large eyes	s	.11	.06	.06
has large hind legs	s	.11	.12	.07
has nose	s	.11	.12	.09
is soft	s	.11	.19	.10
can jump	f	.74	.56	.09
can dig	f	.63	.19	.06
can run	f	.58	.88	.12
can breed	f	.37	.56	.07
is edible	f	.37	.31	.10
can eat	f	.16	.94	.11
can hear	f	.11	.06	.07
can hide	f	.11	.19	.08
can see	f	.11	.25	.10
can walk	f	.11	.75	.08
is agile	f	.11	.25	.12
is vegetarian	e	.47	.50	.09
is wild	e	.32	.75	.09
is docile	e	.26	.12	.07
is a pest	e	.16	.19	.08
is domesticated	e	.16	.38	.05
is timid	e	.16	.06	.07
is herbivorous	e	.11	.25	.15

	Feature type	Dominance	Distinctiveness	Proportion of all intercorrelations significant
Rhinoceros				
is an animal	c	.95	.12	
has horn	s	.95	.06	.05
has legs	s	.58	.88	.12
has skin	s	.58	.44	.10
is heavy	s	.53	.25	.15
is large	s	.53	.62	.06
has four legs	s	.47	.94	.13
has eyes	s	.26	1.00	.13
has tail	s	.26	.81	.11
has small tail	s	.21	.25	.14
is grey/black	s	.21	.06	.05
has ears	s	.16	.69	.09
has hooves	s	.16	.19	.11
has small eyes	s	.16	.06	.05
can make a noise	s	.11	.19	.03
has body	s	.11	.31	.14
has head	s	.11	.38	.04
has large legs	s	.11	.06	.05
has teeth	s	.11	.56	.10
has cloven hooves	s	.11	.06	.05
is fast	s	.11	.62	.08
is ungainly	s	.11	.06	.05
can charge	f	.53	.06	.05
can run	f	.47	.88	.12
can walk	f	.16	.75	.08
can breed	f	.11	.56	.07
can eat	f	.11	.94	.11
can see	f	.11	.25	.10
can swim	f	.11	.25	.04
is dangerous	e	.79	.25	.05
is wild	e	.68	.75	.09
has tough skin	e	.42	.12	.09
is found near water	e	.21	.25	.04
is found in Africa	e	.16	.19	.11
is vegetarian	e	.16	.50	.09
is found in zoos	e	.11	.12	.08
is rare	e	.11	.12	.08

	Feature type	Dominance	Distinctiveness	Proportion of all intercorrelations significant
Saw				
is a tool	c	1.00	1.00	
has handle	s	.95	.88	.03
has teeth	s	.95	.12	.06
is made of metal	s	.68	.88	.04
has blade	s	.63	.50	.06
is sharp	s	.58	.50	.06
is long and/or thin	s	.32	.38	.02
is flexible	s	.26	.12	.03
is made of wood	s	.26	.62	.01
can cut	f	.84	.50	.09
can be sharpened	f	.26	.38	.06
can be played	f	.21	.12	.07
is useful	f	.16	.75	.01
is handheld	f	.11	.88	.03
is dangerous	e	.16	.50	.11
is powered	e	.16	.25	.04
is used in metalwork	e	.16	.25	.05
is used in woodwork	e	.11	.12	.03
Scissors				
is a household item	c	.37	.12	
is a tool	c	.79	1.00	
has blade	s	1.00	.50	.06
has finger hole	s	.84	.12	.03
is sharp	s	.79	.50	.06
is made of metal	s	.58	.88	.04
has hinge	s	.37	.25	.06
is serrated	s	.21	.12	.03
is made of plastic	s	.16	.25	.03
is pointed	s	.16	.12	.03
is small	s	.16	.50	.03
is large	s	.11	.12	.07
is shiny	s	.11	.12	.09
can cut	f	1.00	.50	.09
is handheld	f	.32	.88	.03
can pierce	f	.26	.12	.03
can be bought	f	.11	.25	.01
can be sharpened	f	.11	.38	.06
is useful	f	.11	.75	.01
is used in sewing	e	.37	.12	.03
is used in cooking	e	.11	.12	.03

	Feature type	Dominance	Distinctiveness	Proportion of all intercorrelations significant
Screwdriver				
is a tool	c	1.00	1.00	
has handle	s	.90	.88	.03
is made of metal	s	.70	.88	.04
has blade	s	.45	.50	.06
has square/flat end	s	.40	.12	.02
has shaft	s	.35	.12	.02
is made of wood	s	.35	.62	.01
is sharp	s	.35	.50	.06
is small	s	.30	.50	.03
is long and/or thin	s	.20	.38	.02
can turn screws	f	.90	.12	.02
can be used as a lever	f	.45	.12	.02
is useful	f	.25	.75	.01
is handheld	f	.20	.88	.03
is powered	e	.25	.25	.04
Sledge				
is a toy	c	.33	.12	
is a vehicle	c	.89	1.00	
has runner	s	.94	.12	.04
is made of wood	s	.72	.12	.01
has seat	s	.61	.88	.06
is made of metal	s	.44	.88	.04
has rope	s	.22	.12	.04
is fast	s	.17	.88	.08
is unstable	s	.17	.38	.12
has handle	s	.12	.12	.03
is low	s	.11	.12	.04
is made of plastic	s	.11	.12	.03
can slide over snow/ice	f	.83	.12	.04
can be pulled	f	.67	.12	.09
can be ridden	f	.39	.25	.09
can carry goods	f	.28	.38	.12
can be steered	f	.22	.12	.04
is useful	f	.22	.75	.01
can be carried	f	.11	.12	.04
can be made	f	.11	.12	.04
can move	f	.11	.75	.23
can travel downhill	f	.11	.12	.04
can be pulled by dogs	e	.39	.12	.04
is used in the Arctic	e	.17	.12	.04
is motorised	e	.11	.12	.04

	Feature type	Dominance	Distinctiveness	Proportion of all intercorrelations significant
Spanner				
is a tool	c	1.00	1.00	
is made of metal	s	.84	.88	.04
has handle	s	.75	.88	.03
has open end	s	.50	.12	.02
has sockets	s	.35	.12	.02
is in different sizes	s	.30	.25	.10
is shaped to fit	s	.25	.12	.02
has head	s	.20	.38	.14
is hard	s	.20	.38	.02
is heavy	s	.15	.38	.01
can turn	f	.90	.25	.05
is adjustable	f	.25	.12	.02
is useful	f	.25	.75	.01
is handheld	f	.15	.88	.03
is dangerous	e	.15	.50	.11

	Feature type	Dominance	Distinctiveness	Proportion of all intercorrelations significant
Squirrel				
is a mammal	c	.26	.50	
is a rodent	c	.26	.12	
is a animal	c	.89	.88	
has tail	s	.89	.81	.11
has fur	s	.79	.69	.11
has bushy tail	s	.74	.06	.05
is grey	s	.63	.19	.09
is red	s	.58	.06	.10
has eyes	s	.37	1.00	.13
has teeth	s	.37	.56	.10
has ears	s	.32	.69	.09
is small	s	.32	.50	.02
has legs	s	.26	.88	.12
has sharp teeth	s	.26	.38	.19
has feet	s	.21	.44	.06
has four legs	s	.21	.94	.13
has claws	s	.16	.31	.04
is fast	s	.16	.62	.08
has pointed ears	s	.11	.12	.04
is brown	s	.11	.50	.05
can climb	f	.79	.31	.13
can jump	f	.63	.56	.09
can eat	f	.47	.94	.11
can run	f	.42	.88	.12
can dig	f	.21	.19	.06
can grasp	f	.21	.12	.08
is agile	f	.21	.25	.12
can chew	f	.16	.19	.07
can walk	f	.16	.75	.08
can bite	f	.11	.31	.17
is found in trees	e	.58	.12	.06
can eat nuts	e	.53	.06	.05
can hibernate	e	.21	.12	.06
is a pest	e	.21	.19	.08
is wild	e	.21	.75	.09
is vegetarian	e	.21	.50	.09
has nest	e	.11	.12	.12

	Feature type	Dominance	Distinctiveness	Proportion of all inter-correlations significant
Stool				
is a household item	c	.25	.75	
is a furniture	c	.85	.06	
has legs	s	.95	.12	.07
has seat	s	.80	.06	.06
is made of wood	s	.70	.31	.01
is small	s	.40	.69	.03
has padding	s	.28	.06	.03
is made of metal	s	.25	.56	.04
is square	s	.25	.31	.16
has struts	s	.20	.06	.03
is round	s	.16	.44	.03
is light	s	.15	.44	.02
is made of plastic	s	.15	.50	.03
is stable	s	.15	.06	.03
is tall	s	.15	.06	.03
can be sat on	f	.65	.06	.03
can be stood on	f	.30	.06	.03
can be carried	f	.20	.56	.04
can be polished	f	.15	.12	.07
can support feet	f	.15	.06	.03

	Feature type	Dominance	Distinctiveness	Proportion of all inter-correlations significant
Suitcase				
is a vehicle	c	.11	.06	
is a household item	c	.26	.75	
is a container	c	.37	.44	
is a item of luggage	c	.42	.06	
has lock	s	.79	.06	.06
has handle	s	.74	.50	.03
has strap	s	.53	.06	.06
is made of leather	s	.53	.06	.06
has wheel	s	.47	.19	.09
is square	s	.47	.31	.16
has lid	s	.37	.31	.12
is large	s	.26	.31	.07
is made of plastic	s	.26	.50	.03
is light	s	.21	.44	.02
is small	s	.21	.69	.03
has base	s	.16	.38	.14
has zips	s	.16	.06	.06
is made of fabric	s	.16	.12	.09
has body	s	.11	.25	.20
has corner	s	.11	.06	.06
has fastener	s	.11	.06	.06
has label	s	.11	.06	.06
is brown	s	.11	.12	.09
is hard	s	.11	.44	.02
is heavy	s	.11	.19	.01
is hollow	s	.11	.25	.11
is in different sizes	s	.11	.12	.10
can be carried	f	.58	.56	.04
can hold clothing	f	.37	.06	.06
can be filled	f	.32	.25	.11
can open and close	f	.32	.06	.07
is useful	f	.26	.75	.01
can be lost	f	.11	.12	.09
can be taken on holiday	f	.11	.06	.06
has pocket	e	.26	.12	.09
is strong	e	.16	.06	.11

	Feature type	Dominance	Distinctiveness	Proportion of all intercorrelations significant
Swan				
is a animal	c	.16	.50	
is a bird	c	.84	1.00	
is white	s	.84	.25	.06
has feet	s	.74	.75	.06
has beak	s	.68	1.00	.07
has feathers	s	.68	1.00	.07
has webbed feet	s	.68	.38	.10
has neck	s	.58	.25	.07
has long neck	s	.53	.25	.07
has wings	s	.53	1.00	.07
is large	s	.32	.62	.06
has two legs	s	.21	.62	.13
is black	s	.21	.25	.06
can make a noise	s	.16	.62	.03
has large beak	s	.16	.12	.06
has large wings	s	.16	.25	.07
has legs	s	.16	.75	.12
has yellow beak	s	.16	.12	.06
is elegant	s	.16	.12	.06
has eyes	s	.11	.75	.13
can fly	f	.89	.75	.14
can swim	f	.84	.38	.04
can lay eggs	f	.42	1.00	.05
can walk	f	.26	.75	.08
can reproduce	f	.21	.25	.07
can dive	f	.16	.38	.10
can eat	f	.16	.62	.11
is found near water	e	.53	.38	.04
is dangerous	e	.37	.50	.05
is royal	e	.26	.12	.06
is monogamous	e	.21	.12	.06
is wild	e	.21	.62	.09
can eat weeds	e	.16	.12	.06
has nest	e	.16	.38	.12

	Feature type	Dominance	Distinctiveness	Proportion of all intercorrelations significant
Tiger				
is a cat	c	.16	.06	
is a mammal	c	.16	.50	
is a animal	c	.95	.88	
has stripes	s	.84	.06	.06
has fur	s	.63	.69	.11
has tail	s	.63	.81	.11
has teeth	s	.63	.56	.10
has legs	s	.47	.88	.12
is fast	s	.47	.62	.08
has claws	s	.42	.31	.04
has four legs	s	.37	.94	.13
is large	s	.32	.62	.06
has long tail	s	.21	.25	.11
can growl	s	.16	.06	.06
has ears	s	.16	.69	.09
has sharp teeth	s	.16	.38	.19
has skin	s	.16	.44	.10
has body	s	.11	.31	.14
has eyes	s	.11	1.00	.13
is quiet	s	.11	.06	.06
can run	f	.63	.88	.12
can jump	f	.32	.56	.09
can breed	f	.26	.56	.07
can climb	f	.26	.31	.13
can roar	f	.16	.06	.06
can be trained	f	.11	.25	.17
can eat	f	.11	.94	.11
can walk	f	.11	.75	.08
is agile	f	.11	.25	.12
is dangerous	e	.68	.25	.05
is predator	e	.63	.19	.12
is wild	e	.47	.75	.09
is carnivorous	e	.32	.19	.14
has good eyesight	e	.11	.12	.10
has strong teeth	e	.11	.12	.07
is found in a zoo	e	.11	.19	.08
is found in jungles	e	.11	.06	.06
is rare	e	.11	.12	.08
is strong	e	.11	.31	.21

	Feature type	Dominance	Distinctiveness	Proportion of all intercorrelations significant
Toaster				
is a tool	c	.32	.50	
is a household item	c	.47	.75	
is a electrical item	c	.58	.12	
has a element	s	.74	.06	.05
is made of metal	s	.68	.56	.04
has plug	s	.63	.06	.05
has switch	s	.53	.06	.05
has lead	s	.37	.06	.05
has casing	s	.32	.06	.05
has controls	s	.32	.06	.12
is hot	s	.32	.06	.05
has body	s	.16	.25	.20
has slot	s	.16	.06	.05
has wires	s	.11	.12	.09
is coloured	s	.11	.44	.04
is hard	s	.11	.44	.02
is light	s	.11	.44	.02
is square	s	.11	.31	.16
can make toast	f	.79	.06	.05
can burn	f	.37	.12	.11
can be carried	f	.26	.56	.04
can be damaged	f	.11	.06	.05
can pop up	f	.11	.06	.05
is useful	f	.11	.75	.01
is found in kitchen	e	.47	.06	.05
has crumb tray	e	.11	.06	.05

	Feature type	Dominance	Distinctiveness	Proportion of all intercorrelations significant
Tomato				
is a vegetable	c	.40	.17	
is a fruit	c	.70	1.00	
has skin	s	1.00	1.00	.10
is red	s	.95	.50	.10
has pips	s	.85	.67	.15
is round	s	.65	.67	.13
has flesh	s	.60	1.00	.22
has leaves	s	.40	.83	.19
is juicy	s	.40	.83	.18
has stalk	s	.35	.67	.15
is soft	s	.20	.33	.10
is small	s	.15	.50	.02
is sweet	s	.15	1.00	.22
is edible	f	.70	1.00	.10
can be cooked	f	.50	.83	.17
can be eaten raw	f	.25	.17	.06
can ripen	f	.20	.50	.13
can be picked	f	.15	.67	.15
can fall	f	.15	.33	.10
can grow	e	.65	.50	.13
is found in salad	e	.30	.17	.06
is found in tins	e	.25	.33	.08
is common	e	.15	.17	.06
Toothbrush				
is a toiletry	c	.21	.12	
is a household item	c	.26	.75	
is a tool	c	.42	.50	
has bristles	s	1.00	.12	.07
has handle	s	.89	.50	.03
is long and/or thin	s	.42	.25	.02
is coloured	s	.26	.44	.04
is hard	s	.26	.44	.02
is soft	s	.26	.19	.09
has head	s	.21	.19	.14
is light	s	.11	.44	.02
is small	s	.11	.69	.03
can clean teeth	f	.58	.06	.03
is useful	f	.37	.75	.01
can be washed	f	.26	.12	.07
can clean	f	.26	.12	.05
can hold toothpaste	f	.21	.06	.03
is handheld	f	.21	.06	.03
can scrub	f	.16	.06	.03
is made of plastic	e	.53	.06	.03
is hygienic	e	.16	.06	.03
is found in a case	e	.11	.06	.03

	Feature type	Dominance	Distinctiveness	Proportion of all intercorrelations significant
Train				
is a vehicle	c	.95	1.00	
has carriages	s	.89	.12	.06
has wheel	s	.89	.75	.09
is large	s	.47	.62	.07
is fast	s	.47	.88	.08
can make a noise	s	.26	.75	.08
has seat	s	.21	.88	.06
has wagon	s	.21	.12	.06
has window	s	.16	.50	.19
has funnel	s	.11	.12	.06
can carry passengers	f	.74	.50	.17
can run on rails	f	.47	.12	.06
can carry goods	f	.37	.38	.12
can move	f	.32	.75	.23
has whistle	f	.26	.12	.06
can pull	f	.21	.12	.08
has brakes	f	.21	.38	.12
can reverse	f	.16	.38	.14
can stop at stations	f	.16	.12	.06
can run underground	f	.11	.12	.06
is comfortable	f	.11	.12	.06
is powerful	f	.11	.38	.15
is useful	f	.11	.75	.01
has engine	e	.74	.75	.24
is powered by electricity	e	.37	.12	.06
has driver	e	.32	.38	.14
is powered by diesel	e	.26	.38	.14
is powered by steam	e	.22	.12	.06
is pollutory	e	.11	.12	.06

	Feature type	Dominance	Distinctiveness	Proportion of all intercorrelations significant
Turtle				
is a reptile	c	.26	.19	
is a animal	c	.53	.88	
is a amphibian	c	.58	.12	
has shell	s	.95	.06	.04
has legs	s	.58	.88	.12
has four legs	s	.58	.12	.08
has four legs	s	.56	.94	.13
is slow	s	.37	.12	.08
has skin	s	.32	.44	.10
is hard	s	.32	.06	.09
has feet	s	.26	.44	.06
has head	s	.26	.38	.04
is large	s	.21	.62	.06
has eyes	s	.21	1.00	.13
has small head	s	.16	.06	.06
is brown	s	.16	.50	.05
has claws	s	.11	.31	.04
has flippers	s	.11	.06	.05
has four feet	s	.11	.06	.04
has thick skin	s	.11	.12	.08
is heavy	s	.11	.25	.15
is small	s	.11	.50	.02
can swim	f	.89	.25	.04
can lay eggs	f	.68	.19	.05
can walk	f	.53	.75	.08
is edible	f	.42	.31	.10
can retract head	f	.16	.06	.04
can dig	f	.11	.19	.06
can eat	f	.11	.94	.11
is found near water	e	.42	.25	.04
can hibernate	e	.21	.12	.06
is vegetarian	e	.21	.50	.09
is wild	e	.16	.75	.09
is long-lived	e	.11	.06	.04

	Feature type	Dominance	Distinctiveness	Proportion of all intercorrelations significant
Watering can				
is a container	c	.16	.44	
is a tool	c	.63	.50	
has handle	s	.95	.50	.03
has rose	s	.95	.06	.05
has spout	s	.95	.06	.05
is made of metal	s	.89	.56	.04
is made of plastic	s	.68	.50	.03
has body	s	.21	.25	.20
is coloured	s	.21	.44	.04
is open	s	.21	.06	.05
has base	s	.11	.38	.14
is hollow	s	.11	.25	.11
is round	s	.11	.44	.03
is small	s	.11	.69	.03
can be filled	f	.53	.25	.11
can sprinkle	f	.53	.06	.05
can water plants	f	.42	.06	.05
can be carried	f	.26	.56	.04
can hold water	f	.26	.06	.05
can be emptied	f	.21	.19	.09
is useful	f	.21	.75	.01
can be bought	f	.11	.25	.01
can pour	f	.11	.06	.05
can tip	f	.11	.06	.09
is found in the garden	e	.68	.12	.06
is waterproof	e	.16	.06	.05
can leak	e	.11	.06	.05
can measure	e	.11	.06	.05

Feature types: c = categorising; e = encyclopaedic; f = functional; s = sensory.