Ballistic and controlled processes in the Attentional Blink effect

Dominic Charbonneau & Denis Cousineau. Université de Montréal

Dominic.charbonneau@umontreal.ca

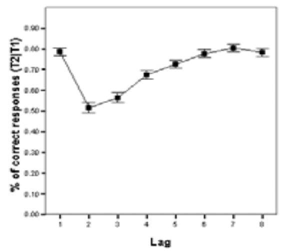
Abstract

The Attentional Blink (AB) effect occurs in a Rapid Serial Visual Presentation (RSVP) of digits, two of which are targets. The subject's task is to report these targets. When the first target is reported correctly, the results show a drop of performance on the second target for lags of two to five. We explored the possibility that a ballistic process causes the AB effect. The alternative hypothesis states that the subject could stop the processing of the first target and identify the second. To test this hypothesis, we presented a RSVP to 32 subjects where the position of the first target was fixed. The subjects were informed of that position. In a second experiment, we repeated the same design but instead fixed both targets positions in the first condition and the distance (lag) between the two targets in the second condition. The results show no effect of this manipulation on the AB effect. However the number of inversion errors at lag one was reduced when the subjects knew the positions of the first and second targets compared to the cases where the subjects knew only the distance between the two targets. These results question the ballisticity assumptions of the AB.

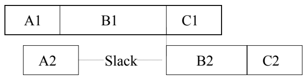
Introduction

A Rapid Serial Visual Presentation (RSVP) is the presentation of items at a rate of 6 to 20 per second. Within a RSVP task, Raymond et al.(1992) asked subjects to report two targets (T1 and T2) at the end of the stream. The results showed a decrease in performance on T2 when T1 is correctly reported for distance between targets (lags) of 200 ms to 500 ms (Figure 1). This effect was named Attentional Blink.

Figure 1: Control condition.



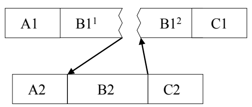
Schema 1:



Many Researchers tried to explain these results (Raymond et al., 1992, Chun and Potter, 1995). Among others, Jolicoeur et al. (2001) proposed a bottleneck model shown in Schema 1. Also, Shapiro et al. (1994) increased T1 processing difficulty. This resulted in a decreasing performance between 200 ms and 500 ms compared to the control condition.

Other researchers have shown all sorts of influence on this phenomenon (Chun and Potter, 1995, Shapiro et al., 1994). But it seems that all those manipulation have succeeded to influence the width but never abolished the decrease of performance completely. Therefore, we can question ourselves if this phenomenon is ballistic or if it can be controlled. In the case where it is ballistic, once T1 processing has started, it would result inevitably in a decrease of performance between 200 ms and 500 ms no matter what the subjects intentions are. In the other case if the process can be controlled, the subject could suspend T1 processing to identify T2 and resume T1 afterward, as seen in Schema 2.

Schema 2:



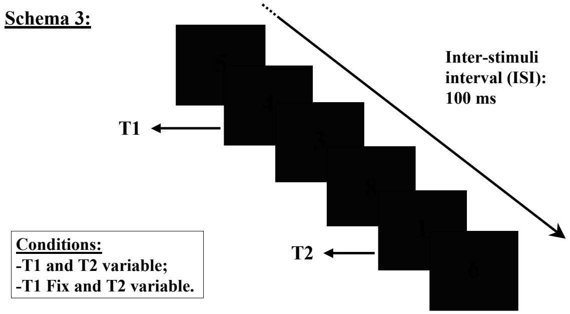
Experiment 1

In the first experiment, we confronted the ballistic hypothesis by informing the subject of the position of the first target. With this information, the subject could prepare to the arrival of the first target and save some attentional resources for the second target.

Method

The first condition was to replicate the AB effect. A RSVP of 16 digits, 14 white and two red (the targets). 12 subjects had to report the two digit at the end of the RSVP on the keyboard. Each digit was presented 100 ms. Each subject completed 400 trials. In the second condition, 12 subject were informed of the position of the first target and knew that this position would be constant for all 400 trials. Procedure is shown in Schema 3.

Schema 3:



Results

The results are shown in Figure 2. An ANOVA analysis showed a significant effect of lag ($F(7,154) = 27.31$, $p<0.01$) indicating the presence of an Attentional Blink effect (Figure 2). But no significant effect of the condition was found ($F(1,22) = 0.10$) except for the % of correct responses for T1 ($F(1,176) = 5.97$, $p<0.05$). The interaction between the lag and the condition was not significant ($F(7,154) = 0.76$).

Experiment 2

In the second experiment, we fixed the distance between the targets in the first condition and the positions of both targets in the second condition. By this manipulation, we wanted to look at the possibility of helping the subject by giving information on the second target, in the first condition relatively of the position of the first target, and in the second condition from the start of the RSVP.

Method

The method is the same has in experiment 1 except what follows. 48 subjects per condition completed 400 trials. In the first condition, the distance between the targets were known by the subjects. In the second, both T1 and T2 positions in the RSVP were known by the subjects.

Results

As shown in Figure 3, we found a significant effect of lag ($F(7,48) = 12.15$, $p<0.01$) indicating that our manipulation did not abolish the AB effect. We see a difference in lag 1 sparing, but this effect is currently not significant. We are running more subjects. We see no effect of the condition on the % of correct responses for T1 ($F(1,48) = 0.78$).

Figure 2: Conditions control (1) and T1 fixed (2).

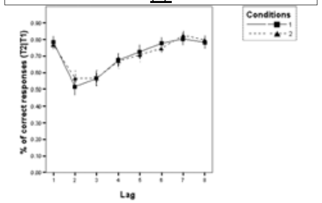
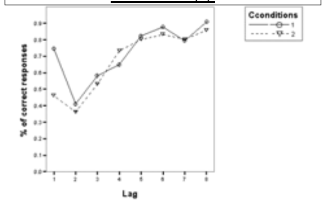


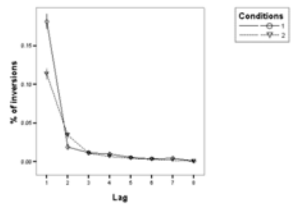
Figure 3: Conditions lag fixed (1) and both T1 and T2 fixed (2).



Inversions

Among other analysis, we looked at the number of inversion of the two targets in the report for the second experiment. The ANOVA showed a significant interaction of the condition and the lag ($F(7,80)=2.28$, $p<0.05$). Simple effect revealed a significant difference for lag 1 between the two conditions ($F(1,87)=4.52$, $p<0.05$), but no difference for the rest of the lags ($F(1,87) <1.00$). On this analysis, it looks like giving more information to the subjects helps them diminish the number of inversions in this task (Figure 4). Thus the decrease in performance seen in Figure 3 does not results from more inversion errors.

Figure 4: Inversions errors.



Discussion

These experiments question the ballisticity of the Attentional Blink effect. The first experiment suggests that whether the subjects know the position of the first target or not does not influence the presence of the parabolic curve. The only effect of the manipulation is the decrease in T1 performance for the second condition. Same thing is observed in the second experiment when the subjects are aware of, in the first case, the distance between the targets, and in the second case, the position of both targets. We conclude that Attentional Blink must be in large part ballistic. Even though the subjects possessed information to control the processing, they cannot influence treatment of the targets in the way shown in Schema 2. On the other hand, we saw that subject in the second condition of the second experiment had less inversions errors than in the first. This tells us that even though subject could not avoid decreasing performance during lag 2 to 5, they could augment their certainty of the order of the targets when they knew their position. In this way, we can think of a minimum of controllability of the process present in the Attentional Blink effect.

On this basis, we can conclude that Attentional Blink is a ballistic process, but some of its properties (like the number of inversions and the % of correct responses on T1 in Experiment 1) are not.

References

Chun, M.M., Potter, M.C. (1995). A two-stage model for multiple target detection in rapid serial visual presentation. *Journal of experimental psychology: human perception and performance*, **21,** 109-127.

Jolicoeur, P., Dell'Acqua, R., Crebolder, J.M. (2001). The attentional blink bottleneck. In K. Shapiro (ed), *The limits of attention: temporal constraints in human information processing*, pp. 82-99. New York: Oxford University Press.

Raymond, J.E., Shapiro, K.L., Arnell, K.M. (1992). Temporary suppression of visual processing in an RSVP task: an attentional Blink? *Journal of experimental psychology: human perception and performance*, **18,** 849-860.

Shapiro, K.L., Raymond, J.E., Arnell, K.M. (1994. Attention to visual pattern information produces the attentional blink in rapid serial visual presentation. *Journal of experimental psychology: human perception and performance*, 20, 357-371.