Typicality and Basic Level: No Constraints on the Basic Level Category Advantage

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Abstract*. In the studies of categorization it was assumed that two important effects – typicality and basic level – are connected in such a way that typical members are recognized at the basic level and atypical members are recognized at the subordinate levels. The results of two experiments described in the paper show that the pattern of interaction between typicality and basic level effect is more complex than it was supposed before. It is proposed to explain the effects in terms of activation of correspondent concept in the conceptual system of a person that makes NN the most plausible alternative for semantic memory modelling.*

Key words: semantic memory, categorization, typicality, basic level.

1. INTRODUCTION

To achieve psychological validity of models of long-term (semantic) memory it is necessary to take into account all effects that exist in real-life situation. One of the well-known effects is the difference in typicality of various category members. The concept of typicality became very influential in cognitive psychology. It is assumed that the most typical exemplars of the category play a special cognitive role in human categorization: typicality gradient of category members is a good predictor of categorization time; typical members are usually mentioned first when subjects are asked to list the members of a category; when subjects are asked to sketch the exemplars of a category they choose the most typical member; children learn the most typical members of the category first; typical members serve as cognitive reference points; typical members of a category have the most attributes in common with all the other members of the category, etc. Any concept is considered as built around some prototype.

The notion of basic level describes similar mechanism in the hierarchical structure of concepts (Rosch, Mervis, Gray, Johnson, Boyes-Braem,1976). It is assumed that basic level is cognitively privileged level of abstraction: it has the maximal cue validity, it is the most inclusive level at which the objects of a category possess numbers of attributes in common, members of a basic level category possess similar overall shapes, it is the most general level at which an averaged shape of an object may be correctly identified as that object, categorization starts from the basic level, etc.

A theory explaining what brain mechanisms work when typicality or basic level effects are revealed would be a part of foundation for semantic memory models. However, to build such a theory we need a clear picture of what is going on. Till now it was also assumed that there is a connection between these two effects - typicality and 'basiclevelness'. At least three studies showed that highly typical members of category are recognized faster and named more frequently at the basic level while the atypical members are recognized faster and named more often at the subordinate level (Hoffman, 1982; Jolicoeur, Gluck,&Kosslyn, 1984; and Murphy&Brownell, 1985). This satisfactory situation makes the theory of prototype and basic level quite reasonable. However, it has many assumptions. The first one is that all highly typical members of a category have the majority of category characteristic features. That was indeed the case in Rosch's study (Rosch,1973; Rosch,1975; Rosch&Mervis, 1975). For example, a typical bird was small worm-eater that flies, sings, makes nests, etc. But not in all the ratings such birds occupy the first rows of the typicality lists. For example, in Bulgarian data (Корнажева, 1981) among very typical birds you can find *stork* and *eagle*. According to previous findings these birds should be named as birds, not with their subordinate names. The reaction time in picture verification task should be also smaller for "*bird*" than for "*stork*" or "*eagle*". At the same time these two birds are quite different from other typical birds (*sparrow, nightingale, robin, …*) and have not so many properties in common with other category members. That's why they may be differentiated at the subordinate level.

To check whether it is possible that highly typical members of a category may be recognized at their subordinate level while some atypical members still show basic level effect was the aim of present study. The idea was to obtain sufficiently long ratings of typicality for some categories and to check whether *all* typical members are recognized at basic level and *all* atypical members are recognized at the subordinate level. If this is so, the notion of typicality may be still considered as universal because the prediction of the theory is satisfied. Otherwise the idea of family resemblance that lies in the basis of typicality theory should be questioned.

2. EXPERIMENTS

In order to check the predictions of prototype theory two experiments were performed: picture verification task and free naming task. In picture verification task a subject is shown a picture followed by a word. His/her task is to determine as fast as possible whether the word names the picture correctly or not. The reaction time is measured and the shortest reaction time is taken as the indicator of

"basiclevelness". In free naming task a subject is shown a picture of an object. His/her task is to name the picture with the first word that comes to mind answering the question "What is it?" The level mostly frequently named is considered as basic. These two tasks were taken to make the results comparable with those of Murphy&Brownell and Jolicouer et al.

Stimuli. The procedure of stimuli selection was the following. At first production frequency was measured for 17 semantic categories. This was done because there were no previous studies on typicality in Belarus and the list of category members arbitrary produced by the experimenter or somebody else may not include highly typical and highly atypical items. It is known, however, that production frequency is highly correlated with typicality (typical members are usually mentioned first when subjects are asked to list the members of a category), that's why we may assume that more frequent members will be more typical. The data received on 103 subjects (61 females and 42 males) were reliable: mean reliability (correlation between two random halves of the sample) = 0,94 and gender reliability (correlation between male and female data) = 0,92 (Радчикова, 2002). That is quite similar to the results of Battig&Montague (1969) and analogical Russian study (Высоков и Люсин, 1997).

Then for all the category members mentioned by subjects typicality rating was obtained. Every item was rated by 70 subjects. Again the data were reliable (mean internal reliability = 0,94). However, the correlation with production frequency wasn't so high (mean Spearman's rho=0,69 varying from 0,44 to 0,86). This fact shows us that production frequency may not be so strongly associated with typicality (Радчыкава, 2003).

Then for three categories (*tree, bird and flower*) highly typical and highly atypical exemplars were determined: members of a category that constitute the upper quartile of typicality distribution were considered as highly typical, members of a category that constitute the lower quartile of typicality distribution were considered as highly atypical. These three categories were chosen because they were frequently used in similar experiments and because it was sufficiently easy to find naturalistic paintings or photographs for their members. Ten members of each category were chosen for the experiments – half of them typical and half of them atypical.

Picture verification task and free naming task were performed with the same set of stimuli.

2.1. FREE NAMING TASK

Procedure. Thirty chosen objects were printed on a colour printer. All of them have the same size 8,5x8,5 cm. Each picture was posted on a separate sheet of white paper 21x15 cm. Three random orders of pictures were prepared for the experiment.

Twenty nine subjects took part in free naming task. All of them were students of psychological department. Subjects were tested separately. They were asked to name the pictures with the first word that comes to their mind answering the question "What is it?" The results were written by the experimenter on a specially prepared answering sheet.

Results and Discussion. For each object the number of superordinate, basic and subordinate terms were counted. Only correct answers were taken into account. As it was expected very few superordinate names were used. For some category members the results similar to those of Murphy&Brownell and Jolicoeur et al. were obtained. However, for the other stimuli the results were opposite to those of Murphy&Brownell and Jolicoeur et al. One can see the pattern of subjects' answers in the following table:

Table

Number and percent of objects' names at different levels of abstraction for typical (*ель, ласточка, ромашка, колокольчик, ландыш, орел, сосна, скворец, береза, роза, синица*) and atypical (*апельсин, тукан, клест, бук, зимородок, секвойя, флоксы, поползень, тис, петуния*) members (χ^2=356,5; p<0,00001)

	Level of abstraction	
	basic	subordinate
Typical members	**19** 6,64%	**267** 93,36%
Atypical members	**197** 90,78%	**20** 9,22%

These results could be interpreted as the fact that it is possible to find the typical members that are recognized and named first at subordinate level and it is possible to find such atypical members that are recognized as the members of their basic category. These results are not in contradiction with the results of Jolicoeur et al. because they chose their stimuli material in order to find atypical examples that are recognized at the subordinate level. They took a small number of examples of every category (three typical and three atypical members). The data received in our experiment provide the evidence that for Belarusan sample population it is also possible to find atypical category members that are recognized at the subordinate level and typical category members that are recognized at the basic level. Therefore it may be concluded that typicality effect is not connected with the basic level effect. Very typical (e.g., *swallow*) as well as very atypical members of a category may show basic level effect. This effect could not be explained by the perceptual characteristics of the objects because swallow does not possess highly differentiated features but toucan does – it has extremely big beak and this feature does not prevent it to be a basic level bird.

The results received showed that the relation between "basiclevelness" and typicality has more complicated pattern than it was supposed earlier. Typicality may be influenced by the frequency of word or object using or by subjects' expertise in the domain, etc.

To check the validity of the obtained results another experiment was performed (i.e., another operational definition was used).

2.2.PICTURE VERIFICATION TASK

Procedure. Fourteen subjects (that did not take part in previous experiment) performed picture verification task.

First, the subjects were presented with the instruction. They were told that they will see a word on the screen of computer after which a picture appears. If they think that the picture is named correctly they are to press the button "YES" on the keyboard. If they think that the word does not name the picture correctly they are to press the button "NO" on the keyboard. The subjects are instructed to keep their index finger of a dominant hand in the middle of the keyboard and use this finger for answers. After the performing the trial they should return the finger in the middle position. The participants are also instructed to do the task as fast as they can and as precise as possible because for the experiment the accuracy and the speed are *both* very important.

Trials are presented through SuperLab Pro (Version 2.01 for Windows). Each trial is preceded by a short (250 ms) "ready" signal – a "+" in the middle of the screen. Then a word appears in the middle of the screen and remains there for a 2000 ms. Immediately following the word the picture is presented and remains on the screen until any appropriate key ("YES" or "NO" button) is pressed. Response time is recorded from the moment of picture presentation till one of the keys ("yes" or "no") is pressed. The responses are stored with the response labels.

The subjects were tested individually in the laboratory of experimental psychology. At first they were presented with the instruction followed by eight practice trials. Then they had the experiment, which consisted of 130 trials. Five practice trials included the names of the objects at different levels of abstraction: superordinate (*animal*), basic (*ship, butterfly*) and subordinate (*salmon*). The words were followed by the picture that may or may not correspond to the name. None of the objects from practice trials appeared later in the test trials. The word-picture pairs were presented at random order and the number of true trials was equal to the number of false trials.

Results and discussion. Only correct responses for the true trials were used for statistical analysis. The items with response time that exceeds the mean three times or more standard deviation were excluded from the analysis. To compare mean reaction time for typical and atypical category members at three levels of abstraction two-way ANOVA (analysis of variance) was used. All calculations were done with help of STATISTICA 5.5 for Windows.

For some stimuli two operational definitions did not converge: for example, the object was named with its subordinate name, but verified faster at the basic level. However, for 22 items (73%) two operational definitions converged. Again, there were typical members that were identified faster at the basic level and atypical members that were identified fastest at the subordinate level. But for 18 stimuli another pattern was obtained as it is shown in Fig. 1.

It is evident that there exist some atypical members of a category that are recognized first and named at the basic level. At the same time there are highly typical members that are named at their subordinate level and are recognized at the subordinate level as fast as at the basic level. This fact reveals more complex pattern of interaction between typicality and "basiclevelness" than it was initially supposed. It seems that basic level effect does not depend on typicality of the object and hardly could be explained by differentiation hypothesis or family resemblance hypothesis.

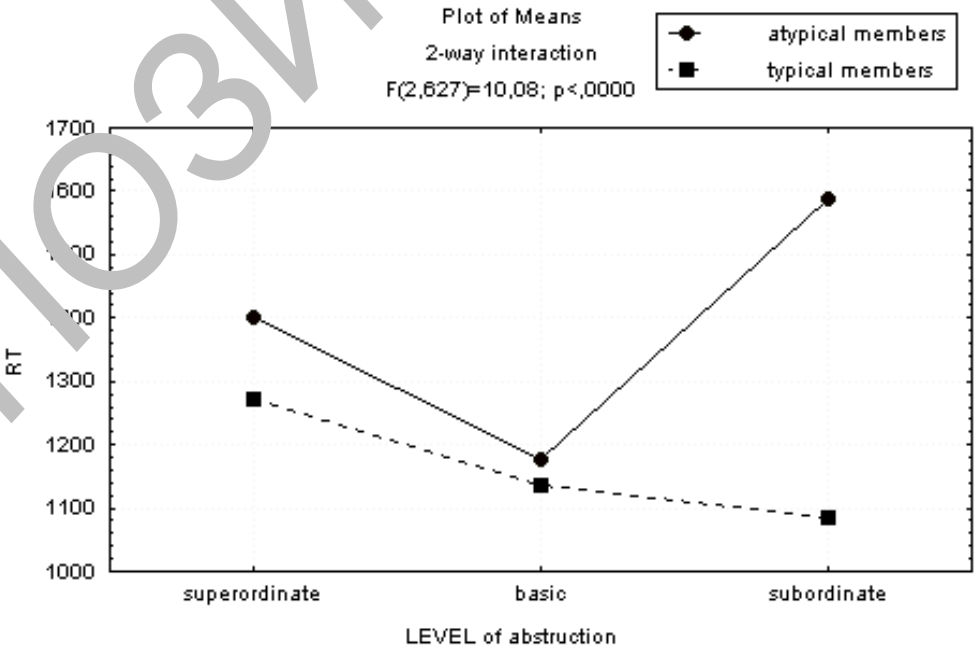

Fig. 1. Mean reaction time for typical and atypical category members at three level of abstraction

3. GENERAL DISCUSSION

One way to explain this complex pattern of interaction between basic level and typicality effects is to assume that one cognitive mechanism works in both cases. Taking into account horizontal structure (i.e., how a concept is organized) or taking into account vertical structure (i.e., how a hierarchical set of concepts are organized) we may assume that some categories (or their members) are cognitively privileged due to higher activation of the corresponding concepts in the conceptual system of an individual. Therefore, everything that may influence the activation of the concept may also lead to various changes in the typicality and basic level effect. Very differentiated items may be highly activated because of their distinctiveness; recency, frequency and context may also play a substantial role (Barsalou, 1987), etc.

If we accept this position we should assume that category structure exists independently of activation patterns. That means that a person who claims that robin is the most typical bird also knows that an ostrich is a bird too. And a person who names a running barking object in the street as a dog knows very well that it is also a mammal and an animal. Typicality and basic level effects reveal only the speed of semantic memory search where the most activated concepts pop up with the least reaction time. It seems that this assumption makes connectionist models the most plausible alternative for semantic memory representation.

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