# THE INFLUENCE OF IRRELEVANT INFORMATION ON PRICE JUDGMENT

**Penka Hristova, Georgi Petkov and Boicho Kokinov**
Central and East European Center for Cognitive Science,
Department of Cognitive Science and Psychology,
New Bulgarian University, 21 Montevideo Street, Sofia 1618, Bulgaria
phristova@cogs.nbu.bg ; gpetkov@cogs.nbu.bg; bkokinov@nbu.bg

**ABSTRACT**

The paper presents an experiment that tests the influence of an irrelevant to the task feature (namely the color of the fonts used) on the judgment of rent prices of various apartments. The rents were presented with either green or red digits that stand for the price of the apartments. Participants judged how expensive the prices are from their perspective on a 7 point scale. As result it turned out that the rents obtained different ratings depending on the color with which they were presented, i.e. there was an influence of the irrelevant to the task dimension “color” on human judgment of a quite abstract dimension such as price. The difference is small but significant. Three possible explanations of these contextual effects are discussed with respect to the specific material used in this experiment. It was argued that spreading activation (Kokinov et al., 2004, Petkov, 2005a, 2005b) provides a better explanation of the reported results than the low-level perceptual “recalibration” (Marks, 1988, 1992, 1994, Marks and Warner, 1991, Arieh and Marks, 2002) or perceptual learning mechanisms (Goldstone, 1995,1998).

## INTRODUCTION

Suppose that you have to rent an apartment. You have a list of offers for apartments and you have to chose among them. The decision seems to be not very difficult since the offers are presented just by the prices of the apartments which are otherwise comparable. Would you expect that font used for representing the prices on the screen or on paper, or the color of the digits in the list may matter? This was exactly the situation studied in the experiment to be described. The main goal of the current study was to explore the possibility for influence of irrelevant information, such as the color of the digits, on price judgments.

Although irrelevant information could be considered as a context for judgment there is not much work on whether and how it may influence human judgments. Moreover, most of the small number of such studies focus on the influence of the irrelevant dimension on judgments of simple stimuli, e.g. loudness of sounds (Marks, 1988), length of vertical and horizontal lines (Potts, 1991, Arieh and Marks, 2002), taste (Rankin and Marks, 1991, 1992), haptic touch (Marks and Armstrong, 1996), olfaction (Rankin and Marks, 2000), color of five-sided polygons and two-line branches (Goldstone, 1995) and line length (Kokinov, Hristova, Petkov, 2004). Typically the effect of the irrelevant dimension is related to perception. For example, Arieh and Marks (2002) argued that irrelevant stimulus dimension “induce perceptual systems to recalibrate their relative supra-threshold responsiveness”. They demonstrated that visual length perception appeared to be specific to the eye and to the retinal region in which the context was induced. Thus, according to Arieh and Marks (2002), this fact confirms the hypothesis for early local changes in sensitivity due to the information conveyed by the irrelevant to the task stimulus dimension. Goldstone (1995,1998), also assumes that irrelevant information influences the judgment process relatively early on in the information processing and discuses the possibility for this effect to be a form of perceptual learning phenomena.

In general, these studies question the hypothesis that these contextual effects might be due to high-level information processing during the judgment process per se, since they propose relatively low-level mechanisms like “perceptual recalibration” (Arieh and Marks, 2002) and perceptual learning (Goldstone, 1995, 1998). However, it seems difficult, if not impossible, to account for the influence of an irrelevant dimension on judgment of abstract stimuli such as prices by referring to the low-level mechanisms described above. At the same time several different and complementary mechanisms may exist that produce these kinds of contextual effects. It is perfectly possible, that context influences judgment on several different levels of information processing. It could also be that other contextually sensitive processes are run in parallel resulting to the judgment process and interact with it thus producing the effects. This additionally impedes the development of detailed and elaborate description of the process of judgment.

In addition, both contrast and assimilation effects were demonstrated due to an irrelevant to the task dimension. Thus Marks and colleagues (Marks, 1988, 1992, 1994, Marks and Warner, 1991, Arieh and Marks, 2002) reported always contrast effect from he context induced by the irrelevant dimension, while Goldstone (1995) demonstrated both assimilation and contrast effects with a similar experimental design. Thus, it could be concluded that the influence of the irrelevant dimension is still quite an controversial issue in the field of judgment. It seems that, irrelevant stimulus dimension influences judgment by different mechanisms but it is still quite doubtful whether this effect could be demonstrated with more abstract complex stimuli, like the ones people usually judge in their everyday life.

Unlike alternative explanations of how irrelevant information may affect judgment; JUDGEMAP (judgment as mapping) proposes detailed mechanisms that may underlie judgment process of both simple and complex stimuli (Kokinov et al, 2004, Petkov, 2005). JUDGEMAP is a computational model based on the DUAL cognitive architecture (Kokinov, 1994b, 1994c). It uses the same basic mechanisms used for analogy-making, like mapping and memory retrieval in modeling the process of context-sensitive judgment. In this respect, JUDGEMAP is integrated with the AMBR model (Kokinov, 1994a, Kokinov and Petrov, 2001), which is based on the same cognitive architecture (i.e., DUAL). The main assumptions behind the JUDGEMAP Model are that: 1) analogy-making is fundamental human capability and thus may be considered as a basic mechanism that underlie different cognitive phenomena, like reasoning, decision making, perception etc. and 2) the same processes may account for judgment of both simple and complex stimuli.

The most important aspect of JUDGEMAP Model with respect to the current discussion is that the effect of irrelevant dimension is in fact among the model’s predictions. JUDGEMAP states that judgment of any particular stimulus is made within a comparison set comprising the most recently judged stimuli, the most familiar exemplars of the target category, and the stimuli most similar to the target on both relevant and irrelevant dimensions. The mechanism underlying this process is the spreading activation mechanism.

## JUDGEMAP MODEL

JUDGEMAP is a model of judgment, implemented as a computer program. It is based on the cognitive architecture DUAL (Kokinov, 1994b,c) and the AMBR model for analogy – making (Kokinov, 1998, Kokinov & Petrov, 2001).

JUDGEMAP treats the judgment process as a process of *mapping* between two sets: the comparison set (consisting of the target stimulus and other contextually activated exemplars in WM) and the set of available scale labels. The main assumptions behind the model are that human memory is associative and constructive, that analogy-making is not a separate human ability but the core of human cognition, and that context is not just a source of noise but is an essential necessity for flexible and effective computations.

*Associative memories* work flexible and fast in a natural environment (Anderson, 2003). When a system, based on associative memory works on a certain item, it keeps the close associates of this item also active, e.g. ready for use, because it probably would face them soon. For example, if one sees a building, it is useful to be ready to perceive other buildings, windows, walls, etc. The buildings are usually concentrated closely to each other. Thus, the associative memories reflect the regularities in the real world.

JUDGEMAP shares the assumption that *analogy-making* (more precisely the ability to map consistent structures) is not an isolated human faculty but rather a fundamental cognitive capability (Hofstater, 2001). Analogy-making is a manifestation of the human ability to integrate new information with old one, manipulating and adjusting both of them until they fit consistently.

In addition, JUDGEMAP treats context as a necessary condition for flexible and effective cognition. In order for one system to be flexible, the set of all possible alternatives should be as large, as possible. In order it to be effective, the set of the actually considered alternatives should be quite small. The context determines the *relevant* paths for searching and solves this obvious contradiction.

JUDGEMAP consists of a huge number DUAL-agents. Each DUAL-agent has a connectionists and a symbolic part. From the connectionists perspective the system works like a neural network. Each agent receives activation, computes its current activation level and sends activation to its neighbors via associative links. There is also a decay that causes the activation level to decrease if there is no current input. The activation level of the agents represents their relevance, not their meaning. The sources of activation in JUDGEMAP2 are two special nodes – INPUT and GOAL, representing the perceptions and the goals of the system, respectively. The stimulus to be judged, the scale and possibly the contextual elements are attached to the INPUT node, whereas the relations, responsible for the task, i.e. the knowledge that stimuli with larger magnitude correspond to higher ratings – to the GOAL node. Thus, the pattern of activation represents the context and continuously changes in response to changes in the task of the system and/or in the environment.

The agents also have a symbolic part – each agent ‘stands for’ something – an object, a property, a relation, a hypothesis, etc. It can also perform very simple symbolic operations – send and receive short messages to its neighbors, modify its connectivity or create new agents. The symbolic and the connectionist parts interact in a very important way. The symbolic operations have a ‘price’ to be paid by consuming energy. Consequently, the most active agents have more energy and therefore work faster; the less active ones work slower; and the inactive ones do not work at all. On the other hand, new agents established by symbolic operations change the connectivity of the system and thus the overall pattern of the activation.

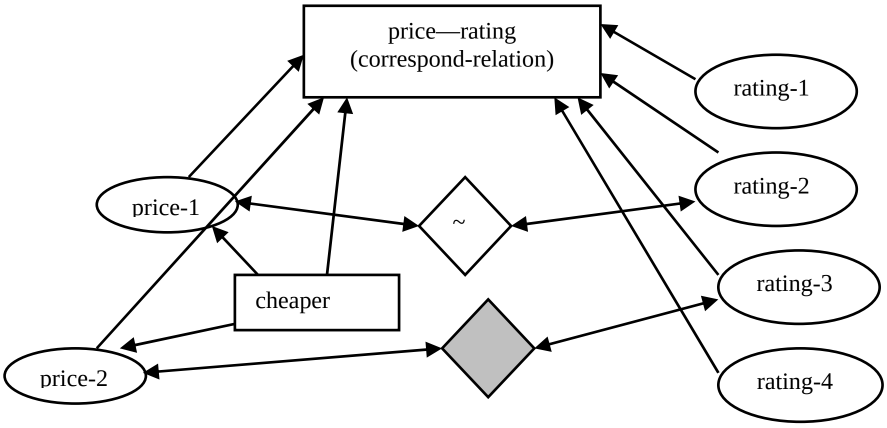


Fig.1. The work of the correspond-relations. Correspond-relations combine information from the active stimuli, ratings, and comparisons and create new hypotheses for correspondences (in gray). The speed of the creation of hypotheses depends on the activation levels, and only a few of them are created during the time before the response.

The comparison set is formed by the spreading activation mechanism. Stimuli similar to the target on both relevant and irrelevant dimensions as well as relevant concepts, together with their prototypes (if they exist) enter WM. Recently judged stimuli also stay in the WM for a while. The activation spreads through more general concepts and back to some of their specific exemplars. However, there are only a few links from the concepts to their instances. The links to the recently used exemplars are created when they enter WM and their weights slowly decrease over time.

*Comparison-relations* are subclasses of a specific type of relations that have two arguments and express a comparison between these arguments. Examples of comparison-relations are concepts like longer, cheaper, better, etc. They are equipped with a special routine that allows them to recognize manifestations of the relation which they are responsible for among the relevant items. For example, the comparison relation ‘cheaper’ can compare the magnitudes of two relevant prices and to create a new agent – for example ‘appartment-10 is-cheaper-than appartment-35’. The new agents are incorporated into the network of agents and are fully compatible with the other agents (the only exception is that they die when they leave WM). Thus, JUDGEMAP constructs temporal relations that represent add-hoc, context-dependent knowledge on the spot.

There are also other theories (Mussweiler, 2003; Manis & Paskewitz, 1984; Manis, Nelson, Shedler, 1988) that assume that local comparisons between the target stimulus and memory traces are at the core of the judgment process, however, JUDGEMAP, assumes also that a second order comparison relations are built. These second order relations enable the system to not only say that A is cheaper than B and C is cheaper than D, but also to say that the difference between A and B is bigger than the difference between C and D (i.e. this allows the system to introduce some kind of metric information and not to stick to an ordinal scale). These second order comparison relations are built in a local way – the corresponding agents discover the relations between two first-order relations and build a new agent representing this second-order relation.

*Correspondence–relations* represent the specific tasks. They can be temporary agents that do not remain in Long-Term Memory. When the model works on a certain judgment task, the knowledge that is explicit in the instruction is represented by such relations. For example, if the task is to judge the prices of apartments, one correspondence relation represents the knowledge “higher prices have to correspond to lower ratings”. The correspondence relations trigger the mechanisms for the construction of hypotheses about correspondences.

Now suppose that the corresponding agent knows that ‘price-1’ was judged with ‘rating-2’ and that ‘price-2’ is lower than ‘price-1’. This information makes a pressure ‘price-2’ to be judged with a higher rating. In such a case the correspond-relation agent chooses the most active rating from the available ones (for example ‘rating-3’) and creates a hypothesis that ‘price-2’ correspond to ‘rating-3’ (Fig1).

Let us suppose that for various reasons and in various moments of time a number of new hypotheses for correspondence between the target stimulus and the ratings emerge. Each hypothesis receives activation from the two elements that it connects, as well as from its justifications, i.e. the agent representing the reason for its creation. Some of these hypotheses duplicate each other since they have been established at different moments and for different reasons, but they have the same content – in this case, they have to be merged and combine their justifications; the contradictory hypotheses create inhibitory links between themselves and in this way inhibit each other. In this way a constraint satisfaction network is being formed. This network is connected to the network representing various concepts and old exemplars, and together participate in a unified spreading activation process. The system gives response when a certain hypothesis about a possible rating of the target wins its competitors. Then the model receives the next stimulus without any initiations and continues with its judgment.

## A PREDICTION OF THE JUDGEMAP MODEL

The model predicts that because of the spreading activation mechanism an irrelevant to the task dimension may matter. Suppose we have multidimensional objects to be rated on a one-dimensional scale, e.g., “Rate on a 7-point-scale how expensive this apartment is”. The model would predict that similar apartments will be retrieved from memory and form the comparison set. These apartments may be similar on an irrelevant dimension, but the very fact of similarity may bring them into WM and make them to participate in the comparison set. Let now take an extreme example. Suppose that the apartment in question has red painted walls. This might turn out to be sufficient to call other red painted apartments into WM. Suppose further that all red painted apartments the judge has seen before were all very cheap (for varieties of reasons having nothing to do with their color, for example, one of them was in the suburbs, another near a factory, a third one having just one room). In this case the comparison set that is formed will happen to contain many low-priced apartments. Therefore during the mapping process all the high ratings will turn out to be already used by other apartments and because of the competition between the hypothesis formed for the same rating, the current apartment will tend to receive lower ratings. Therefore, even irrelevant features may influence the final rating based on their contribution to the content of WM.

This prediction has been already tested in a number of experiments with simple stimuli, such as lines that differ in color (Kokinov et al, 2004, Hristova, 2005a, 2005b). The task was to judge the length of the lines, but the lines formed positively and negatively skewed distributions with respect to their irrelevant feature – their color. The two sets of lines with different colors were mixed and randomly presented for judgment to the participants.

Judges rated the positively skewed lines higher than the negatively skewed ones independently of their equal length. These results were considered to be in support of the JUDGEMAP model confirming the model's prediction about the influence of the irrelevant stimulus dimension. It could, however, be that the effect is due to another mechanism, not necessarily of the spreading activation mechanism. For example, it could be argued that the effect of overestimating of the positively skewed red lines and underestimating the negatively skewed green lines was due to "recalibration of the perceptual system, like Marks and colleges claim (Marks, 1988, 1992, 1994, Marks and Warner, 1991, Arieh and Marks, 2002). In order to test this possible interpretation the following experiment has been conducted.

## PSYCHOLOGICAL EXPERIMENT

Participants were asked to rate how expensive the given rent prices of apartments with equal size were. Their judgments were based on the prices in euro presented on a computer screen. The prices, however, were presented in different color, i.e., analogously to the green and the red lines in the previous experiment (Kokinov et al, 2004, Hristova, 2005a, 2005b) and the red and green sets of prices had positively and negatively skewed distributions, respectively. Since, it seems almost impossible to be argued for any "recalibration" of the "relative suprathreshold responsiveness of the sensory system" in judgment of prices (digits on the screen) this experiment was considered to be able to tell apart JUDGEMAP's prediction from Marks' prediction. If we obtain the same contrast effect than it would be difficult to argue that the "early local changes in receptive sensitivity" of the perceptual system proposed by Marks and colleges could be responsible for these effects (Marks, 1988, 1992, 1994, Marks and Warner, 1991, Arieh and Marks, 2002).

According to JUDGEMAP the same prices would be judged higher if presented in the positively skewed color, than in the negatively skewed color. It was also expected that this difference in judgment of the same prices would be higher for prices in the middle range.

## METHOD

### *Design*

The within-subject factor color of the prices was varied on two levels: positively skewed and negatively skewed. The group was split in two subgroups in such a way that in the first subgroup the red color was positively skewed, while in the second one, the green color was positively skewed. The dependent variable was the mean rating of the eight overlapping prices for each color.

### *Stimuli*

A set of 14 prices was designed. The smallest one was 125 euro, the highest one – 190 euro, and the increment was 5 euro. The prices were presented in a random way. The frequency of the stimulus distribution depending on the stimulus color is presented in Table 1. Color *P* stands for the color of positively skewed and relatively small prices, color *N* – for the color of the relatively high and negatively skewed prices.

| *Price category* | *Prices* | *prices with color P* | *prices with color N* |
|---|---|---|---|
| 1 | 125 | 8 | - |
| 2 | 130 | 8 | - |
| 3 | 135 | 8 | - |
| 4 | 140 | 7 | 1 |
| 5 | 145 | 6 | 2 |
| 6 | 150 | 5 | 3 |
| 7 | 155 | 4 | 4 |
| 8 | 160 | 4 | 4 |
| 9 | 165 | 3 | 5 |
| 10 | 170 | 2 | 6 |
| 11 | 175 | 1 | 7 |
| 12 | 180 | - | 8 |
| 13 | 185 | - | 8 |
| 14 | 190 | - | 8 |

***Table 1. Frequency distribution and color of the prices used in the experiment.***

### *Procedure*

Stimuli were randomly presented for judgment one by one at the center of the computer screen on a gray background. Each price stays on a screen until the participant did judge it on a 7-point scale. Then the experimenter registers the respondents' rating and changes the slide manually. The experiment was conducted in a sound proved boot and lasted for 15 minutes.

The participants were asked to rate how expensive each rent price presented on the screen was on a 7-point scale: where, 1 –"it is not expensive at all" and 7 – "it is very expensive".

### *Participants*

23 (16 female and 7 male) participants took part in the experiment for payment (1 BGL per session). The age of he participants varied from 20 to 50 years.

## RESULTS AND DISCUSSION

As in the previous experiment on line length judgment (Hristova, 2005a) the effect of color on the eight overlapping prices was not significant tested with the repeated measurement analysis (F (1,22) = 0.045, p=0.835). The effect of color on the middle range prices was measured on the 4 middle prices, i.e., prices from 150 euro to 165 euro. The difference in the mean ratings of the middle range prices depending on their color was 0.09 (Table 2).

| | Mean rating | Standard Error |
|---|---|---|
| Color *P* | 5.05 | 0.184 |
| Color *N* | 4.96 | 0.187 |

***Table 2. Mean ratings and Standard Error for each color***

This difference turns to be significant tested with the Repeated Measurement statistics: $F$ (1, 22) = 5.175, $p$=0.035. As was expected, positively skewed middle range rents were rated higher than negatively skewed middle range rents although their equal price (Fig.2).

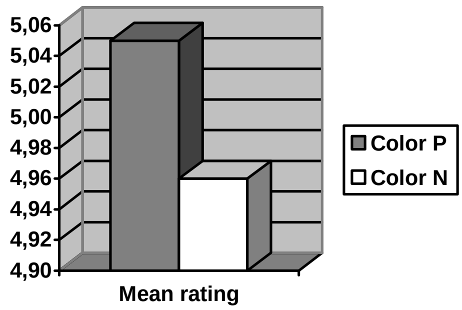


***Figure 2. Difference in mean ratings of the 4 prices in the middle range depending on the color of presentation.***

Thus, the results could be considered as confirming the influence of the irrelevant dimension. Moreover, this result is comparable with the results reported in experiments with line length (Kokinov et al., 2004, Hristova, 2005a, 2005b), where the effect of the irrelevant to the task color of the lines was significant only for the middle length lines, but not for all line lengths. In this respect, the reported experiment confirms the robustness of the effect of the irrelevant information and at the same time tests it with more abstract stimuli.

## CONCLUSION

The paper presents a model of judgment and an empirical test of the model's prediction. The results of the experiment confirm JUDGEMAP's prediction that irrelevant information influences judgment. Moreover, this prediction was tested with more abstract stimuli where the low-level perceptual recalibration hypothesis was ruled out as a possible explanation (Marks, 1988, 1992, 1994, Marks and Warner, 1991, Arieh and Marks, 2002). Thus it seems that the spreading activation mechanism proposed by JUDGEMAP Model better accounts for the presented experimental results. JUDGEMAP proposes mechanisms that may account for contextually sensitive judgment of both simple and complex stimuli.

It seems possible that irrelevant information affects judgment at two different levels: on one side there might be relatively early perceptual "recalibration" (Marks, 1988, 1992, 1994, Marks and Warner, 1991, Arieh and Marks, 2002) and perceptual learning mechanisms (Goldstone, 1995, 1998) that produce context effects as well as high-level judgment effects due to the spreading activation mechanisms of formation of the comparison set.

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