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# A demonstration of intransitivity in natural categories

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*Abstract*

*Two experiments are reported which demonstrated intransitivity in category judgments, thus challenging a widely held assumption that the relation between categorized sets is one of class inclusion. Subjects consistently accepted the truth of certain category statements, in spite of being aware of the existence of counterexamples. Implications for semantic memory theory are discussed.*

One of the aims of semantic memory theory is to account for the logical relations that exist between different verbal concepts. Perhaps the most commonly studied relation has been that of class inclusion—the intuition that some classes are subsets of others. For example, semantic memory models are concerned with how people decide that 'Robins are birds' is true, and that 'Cabbages are bicycles' is false. Such sentences, known as categorizations, are interpreted as predicating that the class of things known as ROBINS is a subset of the class of things known as BIRDS. The assumption that *class inclusion* is the logical basis of category statements is common to most models in this field. However, the models differ in the way category knowledge is assumed to be represented, and in the processes which are presumed to occur when a categorization decision is made.

Smith (1978) has reviewed the theoretical differences between models of semantic memory and has distinguished two main classes. *Prestorage* models assume that the category relations are stored in a network with concepts as nodes connected by labelled links. In such models, the process of categorization involves a search through the network for the two concepts and the retrieval of the link between them (Anderson and Bower, 1973; Collins and Loftus, 1975; Collins and Quillian, 1972; Glass and Holyoak, 1975). A central notion in these models is the idea that inferences can validly be made, based on the transitivity of category relations. Thus for instance, 'A robin is an animal' could be verified by retrieving the two relations 'A robin is a bird'

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and 'A bird is an animal', and employing a syllogistic argument to deduce the truth of the first statement.

The second type of model, the *featural* approach, assumes that verbal concepts are represented as a set of semantic features (McCloskey and Glucksberg, 1979; Schaeffer and Wallace, 1970; Smith *et al.*, 1974). A category decision is made by comparing the sets of features belonging to the category and the item to be categorized, and computing the similarity between them as a weighted measure of feature overlap. To decide that 'Robins are Birds' is true, for example, features such as *feathers*, *wings*, *flies* and so on will be compared and found to overlap. In order to avoid concluding that 'Birds are Robins' is also true, the extra assumption is often made that a concept must possess all of the defining features of superordinate classes to which it belongs, and only some of the defining features of the subordinate instances of which it is composed, (Schaeffer and Wallace, 1970; Smith *et al.*, 1974).

Thus the most influential current semantic memory models make the assumption that a category relation is one of class inclusion. This assumption has not been explicitly challenged in this field. There are, however, various reasons for suspecting that it may not be valid in all cases. First, to take an illustration within semantic memory research, the status of *property* statements about concepts is not seen to be one of class inclusion, although the distinction between property statements such as 'Birds have wings' and category statements such as 'Birds belong to the class of winged things' is hard to justify by any explicit criterion (Smith, 1978). Subjects readily affirm the truth of such statements as 'Fruit grows on trees', or 'Vehicles have wheels', and will generate such descriptions if asked to define the concepts (Ashcraft, 1976; Hampton, 1976, 1979, 1981; Rosch and Mervis, 1975). The existence of counter-examples to these assertions, such as *strawberry* or *hovercraft*, suggests that subjects do not interpret such property statements as universal affirmatives ('*All* fruit grows on trees'), but as merely stating a generalization about the majority of common, typical examples of the class of fruit. Rosch (1975) dealt with this issue by suggesting that such concepts consist of prototypes. Property statements are therefore judged by reference to a prototype, and not by searching for counter-examples. It is the aim of the present paper to show that *category* statements of the type 'A chair is a kind of furniture' may also be held true in spite of counter-examples (such as for instance, objects like *car-seats* or *deck-chairs*). This finding would provide evidence for the view that the truth of category statements is also assessed by reference to a prototype.

A second reason for suspecting the assumption of class inclusion for category relations may be found in studies of ethno-semantics. Kempton

(1978) investigated the classification of drinking vessels in English and in Mexican Spanish. He found that the use of terms such as mug and cup does not fall into a class inclusion hierarchy, although categorizations are used to describe the relation of one term to another. Randall (1976) similarly quotes examples from folk classifications of plants where category judgments are intransitive, from which he argues that taxonomic trees are not stored directly in memory. For example, a *scrub oak* is considered to be an *oak* but not a *tree*, although an *oak* is said to be a kind of *tree*.

If the assumption of class inclusion were to prove invalid, there would be important implications for semantic memory theory. For network models, the hierarchical structure can only generate valid inferences if the class at each node is included in the class at its superordinate node. Thus evidence against class inclusion as the basis of category statements would severely limit the generality of network models. Similarly, featural models such as Smith *et al.*'s (1974) model would find it difficult to allow for category intransitivity, since they assume that there are defining features common to all category members, such that the nesting of defining features determines the nesting of classes. On the other hand, some more recent featural models could readily accommodate such a finding. The 'fuzzy' concept prototype approach (Hampton, 1979; McCloskey and Glucksberg, 1979; Rosch, 1975) suggests that an object is categorized on the basis of its overall similarity to the category prototype. The following example illustrates how intransitivity might be explained. Suppose an object shares enough features with a concept such a CHAIR or BED to be categorized in that class. CHAIR and BED clearly possess enough of the features of FURNITURE to be classified in that category. However, if the first and the second sets of overlapping features contain largely *different* features, then there may be insufficient overlap for the object to be classed as FURNITURE. Categorization (as commonly used) would therefore be capable of intransitivity—'An X is a Y' and 'A Y is a Z' need not necessarily imply 'An X is a Z'. The following two experiments aimed to investigate the question of intransitivity, by attempting to find sets of three concepts X, Y and Z, such that both the statements 'An X is a Y' and 'A Y is a Z' were true, but 'An X is a Z' was false. The procedure and results are summarized below. Full details of the materials and analysis can be obtained from the author on request.

## Experiment I

Twenty students acted as unpaid volunteers to complete questionnaire rating forms. In order to demonstrate intransitivity, three levels of concept generality are required, X, Y and Z as described above. For the first experiment, FURNITURE was chosen as the most general concept. At the intermediate level, five concepts—BED, CHAIR (typical kinds of furniture), LAMP, SHELF (atypical kinds) and CASE (a related concept) were selected. These concepts were termed the 'subsets'. For each subset, sixteen examples were generated all of which shared the same general function as the subset term; (for example BED had a list of things one can lie on, SHELF things one can put other things on, etc.). These examples (termed 'objects') were the most specific level of concept, and were generally described by a short, unambiguous and easily imaginable phrase. The objects were selected by the experimenter with the specific aim of demonstrating intransitivity. To avoid response biases they were chosen so that there should be roughly equal numbers of items in the four class intersections—(Y and Z), (Y and not Z), (Not Y and Z), and (Not Y and not Z). Since only one of these (Y and not Z) would provide evidence of intransitivity, the expected level was 25%. The experiment therefore aimed to test the author's intuitions against the opinions of a group of naïve subjects. (Examples were not selected from normative data, partly because such norms do not exist for the level of specific objects, and also because it was intended to demonstrate the existence of the phenomenon rather than to assess its frequency.)

Subjects were presented with a booklet with two sections, each requiring category judgments on the same 7-point scale. The first section elicited object–subset category judgments for the 16 specific object examples in each of the five subsets. Ratings of 1 through 3 were to be used for objects which *were* examples of the subset, and ratings 5 through 7 for objects which were *not* examples. The rating 4 was reserved for borderline decisions. The second half of the booklet obtained judgments of whether all 80 objects belonged to the category FURNITURE, using the same scale. Also included in this list of examples were the five subset names themselves, plus 8 additional items of known membership in the category FURNITURE (Hampton, 1979) which were included as a check on possible bias in the rating responses. The complete list of 93 items was typed in a random order on five sheets, whose order was also randomized for each subject.

## *Results*

The critical result concerned the possible intransitivity of category relations, as indicated by the frequency with which subjects rated an object as a member of a subset, and that subset as a kind of FURNITURE, but rated the orginal object as *not* a member of the category FURNITURE. Ratings 1–3 were counted as 'Yes' responses and 5–7 as 'No' responses. There were very few 4 ratings. Those that occurred were scored conservatively. A *case* can be defined as a triplet of ratings given by a single subject, consisting of object–subset, subset–category and object–category judgments. If only those cases where the subset was rated as FURNITURE are taken, (corresponding to 80% of the data), then the frequencies of the four possible combinations of the remaining two ratings are shown in Table 1. If category judgments are always transitive, then there should have been very few cases where the object was rated as belonging to the subset but not to FURNITURE (the +– response). In fact 22% (287 cases) of responses were of this type—compared to the expected level of 25% intransitivity which was built into the selection of the materials. This percentage was reliably greater than zero both across subsets (Intransitivity, I = 22.4% ± 1.8) and across subjects (I = 23% ± 1.9). A split-half correlation test indicated that except for the subset SHELF, the intransitive responses were not distributed randomly across the objects, but were consistently given to the same set of items. A final analysis examined the question of response bias in the use of the rating scale for the category FURNITURE. Using the 8 control items included in the list of examples, a related t-test revealed that the mean ratings given in the present experiment were significantly lower than those previously obtained ($t = 4.24$, $df = 7$, $p < 0.01$), the mean difference being 0.53. Therefore the subjects were applying a more *generous* criterion of what is furniture, than those in the previous study, thus excluding the possibility that the intransitivity could have been caused by an over narrow concept of furniture. Examples of intransitive items may be found in the Appendix.

## Experiment II

The first experiment demonstrated intransitivity in one category. The second experiment aimed to test the generality of the result for other category materials. The subjects were 22 student volunteers at the City University, London. They were all native speakers of English and naïve as to the purpose of the experiment. Eight categories were chosen for the most general level of concept. Between one and three subsets were chosen for each category to make a total of 14 subsets in all. Between 7 and 11 examples were then chosen for each subset, making a total of 121 'objects' at the most specific level. Exactly the same criteria were applied in the selection of subsets and specific object examples as were used in Experiment 1. The categories and subsets used are shown in Table 2.

Subjects were presented with a booklet with four sections to be completed. The order of sections differed from that used before. The first sec-

Table 1. *Frequency of responses for subsets categorized as Furniture in Experiment 1*

| | Object rating in subset and category | | | | | |
|---|---|---|---|---|---|---|
| Subset | + + | + − | − + | − − | No. of subjects | % intransitive |
| Chair | 154 | 82 | 31 | 53 | 20 | 26 |
| Bed | 133 | 51 | 37 | 82 | 19 | 17 |
| Lamp | 119 | 76 | 45 | 48 | 18 | 26 |
| Shelf | 92 | 48 | 45 | 55 | 15 | 20 |
| Case | 63 | 30 | 25 | 10 | 8 | 23 |
| Total | 561 | 287 | 183 | 248 | | |

Table 2. *Frequency of responses for subsets given a positive subset–category rating for Experiment 2*

| | | Object rating in subset and category | | | | | |
|---|---|---|---|---|---|---|---|
| Subset | Category | + + | + − | − + | − − | No. of subjects | % intransitive |
| Vehicles | Machines | 74 | 60 | 44 | 42 | 22 | 27 |
| Household appliances | Machines | 92 | 22 | 19 | 27 | 16 | 14 |
| Diamonds | Gems | 69 | 22 | 45 | 31 | 21 | 13 |
| Dogs | Pets | 86 | 47 | 52 | 56 | 22 | 20 |
| Birds | Pets | 38 | 33 | 38 | 27 | 17 | 24 |
| Clocks | Furniture | 31 | 30 | 37 | 22 | 15 | 25 |
| Mirrors | Furniture | 26 | 45 | 16 | 33 | 15 | 37 |
| Saws | Tools | 82 | 3 | 76 | 15 | 22 | 2 |
| Drills | Tools | 88 | 11 | 46 | 23 | 21 | 7 |
| Hammers | Tools | 101 | 20 | 37 | 17 | 22 | 11 |
| Knives | Kitchen utensils | 55 | 88 | 25 | 30 | 22 | 44 |
| Fishing | Sport | 45 | 52 | 29 | 63 | 21 | 28 |
| Archery | Sport | 51 | 61 | 48 | 38 | 22 | 31 |
| Vegetables | Plants | 51 | 15 | 5 | 62 | 19 | 11 |
| Total | | 889 | 509 | 517 | 486 | | |

tion consisted of the subset-category pairs, typed in random order, together with 6 control pairs included to provide some negative category stimuli and to provide some control for response bias. Subjects again used a 7-point scale, for their judgments. The scale had positive numbers (+3 to +1) for 'Yes' decisions and negative (−1 to −3) for 'No', with zero as the category boundary. The second section of the booklet contained 14 lists of objects in random order, each list to be categorized with respect to one of the subsets. In the third section, the objects were grouped together under the general category to which the subset belonged, and subjects rated the extent to which each object belonged to the general category. Finally subjects had to repeat the subset–category ratings without looking back at their previous responses. Exactly the same list was presented as in section 1. This procedure provides the subjects with the possibility of changing their minds about a subset belonging to a category, as a result of experience with the 'intransitive' counter-examples.

*Results*

As above, relevant cases were defined as those for which the subset was rated as belonging to its category—in this case in *both* the first *and* last sections of the booklet. Ninety percent of subset–category ratings were of this type. Table 2 shows the frequencies of the other two ratings. There were 509 intransitive cases corresponding to 21.2% of relevant cases. This percentage was reliably greater than zero both across subsets (I = 21% ± 3.2) and across subjects (I = 21.3% ± 0.5). To test the consistency of the intransitive responses, split half correlations were again obtained. For all subsets except VEGETABLES and SAWS, the correlation was significantly positive, indicating that intransitive responses were consistently made to the same items and were not distributed randomly across items. Analysis of the repeated subset–category ratings in the fourth section of the booklet showed no evidence at all that subjects change, or reduce the confidence of their ratings of subsets in general categories as a result of exposure to the counter-examples in the intervening sections. It was noted that the subsets varied considerably in the number of intransitive examples they contained. This variation can partly be attributed to the experimenter's selection of materials, and partly to the adoption by subjects of a very broad criterion for the category of TOOLS, such that most of the examples chosen were rated as belonging to the category. The intransitive items are shown in the Appendix.

## Discussion

The apparently paradoxical result of these experimental demonstrations was that subjects affirmed the truth of category statements, while at the same time agreeing that counter-examples to such statements existed. The interpretation offered is that when verifying a category statement, subjects interpret 'true' to mean 'generally speaking, typically true'. In other words they use prototype information to make their judgment, and as a result do not consider whether the category statements are true universally. Even when shown counter-examples, subjects did not change the truth of the categorization. Nor was intransitivity found only in atypical subsets of the categories; subsets such as CHAIR and BED are among the most typical kinds of FURNITURE. Before discussing the implications of the results, there is an important alternative account that must be considered.

*Polysemy and Metaphor*

The result might be explicable in terms of the subset names having more than one meaning or sense. Thus, for example, one could say that a car headlamp is an example of $LAMP_1$, whereas it is $LAMP_2$ which is an example of FURNITURE. A similar argument would claim that the use of SHELF, for instance, to name a rocky ledge is metaphorical, and should not therefore be expected to conform to a transitive logical framework. The problem is a crucial one, in that for some of the items, there does appear to be some intuitive force to these explanations. The polysemous and metaphorical items can however be differentiated from intransitivity owing to concept fuzziness, by considering those responses that were *not* intransitive. If a subset is ambiguous, or if it is being used metaphorically, then those subjects who did not respond intransitively, should be those who maintained a consistent sense for the subset term. These subjects should therefore reject the object as a member of both subset and category (a(– –) response). Both the alternative accounts of intransitivity therefore predict that where neither a very small nor a very large proportion of the subjects responded intransitively, the remaining responses should reject the object as a member of the subset. In concrete terms, a car headlamp would not be classed as a LAMP, nor a rocky ledge as a SHELF. The response distributions can be used to test this prediction.

The 44 objects from both experiments with between 25% and 75% intransitive responses were selected for testing. The distribution of responses for these objects was (++)232, (+–)379, (–+)23, (– –)230. Thus there were equal numbers of (++) and (– –) responses, suggesting that no more than half the items could be accounted for in terms of polysemy or metaphor. The distribution of responses across items was strongly bimodal, with most items having either (++) responses or (– –) responses but not both. (The distribution differed significantly from a flat distribution, chi square $(4) = 15.4$, $p < 0.01$). Thus there were two distinct types of intransitive case, those just included in the subset (and so having (– –) responses as well as

(+−)), and those just excluded from the category (and so having (++) responses in addition to (+−)). The second type of case cannot be accounted for in terms of polysemy or metaphor. As a final check on the data, the split-half correlation test for the randomness of the intransitive responses was repeated, excluding any items that could be explained as polysemous or metaphorical (as defined above). Correlations were just as high as in the first analysis, although for 5 subsets in Experiment 2 there were not enough items for the analysis to be performed. Repeating the test with a 50% rather than a 25% lower criterion still produced nearly equal numbers of (++) and (− −) responses.

## *Implications for models of semantic memory*

The most immediate implication of the results is that hierarchical models of semantic memory, which rely on the assumption that category statements are equivalent to universally affirmative class-inclusion propositions, are untenable in any general form. It appears instead that category statements represent *generic* information having the same logical status as property statements. Thus, the subjects were not behaving illogically or inconsistently. No doubt, if asked to say whether *all* chairs are furniture, and given the various counter-examples, most subjects would say No. What has been demonstrated is that even for the most typical members of a category, the implicit quantifier in an unquantified category statement is not 'All' but 'Typically'. If this is the case, then there are implications to be drawn for how people normally operate with concepts, and for semantic memory theory in general. Although the results are inconsistent with both Collins and Quillian's (1969) network model and Smith *et al.*'s (1974) characteristic feature model, there are ways in which both approaches may be modifiable to allow for intransitivity.

## *Network models*

A model could be devised such that inferences drawn from the network are subject to certain constraints. Following the work of Oden (1977) and Zadeh (1965), we could specify that each link has a particular associative strength, and that an inference is only valid if the product of strengths along a pathway through the network is greater than some criterion. In this way the combination of two weak but positive links could result in a negative result. Although worthy of consideration this approach seems fraught with problems. Osherson and Smith (1981) have recently pointed out a series of inconsistencies in the application of Zadeh's fuzzy set theory to verbal concepts and their combinations. In addition the suggestion would predict that typicality must always decrease as the superordinate term moves up the network. There is no evidence for this prediction.

### *Featural models*

Category intransitivity is predicted by prototype models of category structure (Hampton, 1979, 1981; McCloskey and Glucksberg, 1978, 1979; Rosch, 1975, 1977). The crucial point is that subjects do not apparently consider counter-examples as disconfirming the truth of unquantified category statements. This result implies that such statements rely for their verification on the similarity of descriptive meaning of the two concepts (their intensional meaning) rather than on the inclusion of one class of things within another class (the extensional aspect of concepts). An example will illustrate this point. Suppose that *chairs* and *furniture* share a particular set of features (for example 'has legs' and 'is found in homes'). This set of shared features, F1, carries sufficient weight to 'make' chairs furniture. Similarly *car-seats* and *chairs* may share another set of features, F2 (for example 'has a back' and 'is sat upon') which constitute enough overlap for car-seats to be called chairs. However if the sets F1 and F2 do not themselves overlap sufficiently, it is possible that *car-seats* would not be considered to be *furniture*.

The feature approach has been criticized for lacking an explicit formulation of the fuzzy nature of concept definitions. Osherson and Smith (1981) showed that attempts to use Zadeh's (1965) fuzzy set logic as a basis of prototype theories yield many inconsistencies. Kempton (1978) also concluded that fuzzy set theory did not accord with his data on the classification of utensils. There is therefore a need to formulate the logic of verbal concepts in a new and satisfactory way. The phenomenon of intransitivity gives added support to the need for such a formulation, that will capture the fuzziness and polymorphous nature of concepts.

## References

Anderson, J. R. and Bower, G. H. (1973) *Human Associative Memory*. Washington, DC, Winston.

Ashcraft, M. H. (1976) Priming and property dominance effects in semantic memory. *Mem. Cog., 4*, 490–500.

Collins, A. M. and Loftus, E. F. (1975) A spreading activation theory of semantic processing. *Psychol. Rev., 82*, 407–428.

Collins, A. M. and Quillian, M. R. (1969) Retrieval time from semantic memory. *J. verb. Learn. verb. Behav., 8*, 240–248.

Collins, A. M. and Quillian, M. R. (1972) How to make a language user. Pp. 309–351 in E. Tulving and W. Donaldson (eds.), *Organisation of Memory.* New York, Academic Press.

Glass, A. L. and Holyoak, K. J. (1975) Alternative conceptions of semantic memory. *Cog., 3(4)*, 313–339.

Hampton, J. A. (1976) An experimental study of concepts in language. Unpublished Ph.D. thesis. University of London.

Hampton, J. A. (1979) Polymorphous concepts in semantic memory. *J. verb. Learn. verb. Behav., 18*, 441–461.

Hampton, J. A. (1981) An investigation of the nature of abstract concepts. *Mem. Cog., 9*, 149–156.

Kempton, W. (1978) Category grading and taxonomic relations: A mug is a sort of a cup. *Amer. Ethnol., 5*, 44–55.

McCloskey, M. E. and Glucksberg, S. (1978) Natural Categories: Well defined or fuzzy sets? *Mem. Cog., 6*, 462–472.

McCloskey, M. E. and Glucksberg, S. (1979) Decision processes in verifying category membership statements: Implications for models of semantic memory. *Cog. Psychol., 11*, 1–37.

Oden, G. C. (1977) Integration of fuzzy logical information. *J. exper. Psychol.: Hum. Percep. Perf., 3*, 565–575.

Osherson, D. N. and Smith, E. E. (1981) On the adequacy of prototype theory as a theory of concepts. *Cog., 9*, 35–58.

Randall, R. A. (1976) How tall is a taxonomic tree? Some evidence for dwarfism. *Amer. Ethnol., 3*, 543–553.

Rosch, E. (1975) Cognitive representations of semantic categories. *J. exper. Psychol.: Gen., 104*, 192–233.

Rosch, E. (1977) Human categorisation. In N. Warren (ed.), *Advances in Cross-cultural Psychology (Vol. 1).* London, Academic Press.

Rosch, E. and Mervis, C. B. (1975) Family resemblances: Studies in the internal structure of categories. *Cog. Psychol., 7*, 573–605.

Schaeffer, B. and Wallace, R. (1970) The comparison of word meanings. *J. exper. Psychol., 86*, 144–152.

Smith, E. E. (1978) Theories of semantic memory. In W. K. Estes (ed.), *Handbook of Learning and Cognitive Processes (Vol. 5).* Hillsdale, NJ, Lawrence Erlbaum.

Smith, E. E., Shoben, E. J. and Rips, L. J. (1974) Structure and process in semantic memory: A featural model for semantic decisions. *Psychol. Rev., 81*, 214–241.

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


## Appendix

Materials and response frequencies for both Experiments, for positive subset–category ratings. Objects are ranked by the frequency of intransitive responses shown in the first column (+ –). N refers to the number of subjects rating the subset as belonging to the category. Only objects with at least 20% intransitivity are listed. (The subset CASE of FURNITURE is not listed, since only 8 out of 20 subjects judged it to be a kind of furniture.)

## *Experiment I*

| *Subset* | *N* | *Object* | *Response frequencies (subset, category)* + – | + + | – + | – – |
|---|---|---|---|---|---|---|
| Category = Furniture | | | | | | |
| CHAIR | 20 | A chair lift for skiers | 13 | 3 | 0 | 4 |
| | | A sedan chair | 11 | 7 | 1 | 1 |
| | | A car seat | 10 | 8 | 1 | 1 |
| | | A tree stump in a forest clearing | 9 | 2 | 0 | 9 |
| | | A grassy river bank | 7 | 0 | 0 | 13 |
| | | A deck-chair in a garden | 7 | 13 | 0 | 0 |
| | | A shooting stick | 7 | 5 | 2 | 6 |
| | | The steps of a church | 6 | 1 | 1 | 12 |
| | | A church pew | 5 | 13 | 2 | 0 |
| | | A garden swing | 4 | 8 | 1 | 7 |
| BED | 19 | A bird's nest | 9 | 1 | 0 | 9 |
| | | A park bench | 7 | 4 | 2 | 6 |
| | | A hammock | 6 | 12 | 1 | 0 |
| | | A bathing raft in the sea | 6 | 3 | 0 | 10 |
| | | The deck of a ship | 5 | 1 | 2 | 11 |
| | | A mattress on the floor, with blanket | 4 | 13 | 1 | 1 |
| | | A coffin in a grave | 4 | 1 | 0 | 14 |
| | | A dog's kennel | 4 | 4 | 1 | 10 |
| LAMP | 18 | A torch on a miner's helmet | 15 | 2 | 0 | 1 |
| | | A car headlight | 15 | 1 | 0 | 2 |
| | | Sodium electric street light | 14 | 3 | 0 | 1 |
| | | Aladdin's oil lamp | 7 | 10 | 1 | 0 |
| | | The sun | 7 | 0 | 0 | 11 |
| | | A Victorian glass oil lamp | 4 | 14 | 0 | 0 |
| | | Strip fluorescent office lighting | 4 | 8 | 3 | 3 |
| SHELF | 15 | Luggage rack in a railway carriage | 10 | 3 | 0 | 2 |
| | | Rocky ledge on a cliff-face | 10 | 0 | 1 | 4 |
| | | Windowsill inside a room | 4 | 8 | 0 | 3 |
| | | Window-ledge outside | 4 | 4 | 0 | 7 |
| | | Wooden cover on central-heating radiator | 4 | 10 | 0 | 1 |
| | | The stage of a theatre | 3 | 0 | 2 | 10 |
| | | Working-top kitchen counter | 3 | 8 | 4 | 0 |
| | | The back of an open lorry | 3 | 0 | 0 | 12 |
| | | Mantelpiece over a fire-place | 3 | 12 | 0 | 0 |

*Experiment II*

| *Subset* | *N* | *Object* | *Response frequencies* + – | ++ | – + | – – |
|---|---|---|---|---|---|---|
| Category = Machines | | | | | | |
| VEHICLES | 22 | A canoe | 16 | 1 | 0 | 5 |
| | | A raft | 14 | 0 | 0 | 8 |
| | | A baby's pram | 11 | 10 | 0 | 1 |
| | | A surf-board | 8 | 0 | 0 | 14 |
| | | A sailing boat | 7 | 10 | 1 | 4 |
| HOUSEHOLD APPLIANCES | 16 | A broom | 12 | 1 | 0 | 3 |
| | | A paraffin stove | 5 | 11 | 0 | 0 |
| Category = Gems | | | | | | |
| DIAMONDS | 21 | Industrial diamond in a tool | 10 | 11 | 0 | 0 |
| | | Diamond hi-fi stylus | 9 | 11 | 0 | 1 |
| Category = Kitchen Utensils | | | | | | |
| KNIVES | 22 | Stilletto flick-knife | 22 | 0 | 0 | 0 |
| | | Pen-knife | 20 | 1 | 0 | 1 |
| | | Sword blade | 19 | 0 | 0 | 3 |
| | | Rifle bayonet | 16 | 0 | 0 | 6 |
| | | Ivory-handled fish knife | 7 | 15 | 0 | 0 |
| Category = Tools | | | | | | |
| DRILLS | 21 | Derrick for an oil well | 5 | 13 | 3 | 0 |
| HAMMERS | 22 | Chime-striker on a clock | 13 | 2 | 1 | 6 |
| | | Clapper in a church bell | 6 | 5 | 0 | 11 |
| SAWS | 22 | – | | | | |
| Category = Sports | | | | | | |
| FISHING | 21 | Catching herring in a trawler | 21 | 0 | 0 | 0 |
| | | Hunting whales with a harpoon | 12 | 2 | 0 | 7 |
| | | Growing fish in a hatchery | 8 | 0 | 0 | 13 |
| | | Catching lobsters in pots | 8 | 3 | 0 | 10 |
| ARCHERY | 22 | Bowmen at the battle of Agincourt | 21 | 0 | 0 | 1 |
| | | Robin Hood shooting a message | 20 | 1 | 0 | 1 |
| | | William Tell shooting the apple | 13 | 7 | 1 | 1 |
| | | Hunting deer with bow and arrow | 5 | 15 | 1 | 1 |

| *Subset* | *N* | *Object* | *Response frequencies* + – | ++ | – + | – – |
|---|---|---|---|---|---|---|
| Category = Plants | | | | | | |
| VEGETABLES | 19 | A grain of rice | 7 | 3 | 3 | 6 |
| | | A potato | 4 | 15 | 0 | 0 |
| Category = Pets | | | | | | |
| DOGS | 22 | A jackal | 14 | 0 | 0 | 8 |
| | | A husky in a sled team | 12 | 10 | 0 | 0 |
| | | A wolf | 11 | 0 | 0 | 11 |
| | | An alsatian guard-dog | 7 | 15 | 0 | 0 |
| BIRDS | 17 | A vulture | 17 | 0 | 0 | 0 |
| | | An eagle | 14 | 3 | 0 | 0 |
| Category = Furniture | | | | | | |
| CLOCKS | 15 | Big Ben | 14 | 0 | 0 | 1 |
| | | A wrist watch | 12 | 0 | 1 | 2 |
| | | A gas-meter | 3 | 1 | 1 | 10 |
| MIRRORS | 15 | Wing mirror on a car | 15 | 0 | 0 | 0 |
| | | Ladies make-up mirror | 14 | 1 | 0 | 0 |
| | | Bathroom mirror | 7 | 8 | 0 | 0 |
| | | Polished tile foor | 4 | 0 | 3 | 8 |

***Résumé***

**Deux expériences montrent l'intransitivité dans les jugements sur les catégories. L'idée répandue que les relations entre des ensembles se référant à des catégories est une relation d'inclusion de classe est remise en cause. Les sujets acceptent régulièrement la vérité de certaines propositions sur les catégories malgré leur conscience de l'existence de contre-exemples. On discute les implications pour une théorie de la mémoire sémantique.**