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# Visual attention and the reviewing process

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A new presentation of a previously displayed target stimulus makes the reviewing process automatically recover its previous episodic representation. Reviewing is automatic only if it is not affected by visual attention. This assumption was carefully evaluated in two experiments with different manipulations of visual attention. In experiment 1, reviewing was compared using early and late cues. In experiment 2, reviewing was compared using early cues that anticipated the correct (valid cues) and the incorrect (invalid cues) target locations. In both experiments an attentional effect was shown but the reviewing process was not affected by it. In addition, with regard to the «type» and «token» distinction, object specific priming appeared only when the target proceeded from the upper visual field, while conventional priming was not affected by this fact.

*La atención visual y el proceso de revisión («reviewing»).* La presentación repetida de un estímulo hace que el proceso «de revisión» (reviewing) recupere automáticamente su representación episódica. El proceso de revisión es automático sólo si no se ve afectado por la atención visual. Este supuesto fue cuidadosamente evaluado en dos experimentos con manipulaciones diferentes de la atención visual. En el primero, se comparó el proceso de revisión usando señales tempranas y tardías, mientras que en el segundo, se utilizaron señales válidas e inválidas que anticipaban, respectivamente, las localizaciones correcta e incorrecta del objetivo. Aunque en ambos experimentos se obtuvo efecto atencional, éste no afectaba al proceso de revisión. Por otra parte, en relación con la distinción entre «tipo» y «token», el priming específico de objeto sólo se mostraba cuando el objetivo procedía del campo visual superior mientras que el convencional no estaba afectado por este factor.

Kahneman & Treisman (1984) introduced an «Object Files» metaphor to describe how information referring to an object is integrated over time. This analogy is based on the files used by police officers, where everything related to a particular case is stored. When something referring to the same event occurs, the file is recovered and the information contained in it is updated. The analogy characterizes Object Files as temporary report structures that collect information about a given event or object.

According to the theory of object files (Kahneman, Treisman & Gibbs, 1992; Treisman 1992, 1993), when a new object appears in a scene, a new file is opened. This file will contain the visual primitives and visual characteristics of the object, that is to say, its *token* representation. With sufficient time and if the task thus requires it, that information will be paired with information in long-term memory, permitting the introduction of its name or some other prototypical characteristics that constitute the *type* representation. When a change is detected in one element of a scene, its episodic representation (object file) is updated. Otherwise, when a new object appears in the scene, a new object file is opened. The object file and its content (form, color, etc.), are automatically recovered through the action of the «reviewing process» when spatiotemporal correspondence exists between the current object and the previous one, and the object file will be updated if necessary. What determines the recovery of an object file is not its content but the existence of spatiotemporal continuity between the current and previous position of the object.

Numerous studies have explored a double representational system with «type» and «token» representations (Gordon & Irwin, 1996; Henderson, 1994; Henderson & Annes, 1994; Kahneman et al., 1992; Treisman, 1993). The paradigm of «priming of objects in movement» (Kahneman et al., 1992) is an important source of evidence of the dissociation between these forms of representation.

In the paradigm of «priming of objects in movement», two successive letter presentations are related by the movement of the frames that surrounds them. In a typical experiment, two empty frames are presented one above and the other below the fixation point. Within each of the frames a letter is briefly exposed (see Figure 1). Then the empty frames are moved to two new locations. Finally a single letter (target) appears in one of the two frames, and the subject has to name it as quickly as possible.

In some trials the target letter matches one of the earlier two letters and in other trials it does not. Three experimental conditions are defined (see Figure 1): SO (same object): when the target letter appears in the preview field within the same frame. DO (different object): when the target letter appears in the preview field within the other frame. NM (no match): when the target letter matches neither of the preview letters.

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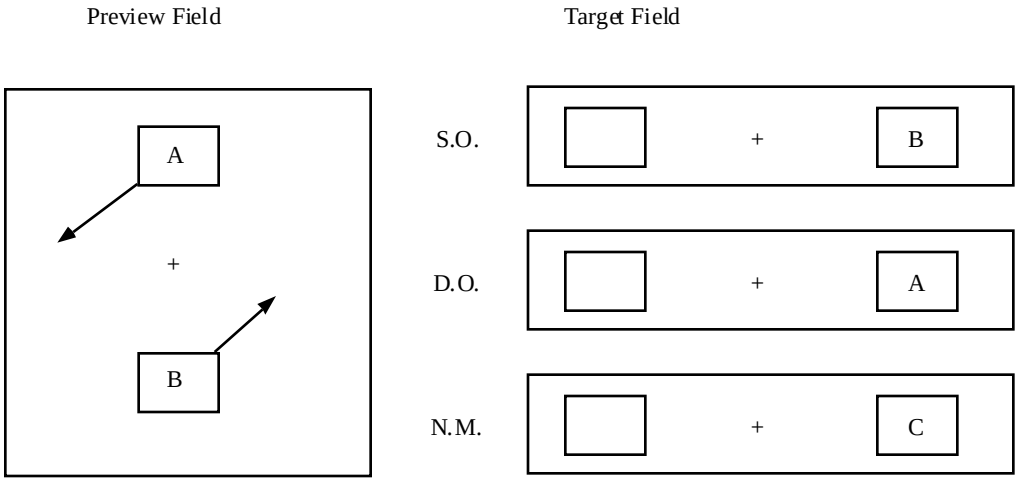


***Figure 1.*** *Conditions of relationship between initial and final presentations, in relation to the target origin. In this example the origin is from the lower fra - mework (SO: Maintenance of Object; DO: Different Object; and NM: No Match)*

The moved frames connect and integrate their contents. In terms of object files (Kahneman et al. 1992), in the preview field a file would be opened for each frame with its corresponding letter. The appearance of the target letter makes the reviewing process recover the current content of the episodic memory. If the new letter is different (NM) from the ones presented in the preview field, the file is updated and the naming time is delayed. On the contrary, the naming time is facilitated when the target and the initial letter are the same (SO). Facilitation will be intermediate between the NM and the SO condition when the target letter matches the initial letter displayed in the other frame (DO). The difference in response latency between the DO and the NM conditions is due to the conventional facilitation effect. The display of the two letters activates their representations in long-term memory. Thus, their «type» representations are primed, and naming either of the two letters is quicker in the DO than in the NM condition. This facilitation is called *conventional priming* by Treisman (1992) or «nonspecific benefit of object» by Kahneman et al. (1992).

The *object specific priming* (Treisman, 1992) or «specific benefit of object» (Kahneman et al., 1992) is obtained by subtracting the reaction time of the SO from the DO conditions. In this case, the response facilitation is originated by the availability of the memory trace (token representation) laid down by the object perceived in the preview field that matches the target.

Our objective in this study is to test the effect of the automatic orientation of visual attention in the reviewing process. This process is supposed to be an automatic process that by definition neither requires attention nor may it be affected by attention. But there are some empirical results which are difficult to fit with this view. According to Kahneman´s et al. hypothesis (1992, p. 209) «the allocation of attention to the target item evokes an automatic process of reviewing…». If attention affects the reviewing process then early cues, signaling the position of the target before the presentation, should show greater object specific priming than late cues, presented at the same time as the target. Indeed this prediction was supported by study 4 of Kahneman et al. (1992) with the paradigm of «priming of object in movement» but not by their study 5.

There are two main empirical manipulations to show the effect of visual attention in detection and recognition tasks. Even when just one target is in a display, response time to the target is faster when attention is focused on the target location in advance of the target display. The second manipulation to show the attentional effect is comparing valid trials with invalid trials. In valid trials the cue is shown in advance in the target location. In invalid trials, the cue is located in advance in a different place from the target location. In invalid trials, attention is supposed to reorient from the cue location to the target location (Posner, 1980). Perceptual information should be processed earlier in valid than in invalid trials. Some theories affirm that attention speeds up perceptual processing (e.g. Sandom, 1991; Van der Heijden, 1992) and others affirm that attention has other functions, like integrating perceptual features (Treisman & Gelade, 1980). Orienting attention to the target position could speed up or improve the recovery of the previous episodic representation.

In two experiments the role of attention in the reviewing process was tested using two different manipulations.

## Experiment 1

To study the effect of visual attention on the reviewing process we replicated study 4 of Kahneman, Treisman & Gibbs (1992). In their study two types of trials were established: early cue trials (the target is anticipated by the cue) and late cue trials (target and cue are shown at the same time).

In both types of trials a cue was displayed that signaled the location of the target letter. The difference between the trials was the moment when the cue appeared. In early cue trials, the cue appeared at the same time as the initial stimuli but in the target place. In the late cue trials, it appeared at the same time as the target stimulus and at the same place. The validity of the cue was at 100%, that is to say, as long as the cue appeared in a specific place the target appeared at the same place. In no case was the cue displayed at a different place from the target.

The Kahneman et al.'s (1992) results showed that reaction times with early cues were always lower than with late cues. And what is more interesting still, the magnitude of the object specific

priming was greater with an early cue than with a late cue. This result supports the claim that visual attention plays some role in the reviewing process.

We have introduced the following modifications to the original study 4 of Kahneman et al. (1992): 1) The attentional factor (with early cue and late cue) was manipulated between subjects. We manipulate this variable within subjects to reduce the experimental error. 2) Concerning the methodology, the subjects themselves eliminated a trial when they thought they had made a mistake. In our experiment an external observer marked the trials when a mistake was produced during the trial or in the subject's responses. 3) In the original study the authors did not find any difference using square or triangle shaped frames. We always use squares. 4) The location of the target, cued by bars above and below it in the original study, was cued by circular signals displayed diagonally above and below the target, in the present experiments.

The most important variation in the present study was that in the original study separate experiments were carried out for the early cue condition and for the late cue condition, using different subjects. On the contrary, in the present study the two types of cues were administered within subjects in a single experiment. On the basis of the Kahneman et al. (1992) results, our prediction is that with an early cue, the object specific effect would be greater than with a late cue.

## Method

### *Subject.*

Eighteen students in the first year of Psychology participated in the experiment for course credit. All subjects reported normal or corrected-to-normal visual acuity. Participants were naive to the purpose of the experiment.

### *Apparatus*

The stimuli were displayed on an IBM 286 System-2 Super-VGA monitor. The experiment was programmed in MEL (Schneider, 1988). The «E-7» text mode of MEL and the «Roman» letter type were selected. The letters were shown in uppercase and, like the frames, appeared white against a black background. The same computer controlled the stimulus presentation and collected vocal response times by a microphone and a vocal key connected to the computer. Subjects' heads were placed in a forehead rest to maintain viewing at the distance of 60 cm.

### *Stimuli.*

In every trial, two squares of 2.1° were shown centered to 2.5° above and below the fixation point ('+' character). This character was presented in high intensity maintaining the maximum contrast conditions of the screen. After 500 ms, an uppercase letter was displayed within each of two squares for 20 ms. The letters were randomly selected from the following stimulus-set: «B, C, D, F, G, H, K, J, S». After the letters disappeared, the empty frames were moved in apparently smooth movement (a presentation every 10 ms). The lower upper frame ascended while the upper descended, both in oblique direction until reaching a centered height at 4.2° on the left and right respectively of fixation. The superior frame was moved towards the left and right side with the same frequency as the lower frame, and always in the opposite direction. The movement of the frames lasted 130 ms. The target letter, which belonged to the stimulus-set, was displayed only within one of the two frames and stayed on until the subject named it. The vocal key detected the voice and the computer registered the time from the target display to the naming response. A new trial started 1500 ms after the response. Two high luminosity points, one over the target letter and the other under it, indicated the location of the target letter. The appearance of this cue took place either before (early cue condition) or at the same time as the target (late cue condition).

### *Procedure*

Subjects were persistently requested to attempt to maintain the sight at the fixation point until the target letter appeared; at that moment they had to name it as fast as possible. They started with one practice block of 48 trials and then two experimental blocks of 144 trials each. Three conditions of relationship were established between the letters used as initial stimuli and the target letter (see basic paradigm in Figure 1). In the same object trials (SO), the target letter had appeared within the same frame in the preview field. In the different object trials (DO), the target letter had appeared in the preview field but in the other frame. In the third type of trial, no-matching trials (NM), the target letter was not displayed in the preview field. The cue was always displayed in the target location, but preceded the appearance of the target by 150 ms in the early cue condition and was shown simultaneously with the target in the late cue condition. The three conditions of relationship (SO, DO and NM) were randomized within each block. There were 3 groups of 48 trials in each block. So, every subject received 144 trials with an early cue and another 144 with a late cue. After each group of trials there was a short resting time for the subject. The order of block administration was counterbalanced between subjects.

The experimenter, who stayed at the end of the room during the entire session, had a complete list with the target letters that appeared during the session for every subject. If a wrong letter was pronounced, the pronunciation was not clear, the vocal key was activated improperly or some incident occurred in the course of the trial, the incident was registered, and the trial was eliminated from further analysis. The complete session lasted 40 minutes approximately. The experiment was carried out in a dimly lit room.

## Results

Six conditions are included consisting of the 2 x 3 factorial combination of the Cue and the Relationship between preview and target stimuli. The two levels of the cue were early and late. This factor was manipulated between-blocks. The three levels of relation were same object (SO), different object (DO) and no match (NM). This was randomized within every block of trials.

Response times longer than 1500 ms and lower than 200 ms were eliminated from the analysis. During the experiment, the observer marked some trials in order to eliminate them from the analysis. A trial was marked when one of the following things happened: there was a mechanical failure in the vocal key; it was activated improperly or the observer could not determine with clarity the response of the subject. The data that finally were eliminated from the analysis were less than 5% of the totals.

*Table 1*
Means naming latencies (in milliseconds) in the six conditions and priming effects separated by the target origin in experiments 1 and 2 (* $p<0.05$)

| | Relationship | | | Priming Effects: | |
|---|---|---|---|---|---|
| | SO | DO | NM | Specific | Conventional |
| **Experiment 1** | | | | | |
| Upper origin. | | | | | |
| Early Cue | 598.09 | 632.41 | 629.26 | 34.32* | -3.14 |
| Late Cue | 639.54 | 668.58 | 669.03 | 29.04* | 0.45 |
| Lower origin. | | | | | |
| Early Cue | 643.49 | 644.42 | 652.55 | 0.93 | 8.13 |
| Late Cue | 676.06 | 679.58 | 682.91 | 3.52 | 3.33 |
| **Experiment 2** | | | | | |
| Upper origin. | | | | | |
| Valid trials | 610.44 | 656.61 | 676.62 | 46.17* | 20.00* |
| Invalid trials | 638.77 | 678.06 | 692.19 | 39.28* | 14.13* |
| Lower origin. | | | | | |
| Valid trials | 666.96 | 661.95 | 681.81 | -5.01 | 19.86* |
| Invalid trials | 701.83 | 697.24 | 725.79 | -4.60 | 28.55* |

Main effects of the variables, Cue [F(1,17)= 24.25; *MSe*= 1419.66; $p<0.001$] and Relationship [$F(2,34)= 23.66$; *MSe*= 164.15; $p<0.001$] were obtained, but not the interaction. Response times in the early cue condition were lower than those in the late cue condition. SO relationship was significantly quicker than DO (LSD; M= 16.80 ms; $p<0001$) and NM (LSD; M= 18.98 ms; $p<0001$) and no differences were shown between DO and NM reaction time (LSD; M= 2.17 ms; $p= 0.48$).

Looking for a measure of selection, the origin of the target was considered as a new factor. In half of the trials targets came from the upper frame and in the other half, they came from the lower one. The Origin factor was added to the previous two in a new ANOVA. Together with the previous reported results, the Origin of the target was significant [$F(1,17)= 9.99$; *MSe*= 3031.49; $p<0.01$]. Response was quicker when the target origin was upper than when it was lower. The only interaction shown was between the variables Origin Cue and Relationship [$F(2,34)= 6.47$; *MSe*= 657.31; $p<0.01$]. The analysis of the interaction showed that the Relationship variable had effect only when the stimulus came from the upper frame [$F(2,34)= 16.50$; *MSe*= 700.29; $p<0.001$], but not when it came from the lower frame [$F(2,34)= 2.15$; *MSe*= 281.94; $p>0.1$]. Therefore, the effect of object specific priming (difference between the conditions DO and SO) and the conventional priming (difference between the conditions NM and DO) could only be presented in the upper origin condition. The post-hoc comparison analysis showed object specific priming (LSD; M= 31.68 ms; $p<0.001$), but not conventional priming (LSD; M= 1.34 ms; $p>0.1$).

## Experiment 2

A more direct test of the hypothesis of Kahneman et. al. is carried out with a new cueing task. If attention participates in the reviewing process, a greater object specific priming effect should be found when attention is directed in advance to the correct position of the target (valid trials) than when it is directed to the opposite, wrong, position of the target (invalid trials).

The time decrease in the target response provided by an early cue comes from two sources: First, the cue acts as an alarm that provokes a general alert of the organism (something is happening) and speeds up any response. Second, the visual attention is directed to the spatial location where the luminous change occurs, facilitating response to any stimulus that occupies that position. In Kahneman et al.'s (1992) experiments, as in our first experiment, both effects are mixed. In early cue trials, the cue produces a general activation and directs attention to its location. However, in the late cue trials, neither of the two things occur before the target appears. The «valid and invalid» paradigm provides a way of studying the directional component of the visual attention, separating it from the general activation component or arousal.

In this new task two types of trials are mixed. In «*valid trials*» the cue indicates the correct location where the target will appear. So, «early cue» trials in the first experiments were «valid trials». «*Invalid trials*» are those in which the cue and the target appear in different places. In the invalid trials, the cue will appear in the final location of the empty frame, the one which does not contain the target stimulus. The general component of activation is present in both valid and invalid trials, since the cue is always anticipated. The difference between valid and invalid conditions is the directional component of the attention: the cue directs to the correct target location or to the wrong, opposite place.

In order to study the most automatic component of the sensory attention (Jonides & Mark, 1984; see in Van der Heijden, 1992), we decided to eliminate the predictivity of the cue. In this way, the subject would not have a differential benefit of obeying the cue, and so, we avoid a strategic component in the attentional measure. The same number of valid and invalid trials were randomly mixed in one block. In these conditions, the cue is said to be non-predictable (validity of the cue is 50%). Although the cue was not predictable, we expect that in the valid trials the subjects will answer faster than in the invalid trials. This difference will be an indicator of the fact that visual attention is what we are measuring. In accordance with Kahneman et al.'s (1992) results, if visual attention is involved in object specific priming, then the magnitude of the object specific priming in the valid trials should be greater than that in the invalid ones.

### Method

#### *Subject*

Sixteen third-year psychology students participated in the experiment for course credit. All subjects reported normal or corrected-to-normal visual acuity. Participants were naive to the purpose of the experiment.

#### *Apparatus and Stimuli*

The apparatus used to control and display the stimuli was the same as in experiment 1. All other chronometrical and physical aspects of the stimulus presentation were identical to those described in experiment 1.

#### *Procedure*

The procedure was similar to experiment 1, with the following exceptions: an early cue was presented in all the trials, but in this case the cue was non-informative, that is to say, the subject could not know in advance if the cue indicates the correct target place or a wrong place. Every subject did a practice block of 30 trials si-

milar to those used in the experimental block. After that, the subjects did only one experimental block that was split into three groups of 72 trials. At the end of every group of trials, the subjects could rest if they wanted to. In this experimental block of 216 trials, there were two types of randomly presented trials: valid trials and invalid trials. The *valid trials* were identical to those used as «early cue trials» in experiment 1. The cue indicated correctly the place where the target was displayed. In the *invalid trials* the cue appeared in the location, opposed to the target location, where the empty frame arrived. The complete session lasted about 30 minutes. This experiment was carried out in the same room and with the same conditions as experiment 1.

## Results

In recognition of the importance of the Origin factor in the previous experiment, it was added to the analysis. So, a 2 x 3 x 2 Analysis of Variance was carried out with 16 subjects. The factors were Cue (valid and invalid), Relationship (SO, DO, IN) and Origin of the target (upper, lower). Twelve experimental conditions were randomly mixed within a block of trials.

The same criteria of elimination of data used in experiment 1 were applied. The data eliminated by these criteria were less than 5% of the total trials.

Main effects of the variables, Cue [$F(1,15)= 18.11$; $MSe= 2371.56$; $p<0.001$], Relationship [$F(2,30)= 34.53$; $MSe= 727.06$; $p<0.001$] and Origin [$F(1,15)= 16.79$; $MSe= 2656.47$; $p<0.001$] were obtained. Response times were faster in the valid trials than in the invalid trials, and they were faster when the targets came from the superior frame than when they came from the inferior one.

Once again the only significant interaction was produced between the Origin and Relationship [$F(2,30)= 15.66$; $MSe= 671.31$; $p<0.001$] variables. The interaction analysis showed that the Relationship variable shows effect when the target comes from the superior frame [$F(2,30)= 44.18$; $MSe= 687.27$; $p<0.001$] as well as when it comes from the lower frame [$F(2,30)= 7.39$; $MSe= 711.10$; $p<0.01$]. The differences between these levels were produced by the presence of the object specific priming (comparison between the conditions DO and SO) only for the upper origin (LSD, M= 42.73; $p<0.001$) but not for the lower origin (LSD, M= -4.80; $p>0.1$).

Contrary to experiment 1, conventional priming (the difference between conditions NM and DO) appears in all the conditions: when the target comes from the upper frame (LSD, M= 17.07; $p<0.01$) and when it comes from the lower one (LSD, M= 24.20; $p<0.01$).

## General Discussion

In the present study a clear dissociation between conventional and object specific priming was shown. In experiment 1 object specific priming but no conventional priming appeared while in experiment 2 both kinds of priming were shown. Conventional priming is mediated by the activation of a long-term representation called the «type» representation. Object specific priming is mediated by the action of an episodic representation. The two representation, have been clearly dissociated in other studies (see, Chun, 1997; Gordon & Irwin, 1996; Henderson, 1994; Kahneman et al., 1992; Kanwisher & Driver, 1992). The main difference between object specific and conventional priming is that only in the first case the spatiotemporal relation between prime and target presentations has to be in such a way that they seem the same stimulus. The paradigm of priming of object in movement used by Kahneman et al. (1992) and in the present study was designed to dissociate object specific priming -where prime and target were a same letter shown in the same frame- from conventional priming -where prime and target were also the same letter but shown in a different frame. In most of the experiments with this paradigm, one of the two kinds of priming is absent. This fact could weaken the tenets of the paradigm. However, results in our experiment 2 are of great value since similar conventional and object specific priming were obtained.

In our experiment 1, as in most of the experiments object specific priming is shown but conventional priming is not. According to Kahneman et al. (1992, p. 210) the absence of conventional priming in this paradigm is due to the reduced number of stimuli used in the experimental session (9 letters). The repeated display of the same stimuli would maintain ceiling activation of those representations in long term memory. Then the display of a stimulus in a trial would not permit the priming of its representation because it is already activated at the maximum level. However, in our second experiment the magnitude of the conventional priming and object specific priming are similar. This result as well as those of Henderson & Anes (1994) do inform us that this explanation does not seem to be a complete one, but it does not permit us to present an alternative explanation. It is possible that conventional priming was affected by one or both of the factors that differ between experiments 1 and 2: that is, the validity of the cue and the method of manipulation of the attentional variable (randomized or blocked). Although it seems difficult to find a simple explanation of the variability in the presence or absence of conventional priming in some studies, our two experiments show that the explanation offered by Kahneman et al. (1992) and assumed by others (Treisman; 1992, p. 863; Henderson & Anes 1994, p. 828) can be questioned.

One result is of great importance for the dissociation between conventional and object specific priming. The origin of the target (upper, lower) affects object specific priming but not conventional priming. In both experiments object specific priming was only shown when targets came from the upper frame. However, the upper or lower origin did not affect the magnitude of the conventional priming: whereas in experiment 2 the same magnitude of conventional priming was shown in the two conditions, in experiment 1 conventional priming was absent in both conditions. In our experiments the origin factor was not considered in advance, but it became essential for the object specific priming. Kahneman et al. (1992) did not report this factor, and so we cannot know what role it may have played in their experiments. Henderson & Anes (1994; table 5; p. 837) did report convergent data. In their experiment 1 object specific priming was almost twice as great in the upper position.

Thus the asymmetry of the position of the stimulus for the construction of the object file deserves some attention. While the activation of the type representation does not seem to have to do with the location of the stimulus, the combined token representation of the frame with its content is more easily carried out in the upper field than in the lower field. But why should tokens be treated in a different way depending on their upper or lower location in the field? Previc (1990) argued that there is a functional specialization

in the upper and lower visual field based on evolutionary roots, which leads to different strategies in processing the visual fields. While «local» processing is required for object searching and recognition in the upper visual field, more «global» processing is required in the lower visual field in order to reach object (visuomotor coordination) in optically degraded conditions with diplopic images. Previc's hypothesis holds that the perceptual system is biased toward the upper visual field «… to glue features into integrated wholes, so as to ensure that forms composed of identical features in different arrangements are not confused» (Previc, 1990; p.536-537). If this hypothesis is correct, the construction of object files should be easier in the upper than in the lower field. Thus, a better perceptual integration of stimuli with their frames in the upper field could explain the asymmetry of the object specific priming in the two present experiments and in Henderson & Anes's (1994) experiments. In two other experiments, Christman (1993) obtained empirical support for the specialized processing of local and global information in the upper versus lower visual fields. Further investigation is needed to provide a more direct test of Previc's hypothesis and its relation with constructing object files.

It is important to remark again that object specific priming is a robust effect which was present in experiments 1 and 2, as in previous experiments (Gordon & Irwin, 1996; Henderson, 1994; Henderson & Anes, 1994; Kahneman, et al., 1992).

The main objective of the present study was to clarify the role of the automatic orientation of visual attention in the reviewing process. On the one hand, Kahneman et al.'s (1992) hypothesis is that «the allocation of attention to the target item evokes an *auto - matic process* of reviewing, which selects one of the current object files, resulting in facilitation when the target and its retrieved item match, interference when they do not.» (Kahneman et al., 1992; p. 209). The reviewing process is described as an automatic process. But what does «automatic» mean for the authors? Kahneman & Treisman (1984; p. 42) distinguished three levels in automation of processes in perception: strongly automatic, partially automatic and occasionally automatic. In general, a process is automatic if it *can be* completed without attention, although *occasionally auto - matic* processes often require attention. Attention does not affect strongly automatic processes, neither facilitating the processing when attention is focused on the target nor impairing the process by *diverting* attention from it. A process is partially automatic when attention focused on the target facilitates the process and when attention diverted from the target impairs the process. One way to show how focusing attention affects perceptual processing is by comparing the time in naming a target between an early cue (a cue displayed in advance in the location of the target) and a late cue (cue and target are displayed at the same time). Naming is facilitated with the early cues, when attention is already focused on the target location before the target display. So attention affects the process of naming. If reviewing is a partially but not strongly automatic process, focusing attention in advance on the target location could facilitate the process of reviewing and so increase the magnitude of object specific priming.

In Kahneman et al.'s (1992) study 4, the allocation of attention in advance by an early cue to the target location increased the magnitude of the object specific priming with respect to other experiments where the cue and target were displayed at the same time (late cue). This result seems contrary to the assumption that the reviewing process is a strongly automatic process. Object specific priming is a measure of the correct recovery of the memory trace laid down by the prime. If attention could increase the efficiency of the recovery, the reviewing process should be seen (at best) as a partially automatic process. In a subsequent experiment with the same manipulation of visual attention, results support the strong view of automaticity in the reviewing process. In this experiment Kahneman et al. (1992; study 5) displayed four moving frames instead of two. As in the previous study, the cue was effective to direct attention to the signaled place because reaction time in the early cue condition was quicker than in the late cue condition. But contrary to the previous study, similar magnitudes of object specific priming were shown for early and late cue conditions.

The two present experiments try to analyse the unexpected result of Kahneman et al. (1992) in more controlled situations, that is, to evaluate a possible effect of the automatic orientation of attention in the reviewing process, so testing the statement that the reviewing process is strongly automatic. Given the opposite results of Kahneman et al.'s (1992) studies 4 and 5, we decided to replicate the experiments of Kahneman et al.'s (1992) study 4 but manipulating early versus late cue conditions in the same experiment. Remember that in the original study the magnitude of object specific priming was compared between experiments and this fact could show that differences are not due to the timing of the cue. In our second experiment, visual attention was manipulated by directing in advance to the place where the target was displayed (valid trials) or to the opposite place (invalid trials). Both manipulations of visual attention were effective, that is, reaction time was faster in early cues in experiment 1 and in valid trials in experiment 2. Despite the fact that cueing in both experiments was effective in orienting visual attention, the magnitude of object specific priming was not affected by visual attention. Object specific priming was of the same magnitude even when attention was directed to the opposite place from where the target was displayed (invalid trials). In conclusion, in experiments 1 and 2, as in study 5 of Kahneman et al. (1992), the two attentional manipulations produced the same result: clear attentional and specific priming effects but no interaction between those factors was shown. That is, focusing attention on the location that will occupy the target stimulus does not affect the magnitude of the specific priming. Thus, we can say that the reviewing process could be a strongly automatic process.

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