An investigation of the Attention White Bear hypothesis

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Abstract

The Attention White Bear (AWB) hypothesis (Tsal & Makovski, 2006) argues that when participants are required to respond to a target while ignoring distracters, top-down attention is actually allocated to the distracter locations. They found indications that when subjects are required to repeatedly ignore a stimulus in the same location, detection of probes in that location is enhanced. However, the repeated nature of the probes may have encouraged the subjects to in fact allocate attention to that location. In the present experiment, we use a similar task but with a single "surprise" probe. The reduced amount of data required large numbers of subjects. Through Web-based experimentation, we were able to recruit nearly 500 subjects. The results were inconclusive, with neither evidence of enhancement or inhibition of the "ignored" location.

Introduction

The Attention White Bear (AWB) hypothesis (Tsal & Makovski, 2006) argues that when participants are required to respond to a target while ignoring distracters, top-down attention is actually allocated to the distracter locations. In that study, the authors devised stimulus-probe method to assess the allocation of attention as a function of subjects' top-down expectancies concerning distracter and target locations. Participants performed the flanker task. Distracter locations remained fixed. On some trials, instead of the flanker display either two simultaneous dots or a horizontal line appeared. The dot in the expected distracter location was perceived to occur before the dot in the expected empty location, and the line appeared to extend from the expected distracter location to the expected empty location, suggesting that attention is allocated to expected distracter locations prior to stimulus onset.

Here, we seek further evidence to support the AWB hypothesis only by using a single task paradigm. That is, one might claim that the presence of a secondary task is Tsal and Makovski's (2006) study made the distracter locations somewhat relevant and thus more attention was allocated to those positions. However, the authors showed that there was no more "flanker effect" from the relevant locations, suggesting that wasn't the case. Yet, one can further argue that the flanker measurement was not sensitive enough and in order to fully overcome this concern the secondary task need to be abandoned.

To that end we designed a one-trial experiment where the response to a surprised stimulus would be used to measure attentional deployment prior to the trial. That is, participants are instructed to perform a flanker task (press as fast and as accurate whether the central letter is H or S, while ignoring the flanking letters) and after several trials a letter would flash briefly either in the distracter location or in a neutral empty position. We expect to find more accurate responses in the former. It is important to note that while finding the opposite results – i.e., better accuracy in the empty location, suggesting active suppression of the flanker location – would present major difficulty to the AWB hypothesis, not finding any difference in accuracy between the distracter location and a neutral location might only suggest that our choice of attention probing was not sufficiently sensitive.

In order to preserve the surprise nature of the task and to avoid the pitfalls of the previous study, each participant can be tested only in a single surprise trial. Therefore we need large number of subjects doing very short trials. Thus on-line experiment seems as the best approach. To accomplish this, we turned to Web-based experimentation. Participants were recruited through our website (vacognition.wjh.harvard.edu).

Method

Participants: 497 subjects over the age of 18 who reported normal vision and that they had not previously participated completed the experiment. The mean age of the remaining subjects was 30.7 (SD=11.4, range = 18-74). 207 were male.

Equipment: Stimuli were programmed in Flash MX and presented over the Internet. The stimulus package downloaded completely before the experiment began.

Materials: The display window measured 500 pixels X 400 pixels. Stimuli in the flanker task were H, C, S & K. As targets, they measured approximately 18 pixels X 24 pixels. As flankers, they measured approximately 30 pixels X 40 pixels. The surprise probes were "p" or "q" and measured approximately 14 pixels X 24 pixels.

Procedure: Each trial began with a 625 ms presentation of a "+" in the center of the screen, followed by a 250 ms blank interval. The target letter was then presented in the center of the screen for 62.5 ms, flanked by two distracters. Subjects were randomly assigned to have the distracters appear to the upper left and lower right or lower left and upper right of the target. The centers of the distracters were approximately 71 pixels from the center of the target. The target presentation was followed by a 250 ms mask (an array of X's) and then a blank screen that persisted until a response was recorded. The subjects responded by pressing one key if the target was H or K and another if it was S or C. For half the trials, the distracters matched the category of the target (congruent trials); on half the trials, the distracters were of the other category (incongruent trials). On the 17th trial, instead of the flanker task, a "p" or "q" appeared either 71 pixels above and to the left of the target or 71 pixels above and to the right of the target. Thus, for a random half of the

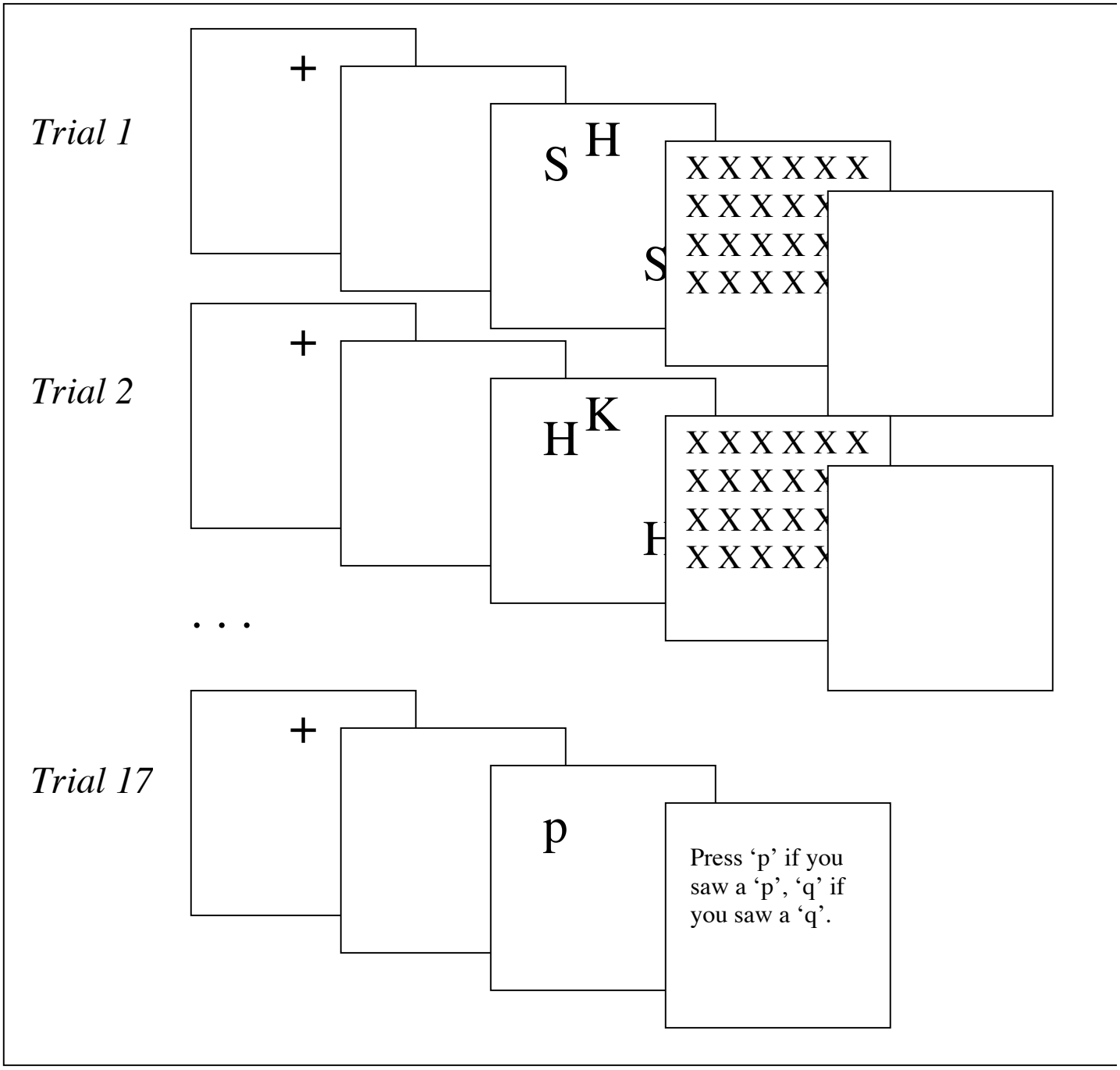

Figure 1. Diagram of the experiment.

subjects, the probe appeared in a flanking distracter location, and for half it appeared in a location that had previously been empty during every trial. The probe was displayed for 62.5 ms, followed by a 250 ms mask. Subjects were then instructed to respond as to

which letter they saw. Subjects were not aware this trial would happen. On a final, 18th trial, subjects were forewarned that either a 'p' or a 'q' would appear. Thus, the 18th trial was a repetition of the 17th trial, but without the element of surprise.

Subjects participated in a 4-trial practice of the flanker task, which they were allowed to repeat as many times as they wished.

Results

Accuracy was higher in the congruent trials (87.4%, SE=0.8%) than in the incongruent trials (77.2%, SE=1.1%), a difference which was significant ($t(496)=10.64$, $p<.001$). Subjects responded more quickly on congruent trials (mean = 1213 ms, SE=29 ms) than incongruent trials (mean=1290 ms, SE=35 ms), a difference which was significant ($t(496)=2.15$, $p=.03$).

Subjects correctly identified the surprise probe 73.1% of the time when it corresponded with the distracter location and 70.7% of the time when it did not, a difference which was not significant in a Chi-square (_^{2}=0.34, p=.56). On the final trial, which subjects expected to see a 'p' or a 'q', accuracy was high: 94.6% in the distracter location and 95.3% in the non-distracter location ($\chi^2=0.16$, $p=.69$).

Restricting to the 399 subjects 40 years old or younger did not affect these results. Accuracy on the surprise probe was 71.6% and 71.7% in the distracter location and the non-distracter location, respectively.

Restricting analyses to subjects with high accuracy on the flanker task likewise does not affect the pattern of results. The 378 subjects who scored 75% correct or better showed a similar pattern of non-significantly better performance in the distracter location

(77.2%) than in the non-distracter location (74.7%; χ^2=.32, p=.57). Similar results were obtained for the 128 subjects who performed perfectly in the flanker task: 78.7% correct in the distracter location and 76.1% correct in the non-distracter location (χ^2=.12, p=.73).

Discussion

There was no evidence of either inhibition or increased attention to the distracter locations. These results were inconclusive, but stable. Indeed, we actually ran several other versions of this experiment, adjusting the number of trials of the flanker task, the size and positioning of all the stimuli, the length of presentation of the stimuli, etc. In all these versions, subjects were either at chance or ceiling on the probe detection or performed equally in both conditions (distracter location or non-distracter location). Thus, in no version was suppression or enhancement of the distracter location found.

There are several possibilities. One, of course, is that Tsal & Makovski's results were due to the repeated nature of the probe task. Another is that either our flanker task failed to sufficiently engage attention or our probe task was insufficiently sensitive.

Although the experiment was inconclusive with regards to the Attention White Bear hypothesis, the results did support the methodology itself. Despite the looser controls over timing, display size and background noise inherent in Web-based presentation, a significant reaction time difference of less than 80 ms in the two flanker conditions was observed. This, to our knowledge, is one of the first demonstrations that this methodology can be used for reaction time experiments, at least when the RT difference is moderately large. We were also able to adjust the presentation time such that the probe was difficult but not impossible to detect (i.e., neither at floor nor ceiling).

Thus, Web-based experimentation may be a useful tool for experiments such as the current one that require large numbers of subjects but relatively few trials.