The Efficiency in the Spot the Difference Task with Illusory Pictures Solved by Preschool Children

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Abstract² Twenty children, 5 to 6 years old, were offered a series of paired images. The task was to find the differences in details as quickly as possible. The images could be the same or one picture could be 10% larger than another, or, one picture could seem larger than another (visual illusion of Ponzo and Delboeuf). The time and the accuracy were measured for each pair of images. Significant differences in visual search were found for images with illusory differences, real differences in size, and identical ones. Children need more time to make the decision in the pictures illusory different in size. We did not find significant influence of illusion on the accuracy in the task. We suggest to take the factors related to the development of perception or cognition into the account, since it can lead to different results in visual search tasks for groups of children of the same age.

Keywords² visual illusions, visual search, preschool children

I. INTRODUCTION

Visual selective attention refers to the direction of visual attention to relevant elements in the visual scene and ignoring irrelevant elements [1]. It is one of the prerequisites for conscious visual perception [2]. Visual selective attention is considered to be controlled by bottom-up process when salient elements are involuntarily selected due to their physical properties. The top-down process helps to select elements, which are in line with the goal [3, 4]. Whether selection is more driven by bottom-up or top-down mechanisms remains a major issue in vision research. It is considered to be two different attention states. The global and the local state [5]. In the global state, multiple elements are selected and integrated. In the local state, specific elements are selected and separately processed [6]. In the spot the difference task the ability to select the element in the global image plays the great role for the effectiveness. However, to make this selection, one should ignore irrelevant differences (ex. right or left localization of the image is not the relevant difference, only the details inside the picture is considered to be right answer). Still, what if the irrelevant differences are the physical characteristic of the object and one need effort to ignore it (ex. size), and moreover, what if the difference is the illusion?

Reality and our ideas about it do not always coincide. Visual illusions are the example of such discrepancies. Illusions are usually defined as errors in which subjective perception does not correspond to the actual parameters of the object. Errors can be associated with various reasons: optical phenomena (for example, the effects of light refraction), the anatomy of the organ (eye) (blind spot phenomenon), limitations of information (size illusions that occur when observer looks on the stage through the hole with one eye in the Ames room), incorrect judgments about size, shape, color (geometric illusions, color and contrast illusions). For this study, the important type of the illusions is geometrical illusions. They are the subject of active theoretical discussions in the field of visual perception

Different geometrical illusions are supposed to have different mechanisms. Some mechanisms are mainly associated with low-level processing another with cognitive processing [2, 7, 8]. Nowadays it is difficult to imagine an explanation of geometrical illusions without cognitive mechanisms. Visual illusions in psychology can either be an independent subject of research or serve as material for studying the mechanisms of operation and development of various mental processes [9, 10].

One of the areas of research with visual illusions is studying their influence on solving cognitive tasks (discrimination, identification, categorization), to explore the contribution of top-down processing in the task.

The study of the visual search in the pictures with the illusory differences showed that the illusory difference makes the visual search more difficult than the real differences in size. The authors suggested that the illusion brings the uncertainty to the task, because the difference in size is the error [11]. This way the person needed more time to make the decision and made more mistakes [12]. Decision-making occurs when it is necessary to choose two or more alternatives. The effect of the so-called ³post-conflict slowdown´ is known when solving problems where incongruent stimuli must be ignored [13].

Since the slowdown is present in all tasks where there is a conflict of several stimuli or properties, it can be used as an indicator of conflict. It will be the decrease in the reaction time in a task where it is necessary to ignore any characteristic, and it implies the presence of a conflict. The mechanism of such a slowdown is described in various works on the study of cognitive control. It is believed that when a person is faced with a conflict, cognitive control allows them to choose properties relevant to the goal and block irrelevant properties. Thus, the conflict and the reaction to it affect the effectiveness of solving the problem [14, 15]. If the subject has the task in which he (she) needs to find differences in two pictures that differ in two parameters (one is easy to find size or color) and another parameter requires the effort to find it), then due to the conflict of ³ E L J´ obvious and ³ V P D O O´ hidden differences, we should expect a decrease in the efficiency of searching for the ³ V P D O O´ difference. It should take more time than the images with ³ R X W´ difference, only with the ³ V P D O O´. For example, if the subject needs to find differences in two identical images and two images that are different only

in size (while the size is irrelevant parameter that should be ignored), then it is likely that the time to search the differences in two images that are different in size will be longer than in two identical images. A similar deceleration effect can be assumed for two pictures that differ in size only due to the illusion. Even if the difference in size is illusory, the stimuli are still perceived as different, which means that this fact must be ignored, so cognitive control mechanisms associated with slowing will be involved.

The size of the illusion depends on various factors. The strength of the illusions is different in different cultures and different ages. There were studies that showed that children are less susceptible to visual illusions, than adults [16, 17]. Usually, the age of 5±6 years is marked, as the transition point to the perception of geometric illusions as adults. Leibovitz published a graph of the illusory effect of the Ponzo illusion as a function of age ± the strength of the distortion is minimal at the age of 5 years and subsequently increases, reaching a value that persists into adulthood by the age of 10 years. In 1974, Brislin published similar results.

The reasons for these differences of the illusory effect in different age groups remain unclear. The mechanisms of illusions depend on the mechanisms of perception and the development of the perception in ontogenesis [18].

We studied the influence of the illusion in visual search in spot the different tasks with children. : ccording to literature, preschool children GRQ¶WKDYHDVELJLOOXRUHIIHFWDVDGX

Purpose of the study: Study the efficiency of solving the problem of finding differences in identical images, in the images different in one parameter (size), and in images having illusory differences (size).

Hypotheses:

± The response time will be longer for images that already have an obvious difference in size compared to images without size differences (illusory or real). Participants need to ignore irrelevant physical parameters of the pictures and it takes resources (time).

± The efficiency will be significantly lower for images that already have an obvious difference in size compared to illusory different images, (that will be reflected in an increase in time and in the number of errors). Since preschool children GRQ¶WKDYHDVELJLOOXRUHIIHFWDVDGXWV

II. Procedure

Twenty children participated in the experiment, aged 5 to 6 years, 11 girls and 9 boys. The average age was 5 years and 7 months. The choice of age limits was determined by the specifics of perception visual illusions. We did not invite children of younger age because it seems to be difficult for them to carry out multi-step instructions. The criteria for selecting children into the test group were the absence of data on severe speech disorders, color vision disorders (we had colored pictures), or diseases of nervous system. All children attend the eldest kindergarten group. Participants were offered a series of paired images in which it was necessary to find the difference as quickly as possible.

All stimuli were presented on a 19-inch computer screen. PsychoPy software was used to present stimuli and record responses. Participants were asked to answer whether the two images differ in details, such as extra strokes or lack of some details. The instructor pressed the key on the board according to the answer of the child. After pressing the key, the grey screen arrived and the child should describe the differences (if he or she found it). The differences in size or context surrounding the image had to be ignored. Examples of differences in details include: different time on the clock, owl eyes turned in different directions, presence/absence stripes on fish fins, number of dots on the vase (Figs. 1 and 2).

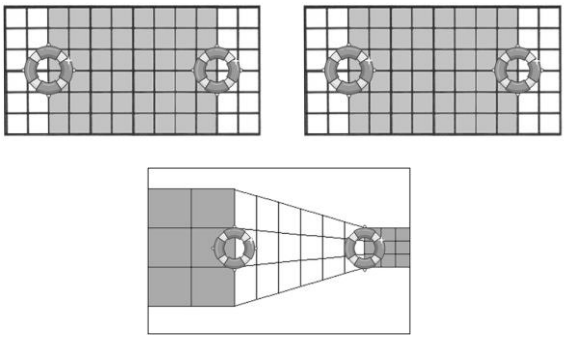

Fig. 1. Example of the three types of images with the 10 percent difference in size, without difference in size and with the illusory differences in size, all the pictures are without differences in details.

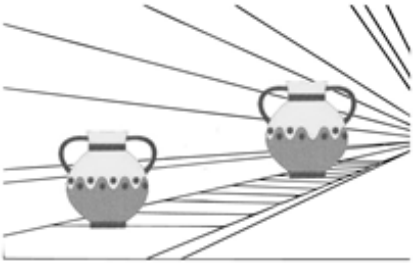

Fig. 2. Example of the image with illusory difference in size and in details (number of dots).

In total, the subject was shown 72 pairs of objects in random order: 24 pairs of objects of the same size, 24 pairs with a 10% difference in size, and 24 pairs with an illusory size difference. Of every 24 pairs, 12 had differences in details and 12 did not. A pair of images were shown on the screen simultaneously for 5 seconds. Pairs showed randomly. We made two parts for the experiment, because children tired of 72 stimuli, so it was 36 one day and 36 images next day. The time of each part of the experiment was 10±15 minutes. Before the start, we performed a training for 5 minutes in order to make sure, that each child understands the instruction. We used the images from the experiment by Karpinskaia *et al.* [12].

III. Results

Statistical analysis was performed using IBM software: SPSS Statistics 26.0 for the Windows 10 operating system.

There were two types of pictures according to the difference in details: 1 ± ZWKGLIIHUHQHVDQ ± ZWKRXW GLIIHUHQHV´

And three types of pictures according to the difference in size: A ± no difference in size, B ± illusory difference in size, C- different sizes).

We fixed the reaction time (the time of the answer) and the QEHURIHUURUVLIWKHSDUWLFLSDQWQZHUHGLIIHUHQWR

the picture type 2, and no difference on the picture type 1). Two separate repeated measures ANOVA were made. We separated the measures according to the differences in details (1 type or 2 type of pictures).

In the 2 type (without differences in details) we found the effect of illusion (type B) on visual search time ($F(2,18) = 8.96$; $p < 0.05$).

Paired comparisons showed significant differences between all three types of the pictures:

1) The time of the search in the type B (illusorily different pictures) significantly increased compared to the time in the type A (same size) ($t = 1.525$; $p < 0.001$);
2) The time of the search in the B significantly increased compared to search time in the type C (different size) ($t = 0.891$; $p < 0.05$);
3) The search time in the type C (different sizes) is significantly increased compared to the search time in the type A (same size) ($t = 0.634$; $p < 0.05$).

In other words, when there were no differences in detail between pictures (type 2) children responded significantly slower for the pictures with illusion (type B), than for the other two types (A, C). Interestingly, no significant differences were found in accuracy: ($F(2,18) = 0.794$; $p < 0.46$). Average percentage of errors in A, B, and C types was 4.4% for A (same size), 7.3% for B (illusion), 3.7%. for C (different sizes). The results are in Table 1.

Table 1. The results for the 2 type of stimulus (without differences in details)

Stimuli	Average time (sec.)	Average number of errors (%)
Same size A	8.8	4.4
Illusion	10.3	7.3
Different size	9.4	3.7

Slightly different results were found in for the 1 type of the picture (with differences in details). We found the effect of illusion (type B) on visual search time ($F(2,18) = 4.07$; $p < 0.05$). Paired comparison revealed that in the type B the search was significantly slower than in type A (the same size) ($t = 0.817$; $p < 0.05$). But the search time did not differ for the type B and C ($t = 0.04$; $p < 0.9$). The number of errors similar to the type 2 (no differences in details): no significant differences in all types (A, B, and C) ($F(2,18) = 1.87$; $p < 0.2$). The results are in Table 2.

Table 2. The results for the 2 type of stimulus (with differences in details)

Stimuli	Average time (sec.)	Average number of errors (%)
Same size A	8.8	4.4
Illusion	10.3	7.3
Different size	9.4	3.7

IV. Discussion

This way it was shown that in the pictures without differences in details yet with illusory differences in size, children search the differences significantly longer, than in any other type of pictures. This is similar to the result with adults [12].

Despite the fact that illusory effect is weaker for the children than for adults, we observe the slowing effect for the children. They need more time to make the decision in the pictures illusory different in size. It may be due to the fact that illusory effect is not stable at this age. Preschool children of the same age can show less or high illusory effect. It was shown that the perception of illusions is related to the formation and maturity of constancy of visual perception and not to age [5, 19]. It means, that it is important to take this factor into account and there could be more factors related to the development of perception or cognition, which leads to different results in the groups of children of the same age.

In the experiment with the children, we did not find the significant influence of illusion on the accuracy of the task. However, the adults showed the worst accuracy in the pictures with the illusory difference. We think, that it could be associated with the uncertainty of the illusory pictures. If the illusory effect for the children is smaller, than for adults, it is more difficult for adults to make the decision, than for children in all the situations with illusions. But the total number of errors for children is larger than for adults. The possible reason is fatigue: it needs a lot of patience from the child to sit down and give the answer for the large number of stimuli.

V. Conclusion

The hypotheses that the response time will be longer for the images that already have an obvious difference in size, compared to images without size differences, was proved. The longest time children need to make the decision was for the pictures with the illusion. And the results are aligned with the results for the adults, for participants need to ignore information that corresponds to the physical parameter (size), which is irrelevant according to the instructions.

We partly proved the hypothesis that the efficiency will be significantly lower for images that already have an obvious difference in size compared to illusory different images, because children have less illusory effect than adults. We found the difference in time to make the decision in the spot the different tasks (the time was longer for the pictures with the illusion in comparison with other types of pictures). However, the accuracy did not differ significantly for the pictures with the illusions. Children made more mistakes than adults in general.

We conclude that to study the visual search task in childhood, it is important to take factors related to the development of perception or cognition into account, for it can lead to different results in the groups of children of the same age.

Conflict of Interest

The authors declare no conflict of interest.

Author Contributions

V. Karpinskaia supervised the study and wrote the paper; A. Dotdaeva conceived the experiments and analyzed the data; both authors contributed to the article and approved the submitted version.

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