# The Dynamics of Basic Level in the Structures of Human Semantic Memory

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***Abstract*****:** *In the article a new explanation of basic level effect is presented. This explanation is given in terms of activation of particular concept in human semantic memory. In order to check the predictions of the proposed explanation the experiment was done. The main idea of the experiment was to give additional activation to the concepts that were not strongly activated before and to check whether they could show basic level effect in these new conditions. Experimental data could be interpreted as the evidence in support of the suggested explanation of basic level effect.*

*Key words*: semantic memory, categorisation, basic level.

## 1. INTRODUCTION TO THE PROBLEM

People usually name objects they see at one particular level of abstraction. For example, they say "*It's a chair", "It's a dog"*, but very rarely "*It's furniture", "It's a fox-terrier*". The categories that belong to this special level of abstraction are usually refereed to as basic level categories. The categories of higher level of abstraction are sometimes called superordinate categories, and the categories of lower level of abstraction are called subordinate categories.

In present study our goal will be to compare the explanations of basic level effect given by two well-known theories of categorisation: prototype and basic level theory and classical (Aristotelian) theory.

From the point of view of prototype and basic-level theory *basic level is a very special level that plays important cognitive function*. The theory states that "… there is generally one level of abstraction at which the most basic category cuts can be made. In general, the basic level of abstraction in a taxonomy is the level at which categories carry the most information, possess the highest cue validity, and are, thus, the most differentiated from one another." (Rosch, Mervis, Gray, Johnson, &Boyes-Braem, 1976: 383).

Besides, the basic level categories possess some remarkable properties that could be taken as the operational definitions: members of a basic level category possess similar overall shapes; the basic level is the level of the most inclusive categories at which consistent motor programs are employed for all objects of a class; the basic level may be the most abstract level at which it is possible to have a relatively concrete image, etc.

From the very beginning of basic level studies a special attention was paid to the role of perception and motor interaction with the world in selecting a special level of abstraction in a taxonomic hierarchy. Basic level was claimed to be "functionally and epistemologically primary with respect to the following factors: gestalt perception, image formation, motor movements" (Lakoff, 1987:13). "What determines basic-level structure is a matter of correlation: the overall perceived part-whole structure of an object correlates with our motor interaction with that object and with the functions of the parts (and our knowledge of those functions). It is important to realise that these are not purely objective and "in the world"; rather they have to do with the world as we interact with it: as we perceive it, image it, affect it with our bodies, and gain knowledge about it" (Lakoff, 1987: 50). In such a way, sensory-motor activity plays a crucial role in the determination of basic level, and, therefore, in the whole process of the formation of categories.

Now let us turn to the explanation of basic level effect given by another popular theory of categorisation - classical (Aristotelian) one. Within classical approach we could think about basic level as about the level of categories to which we have only psychological preference that has nothing in common with the very process of categorisation. If the situation changes, the "basic level" also changes, but the division of the categories remains the same. Basic level effect could be seen as an effect revealing the mechanism responsible for instructiveness rather than categorisation. Basic level effect is an effect ***on*** the system of categories. That's why it should be explained from the prospect of how we use categories rather than how we form categories.

For example, Jolicoeur proposed the notion of "entry point level" - "one particular level at which contact is made first with semantic memory" (Jolicoeur, Gluck, &Kosslyn, 1984: 272). In some cases "entry point level" coincides with so called basic level identified by Rosch et al. (1976), for example, in the case of typical birds. In some other cases "entry point level" is different (like, for example, in case of some atypical birds).

Repeko (1998) proposed to use the notion of "bookmark" for explanation of basic level effect. According to him the categories that show basic level effects are "bookmarks" in our conceptual system. A "bookmark" is a special mechanism that is applied to the semantic memory. It provides a primary access to the "marked" concept within the memory. This mechanism was called "bookmark" by analogy with the real bookmark we could put in a book in order to facilitate access to the important or frequently used information.

As a mechanism operating on semantic memory "bookmarks" could facilitate the search of important information that could be crucial in "real-time" conditions of our life. The mechanism of "bookmarks" is dynamic and is bound to a particular level in the categorical structure, i.e., every concept could be "marked". What was taken for the unique and cognitively privileged "basic level" is only a temporary "bookmark" that could be relatively easy shifted or added.

"Bookmarks" as well as the "entry points" are mechanisms that are independent of the process of categorical division, they can work both on scientific and folk taxonomies. The number of used "bookmarks" is not restricted by any rules as well as their amount in one taxonomic chain. With the increase of importance of certain information it would tend to be "marked" for easier access (i.e., it will show basic level effect). This could be gained by the increase in expertise or by the explicit or implicit stress on the importance of information (for example, explicit claim that information is vitally important or impressive style that would convey implicit stress). The growth of expertise would result in a growth of necessity for faster access to more detailed information, i.e., to the shift of basic level effect to subordinate levels, while the growth of ignorance would make detailed information unnecessary and, thus, shift basic level effect to the superordinate levels.

In such a way, the taxonomic structure of the conceptual system as well as categorisation mechanism is claimed to be independent from the process that is responsible for 'basiclevelness' of a category. "Basiclevelness" could be explained as a certain mechanism that temporary facilitates access to a certain place in the semantic memory. It could be seen as an effect of long-term activation of necessary information having nothing in common with the ways how this information was got.

From this hypothesis it is possible to derive consequences that could be tested experimentally:

- Any concept can be strongly activated, therefore, ***any*** category can show basic level effect under certain conditions.
- Categories from different levels of abstraction may show basic level effect simultaneously even if one of them is genus and the other is species. Indeed, nothing prevents the concepts that correspond to such categories to be both highly activated.
- Basic level could be **easily** shifted or added because the mechanism of activation needs to be quick and efficient to serve for the adaptation purposes of cognitive being.

These consequences are in contradiction with the theory of prototype and basic level as it is presented, for example, in Rosch et al. (1976), Rosch (1978), and Lakoff (1987). Following the theory of prototype and basic level we have to accept that there is only one level of abstraction in the hierarchy of categories that is basic. Basic level can not be easily added or shifted (and it also cannot be context dependent) since it is characterised by the maximum amount of features that could be attributed to any member of a category. For any level of abstractness that is higher or lower than basic level the amount of attributes common for the members of a category is much less. Basic level cuts are made at "natural discontinuities" (Rosch, 1978: 31) in the world and it is not in human power to shift or redistribute the natural discontinuities. "Human knowledge cannot provide correlational structure where there is none" (Rosch et al., 1976: 430).

For example, if a *table* is a basic level category, it possesses many attributes common for all tables, while about *kitchen table* could be said very little new if we subtract the attributes common for all tables. According to basic level theory the category of *kitchen table* can not happen to be basic because it simply does not possess the sufficient amount of newly occurred attributes. Consequently, any learning about kitchen tables and different features of kitchen tables can not lead to the shift of basic level to this subordinate level.

The prediction of prototype and basic level theory would be that learning some facts about kitchen tables or some properties of kitchen tables will not shift/add the category of kitchen tables to the basic level. On the contrary, if we assume that basic level effect is only the result of activation distribution it could be easily shifted and/or acquired.

In this work we are going to check whether any category could show basic level effect under certain conditions, whether categories from different levels of abstraction may show basic level effect simultaneously even if one of them is genus and the other is species and whether basic level could be **easily** shifted or added because the mechanism of activation needs to be quick and efficient to serve for the adaptation purposes of cognitive being.

The general idea of the experiment is to try to shift or add the categories that are at the subordinate level to the basic level, i.e., to show that under some conditions the categories that did not show basic level effect before could show it now. If this is possible, then basic level effect does not play any role in the process of categorisation but is a "measure of performance" (Gosselin&Schyns, 1997) - an effect that is unstable and could be easily manipulated.

As the indicator of basic level categories the shortest response time in picture verification task was chosen. In picture verification task the subjects are presented with a word and then with a picture. The task is to decide whether the word is a correct name for the picture.

If basic level effect is connected with the processes of activation it could be sufficiently easy shifted or added by the performing any task that requires deep semantic processing. Memory task was chosen as an appropriate one. Participants are to read and retell the story of previously not very well known to them object. This will activate the concept of the object in question at the level lower than it was before the task completion. This will add/shift a subordinate category to the basic level, i.e., the subordinate category will show basic level effect after additional activation.

From the point of view of prototype and basic level theory, however, it is not so easy to add/shift a category from the subordinate level to basic. It is because "(1) in the received world, information-rich bundles of perceptual and functional attributes occur that form natural discontinuities, and that (2) basic cuts in categorisation are made in these discontinuities" (Rosch, 1978: 31). Since basic-level categories are **already** categories "that best mirror the correlational structure of the environment" (Rosch, 1978: 31) it is difficult to explain what could cause the changes in distribution of basic level categories. It seems impossible to manipulate the correlational structure of the environment while to manipulate the activation of concepts in the conceptual system of an individual is easy and non-problematic.

## 2. EXPERIMENT

***Method.***

The experiment was modified after Rosch et al. (1976) object recognition task, Murphy&Brownell (1985), and Johnson&Mervis (1997) category verification task. In these experiments the participants were presented with a word and a picture. They were to answer whether the word names the picture correctly. The words were chosen at different levels of abstraction. Within-subject modification of this experiment was used. If basic level effect is only an effect of activation it could be shifted by the task that requires deep semantic processing. In other words, the category that did not show the basic level effect before may show it after additional activation. Our task is to see whether this will happen after the memory task - reading and retelling of the story about a particular object.

***Participants.***

The participants were 32 students from New Bulgarian University (Sofia, Bulgaria). All of them were native Bulgarian speakers. The subjects were paid for participation in this experiment.

***Materials.***

Colour pictures (naturalistic paintings or photographs) of different objects were digitised, edited, and presented on a colour high-resolution monitor. All pictures were presented against a white background in the middle of the screen. All of them were of the same size (10 cm ×10 cm). Pictures were taken from two different domains - animals (insects and dogs) and artefacts (weapons).

The names for the pictures were chosen at three different levels of abstraction. The names that supposed to be basic were chosen in the pre-test when a group of people (5-10 persons) was asked to name an object on the picture with the first name that comes to their mind. The most frequently generated name was taken as basic. The superordinate categories were chosen so that the members of these categories have very different shapes and that categories are familiar to Bulgarian speakers. The subordinate categories were chosen at the most specific level as possible.

All stimuli that were used for the experiment are presented in the Table 1. In the first group there are three different basic level names while in the second and the third groups there is only one.

Three groups of objects are taken to ensure the generality of the effect. In any experiment only the objects of one group (insects, animals or weapons) were used as a test group, the objects from two others serving for filler trials.

In addition, 5 different pictures of the same size were prepared for practice trials.

**Table 1.**
**List of stimuli used in the Experiment**

| superordinate level | basic level | subordinate level |
|---|---|---|
| insect | spider | Phalanx (*Solpigides*) |
| | butterfly | *Vanessa Urticae* |
| | beetle | *Cerambycidae* [1] |
| animal | dog | German Shepherd |
| | | Staffordshire Terrier |
| | | Doberman Pinscher |
| weapon | sword | katana |
| | | china sword |
| | | two-handed sword |

Three stories were written about one object in every group. The stories were not very long (200-300 words). Stories were printed on separate sheets of paper and include the modified (black&white and minimised) picture of the object in question. The stories contain different information about the selected object.

***Procedure***

Participants were told that they participate in two experiments. The first experiment is picture verification task and the second one is memory task. To do picture-verification task they need to perform the experiment twice.

**1st stage of the experiment: picture verification task.** First, the subjects are presented with the instruction. They are 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 button box. If they think that the word does not name the picture correctly they are to press the button "NO" on the button box. The subjects are instructed to keep their index finger of a dominant hand on the button in the middle of the button box 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 PsyScope (Version 1.0 for Apple Macintosh). 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 2500 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 an isolated booth. At first they were presented with the instruction followed by eight practice trials. Then they had the experiment, which consisted of 108 trials separated by a rest break in two blocks of 54 trials each. Eight practice trials included the names of the objects at different levels of abstraction: superordinate (plant, animal), basic (flower, monkey) and subordinate (salmon). The names for the pictures for practice trials were chosen in the same manner as for the stimuli presented in the Table 1. 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. After the practice trials the instruction was repeated and subjects were familiarised with the list of objects at all three levels of abstraction. This was done to reduce the amount of mistakes because the subordinate names of the presented objects were not very familiar to many subjects. Each word-picture pair was presented twice - before and after rest period. The word-picture pairs were presented at random order and the number of true trials was equal to the number of false trials. Each picture appeared on the screen 12 times.

**2nd stage of the experiment: memory task.** After the performing picture verification task the participants were asked to do the second experiment - memory task. They were given 10 minutes to read a text - a story about the selected object, then the text was taken away and the subjects were to retell the text in the written form. For the retelling the participants had as much time as they needed to complete the task.

**3rd stage of the experiment: picture verification task.** After the completion of the memory task the subjects were asked to do picture verification task again. The participants performed the same procedure as at the 1st stage of the experiment except that they were not given the instructions and practice trials any more. In such a way, the participants saw each word-picture pair four times.

The experiment takes about 40-50 minutes.

Participants were divided into three groups and each group performed the experiment with one of the stories. The first group performed the experiment with the story about a particular spider (9 people), the

[1] Sorry for Latin, but I could not find folk English names.

second group - with the story about Staffordshire Terrier (13 people), and the third group - with the story about katana (10 people).

***Results and Discussion***

For all three groups of subjects similar results were obtained. That's why we will present the joint analysis of all three groups of stimuli. Despite that the stimuli set contained some not very familiar items percent of correct responses was high: 96% correct answers for true trials and 96% correct answers for false trials. Only the correct responses for the true trial were used for statistical analysis. The items with response time that exceeded three times or more standard deviation were excluded from the analysis. For the analysis of the data STATISTICA 5.0 for Windows was used.

For the comparison of data obtained during the first and the third stage of the experiment, i.e., before the reading and retelling the story about chosen object and after this task, 2-way ANOVA was done. The difference between the 1st and the 3rd stages of the experiment for the experimental sets of stimuli appeared to be statistically significant (see Fig. 1).

LSD post-hoc test indicates that there is statistically significant difference between subordinate level before and after memory task ($p<.0001$) as well as between basic level before memory task and subordinate level after memory task ($p<.015$). Post hoc test shows also that after memory task the subjects answered as quickly at the subordinate level as at the basic level ($p=.1068$) and there was no significant difference between the response time at basic level before memory task and the subordinate level after memory task ($p=.4066$).

Mean response times obtained in this experiment are higher than in Rosch et al.'s (1976) object recognition experiment but lower than reported by Johnson&Mervis (1997). The difference may be due to the equipment used and to some differences in the design (between-subjects vs. within-subject).

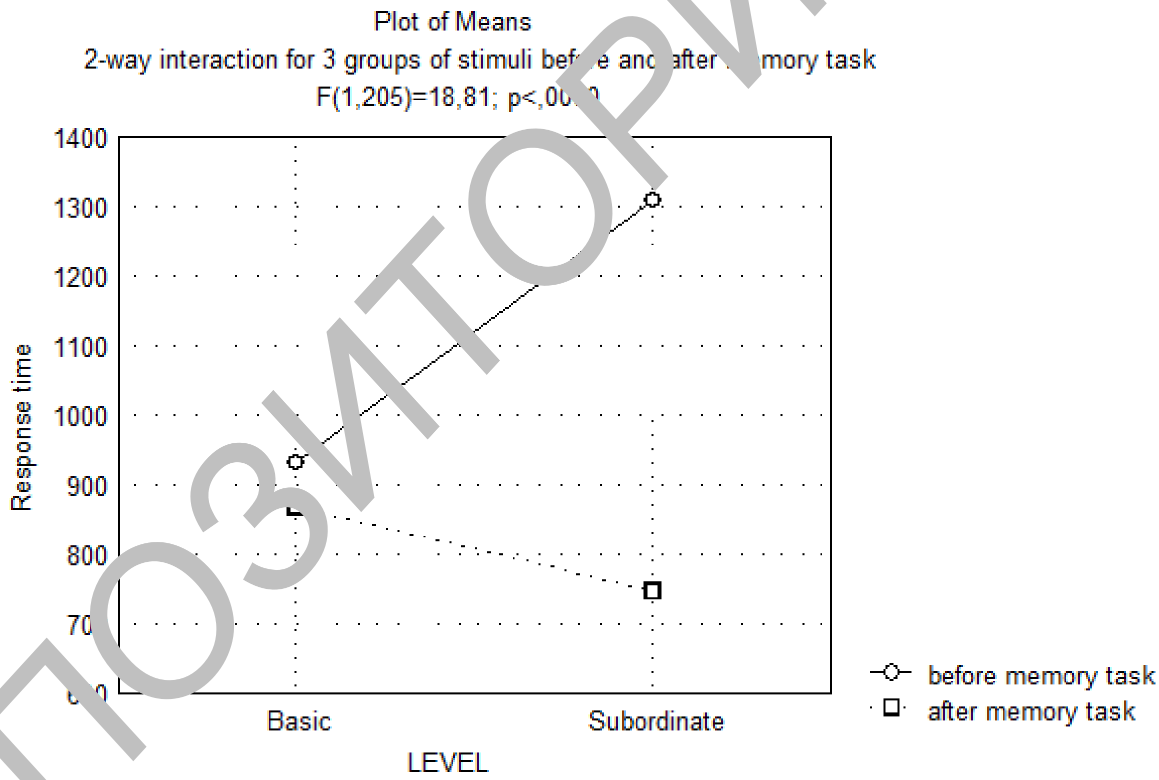


**Fig. 1. Mean response time for experimental sets of stimuli before and after memory task**

The data provide the evidence that the category that did not show basic level before (*Phalanx, Staffordshire Terrier* and *katana*) showed this effect after the memory task. Before the completion of memory task the chosen categories could not be counted as basic because the response time for its verification was significantly higher than for its superordinate category (genus). After the performing of memory task there is no statistically significant difference between the former subordinate category and basic-level category.

Thus, in the beginning of the experiment (stage 1) a chosen category (*Phalanx, Staffordshire Terrier, katana*) could not be considered as basic because the verification time for it was significantly higher than for its genus. Therefore, this category could be considered only as subordinate. After the memory task that provided additional activation the category in question began to show basic level effect: its verification time became statistically equal to the verification time at the basic level, being actually less (the mean difference is 124 ms). If we think that the shorter verification time provides necessary condition for 'basiclevelness', then former subordinate category can be considered as 'basic', i.e., it shows basic level effect. Moreover, from the data obtained it is evident that the former subordinate categories that were activated have the shortest verification time. Although this time is not statistically much less than verification time for basic level categories, it is impossible to claim now that the objects "are first seen or recognised as members of their basic category (with additional processing required to identify them as members of their superordinate or subordinate category)" (Rosch et al., 1976: 412). It is evident that after memory task additional processing was required to recognise the objects at their initial basic level, while the objects were seen and recognised first at the level lower than before additional activation.

The obtained results seem to be in agreement with classical theory. As it was predicted, the task that requires deep semantic processing provided additional activation for the concept of category that did not show basic level effect and made this category to show basic level effect.

It is difficult, however, to explain the obtained experimental data from the point of view of prototype and basic level theory. It appeared that subordinate categories could be easily added to the basic level, while basic level categories also remain basic (in terms of verification time). Here the violation of the uniqueness of basic level happens. For example, the categories *dog* and *Staffordshire Terrier* show basic level effect at one and the same time for one and the same person.

## 3. CONCLUSION

The main idea of the presented experimental study was the following: if some categories that are psychologically privileged (show basic level effect) due to the activation of the corresponding concept, then it is possible to take an arbitrary category, that is not psychologically privileged and make it psychologically privileged (show basic level effect) by additional activation. Memory task (retelling of the story about selected object) was chosen as the task that could provide additional activation. The results of the experiments could be interpreted in favour of classical theory. The categories that did not show basic level effect started to show it after the performance of memory task: the response time in picture verification task was significantly reduced. The obtained results, however, are not in agreement with prototype and basic level theory. Therefore, the experimental data could be seen as evidence in support of classical theory.

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