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Data-Limited Manipulations of T1 Difficulty Modulate the Attentional Blink

Troy A. W. Visser and Jeneva L. Ohan
University of British Columbia - Okanagan

Abstract When two targets are embedded in a temporal stream of distractors, second-target identification is initially impaired and then gradually improves as intertarget interval lengthens (attentional blink; AB). According to bottleneck models of the AB, difficulty of first-target processing should modulate the magnitude of the second-target deficit. To test this, we examined whether a data-limited manipulation of T1 difficulty (forward masking) would modulate AB magnitude. In two experiments, we show that data-limited manipulations of T1 difficulty do affect the AB, so long as T1 is not masked by an immediately trailing distractor. When such a trailing item is present, the relationship between T1 difficulty and the AB disappears.

Résumé When two targets are embedded in a temporal stream of distractors, second-target identification is initially impaired and then gradually improves as inter-target interval lengthens (attentional blink; AB). According to bottleneck models of the AB, difficulty of first-target processing should modulate the magnitude of the second-target deficit. To test this, we examined whether a data-limited manipulation of T1 difficulty (forward masking) would modulate AB magnitude. In two experiments, we show that data-limited manipulations of T1 difficulty do affect the AB, so long as T1 is not masked by an immediately trailing distractor. When such a trailing item is present, the relationship between T1 difficulty and the AB disappears.

When two targets are presented in rapid succession, identification of the first (T1) is nearly perfect, while identification of the second (T2) is severely impaired when it follows the first within about 500 ms (Chun & Potter, 1995; Jolicoeur & Dell'Acqua, 1998; Raymond, Shapiro, & Arnell, 1992). This second-target deficit has been termed the *attentional blink (AB)* in keeping with phenomenological reports that T2 is simply absent as though it had been presented during a physical eye blink.

Studies have demonstrated that the AB occurs for many types of stimuli such as colours (Ross & Jolicoeur, 1999), oriented gratings (Joseph, Chun, & Nakayama, 1998), and alphanumeric characters (e.g. Raymond et al., 1992). In addition, an AB has been obtained in visual (e.g. Chun & Potter, 1995), auditory (e.g., Arnell & Jolicoeur, 1999) and tactile (e.g., Dell'Acqua, Turatto, & Jolicoeur, 2001), modalities as well as when targets are presented in different modalities (e.g., Dell'Acqua et al., 2001).

The pervasive nature of the AB has spawned numerous theoretical accounts that have emphasized the role of central resource limitations. On these accounts, known as bottleneck models, target processing is said to proceed in two broad stages. In the first, incoming stimuli are scanned in parallel in order to flag potential targets. This analysis is relatively detailed; however, representations in Stage 1 are relatively short-lived and vulnerable to masking by trailing stimuli. For these reasons, representations must be passed on to a second stage of processing for short-term memory consolidation (Jolicoeur & Dell'Acqua, 1998), response planning, and execution (Chun & Potter, 1995).

According to bottleneck accounts, the AB arises at short intertarget intervals (lags) because T2 is presented while Stage 2 processing is busy with T1. This forces T2 to remain delayed in Stage 1 where it is vulnerable to decay or masking. On the other hand, when T1 and T2 are separated by a relatively lengthy temporal interval, second-stage processing of T1 is completed by the time T2 is presented. This allows T2 to gain immediate access to Stage 2 and thus escape decay or masking.

One key prediction of bottleneck models is that increasing processing time for T1 should yield a larger AB. This is because lengthier T1 processing should correspondingly increase the period of delay for T2 in Stage 1, and thus T2's vulnerability to decay and masking. This prediction has been the focus of much empirical investigation in recent years, which has yielded results both for and against bottleneck models. For example, Jolicoeur and Dell'Acqua (1998) compared T2 response times when T1 required encoding one letter or three letters. They reasoned that consolidation of three letters in memory would take longer than one letter, thereby delaying T2 in Stage 1 for longer and increasing T2 response times. This prediction was supported, with a large difference in T2 response times as a function of T1 encoding condition at shorter lags that disappeared as lag increased.

In contrast, McLaughlin, Shore, and Klein (2001) presented observers with a pair of central targets to identify, each followed by a single pattern mask. They manipulated T1 difficulty by reciprocally varying target and mask durations, while holding their interstimulus interval (ISI) and the total duration of the display constant. The goal of this manipulation was to vary available processing time for T1. For example, in the "easy" condition, T1 duration was 45 ms, the ISI was 15 ms, and the mask duration was 45 ms (total duration: 105 ms), while in the "hard" condition, T1 duration was 15 ms, the ISI was 15 ms, and the mask duration was 75 ms (total duration: 105 ms). McLaughlin et al. (2001) found that difficulty had a strong influence on T1 accuracy but no impact on the AB deficit.

In interpreting their failure to find an effect of T1 difficulty on the AB in light of other results to the contrary, McLaughlin et al. (2001) posited that the presence of such effects might depend on the type of difficulty manipulation employed. Specifically, they differentiated between "data-limited" manipulations, in which identification accuracy is impaired by degrading the target stimulus, and "resource-limited" manipulations, in which accuracy is impaired by limiting the availability of processing resources for the target (Norman & Bobrow, 1975). On the assumption that their masking manipulation primarily influenced stimulus quality, McLaughlin et al. suggested that data-limited manipulations of T1 difficulty do not yield variations in AB magnitude.

Before accepting this interpretation, however, it is important to consider whether other factors might have led to McLaughlin et al.'s (2001) failure to find a relationship between T1 difficulty and AB magnitude. One potentially relevant factor is their use of a mask presented after T1. Recently, Visser (in press) examined the role of T1 masking in modulating T1 difficulty effects. In his experiments, the T1 task could be an easy or difficult size discrimination task, or a visual search task in which T1 was presented amongst varying numbers of confusable distractors. In both cases, T1 was either followed by a mask or the mask was omitted. The results were straightforward: T1 difficulty modulated the AB when the mask was omitted, but had no effect on the AB when T1 was masked. To explain this, Visser suggested that the hard size discrimination task did increase T1 processing time. However, this increase was negated by the mask after T1, which interrupted target processing.

This result suggests a possible alternative explanation for the results of McLaughlin et al. (2001). As the authors themselves note (see McLaughlin et al., 2001, Footnote 6), it is likely that the trailing mask presented after T1 not only reduced stimulus quality but also interrupted target processing. This opens up the possibility that McLaughlin et al.'s masking manipulation did influence T1 processing time due to its effect on stimulus quality. However, this influence was at least partially offset by the interruption of T1 processing also caused by the mask. Thus, in the end, failure to find an effect of T1 difficulty was not due to the use of a data-limited difficulty manipulation per se, but rather to interruption of T1 processing by the mask, which effectively equated T1 processing time across levels of difficulty, thereby yielding similar AB deficits.

The goal of the present work was to test these alternative hypotheses in order to determine whether data-limited manipulations of T1 difficulty influence AB magnitude in the absence of interruption masking of T1. In order to ensure that our difficulty manipulation was truly data-limited, we made a number of procedural changes from the paradigms employed in Visser (in press). First, our experimental design eliminated task switches by presenting observers with two central letter targets that both required identification. Second, to prevent possible strategic changes in attentional deployment, difficulty was varied randomly from trial to trial, rather than manipulated between blocks of trials as in Visser. To vary the perceptual quality of T1, we presented a pattern mask at varying interstimulus intervals (ISIs) prior to T1. This procedure, known as forward masking, degrades the target in a manner akin to adding noise to a signal (Turvey, 1973), but does not interrupt target processing because the mask precedes the target. Finally, to examine the role of backward masking in modulating data-limited difficulty effects, we employed an additional mask presented after T1 in Experiment 2, but omitted this mask in Experiment 1.

To anticipate the results, we found a strong influence of T1 difficulty on the AB in Experiment 1, demonstrating the effectiveness of data-limited manipulations of T1 difficulty. Moreover, consistent with the results of Visser (in press), T1 difficulty effects were eliminated in Experiment 2 when a mask was inserted following T1.

Experiment 1

In Experiment 1, T1 difficulty was manipulated by presenting a mask prior to T1 in order to degrade its perceptual quality. On "easy" trials, the ISI between the

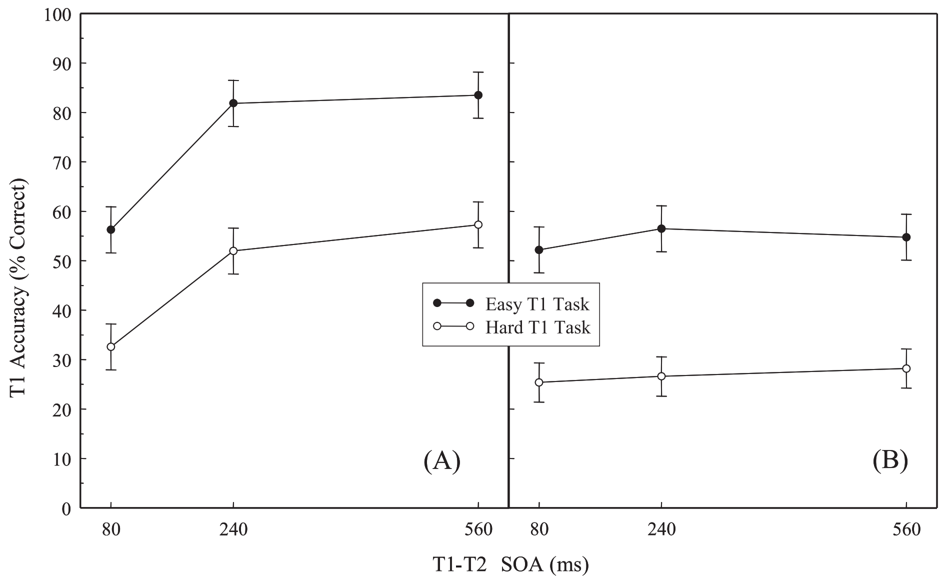

Figure 1. Panel A: Mean percentage of correct identification of the first target, calculated separately for "hard" (20 ms mask-target ISI) and "easy" (40 ms mask-target ISI) trials in Experiment 1. Panel B: Mean percentage of correct identification of the first target, calculated separately for "hard" (20 ms mask-target ISI) and "easy" (40 ms mask-target ISI) trials in Experiment 2. Error bars represent average 95% within-subjects confidence intervals (Loftus & Masson, 1994).

mask and T1 was 40 ms, while on "hard" trials, the mask-target ISI was 20 ms. Both T1 and T2 were letters to be identified, while masks consisted of keyboard symbols.

Participants

Twenty-four undergraduate students (18 female) participated for course credit or a small honorarium ($10). All participants reported normal or corrected-to-normal vision.

Apparatus and Stimuli

Stimuli were presented on a 19-inch Viewsonic monitor (Model G190T) running at a refresh rate of 100 Hz, slaved to a Pentium-4 computer running Presentation software (Version 0.91, Neurobehavioural Systems, 2004). The background and surrounding visual field were dark, except for dim illumination of the keyboard. All stimuli subtended approximately 1° of visual angle at a viewing distance of 60 cm. Targets were shown in upper-case Arial font (28 point; RGB: 75, 75, 75) and consisted of all letters of the English alphabet except I, O, Q, and Z, which were omitted due to their structural similarity to the digits 1, 0, 2, and 7. Target masks were symbols shown in Arial font (28 point; RGB: 250, 250, 250) that were chosen randomly from the set @, #, and %.

Design and Procedure

The experiment was approximately 35 minutes in length and comprised 240 trials equally divided between two T1 difficulty conditions and three T1-T2 temporal lags (80, 240, 560 ms). Before beginning the experiment, participants were given detailed written and oral instructions. They then performed practice trials until they reported being confident about the nature of the experimental procedure and their task.

Each trial began with a fixation cross in the centre of the screen. Participants were instructed to focus their gaze at fixation and press the spacebar to initiate a trial. Following a blank screen presented for 500-800 ms, a symbol mask was presented at the centre of the screen for 10 ms, followed by a blank screen for 40 ms (easy condition) or 20 ms (hard condition), followed by a central T1 for 10 ms. Depending on T1-T2 lag, T1 was followed by a blank screen for 70 (SOA: 80 ms), 230 (SOA: 240 ms), or 550 ms (SOA: 560 ms). Finally, T2 was presented centrally for 10 ms, followed by a 70 ms blank ISI, and then a single symbol mask in the same location as T2. The second target was always a different letter than the first target. Symbol masks were chosen randomly with replacement on each trial.

When the final symbol mask disappeared, the display remained blank as a signal to participants to report the letters presented during the trial by pressing appropriate keys on the keyboard. Responses could be

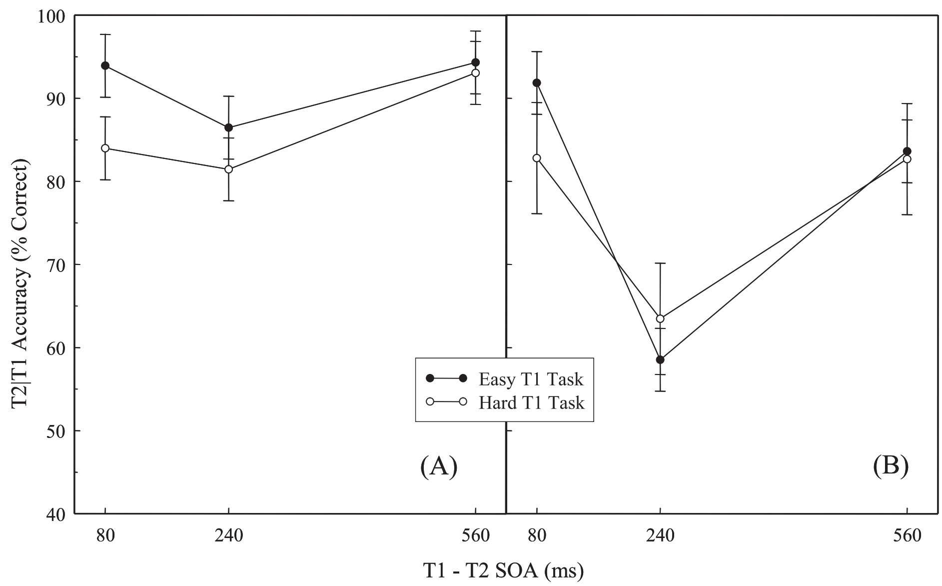

Figure 2. Panel A: Mean percentage of correct identification of the second target (given correct identification of the first), calculated separately for "hard" (20 ms mask-target ISI) and "easy" (40 ms mask-target ISI) trials in Experiment 1. Panel B: Mean percentage of correct identification of the second target (given correct identification of the first), calculated separately for "hard" (20 ms mask-target ISI) and "easy" (40 ms mask-target ISI) trials in Experiment 2. Error bars represent average 95% within-subjects confidence intervals (Loftus & Masson, 1994).

made in any order. After making two responses, the fixation cross reappeared and participants could begin the next trial by pressing the spacebar. Participants were encouraged to take rest breaks when required while the fixation cross was on the display.

Results and Discussion

Mean T1 accuracy levels were calculated as a function of lag and T1 difficulty. These means are plotted in Panel A of Figure 1. Inspection of the graph suggests that T1 accuracy was poorer in the "hard" condition than in the "easy" condition and that T1 accuracy increased slowly with lag.

To confirm these impressions, mean T1 accuracy was analyzed in a 2 (T1 Difficulty: "Hard" vs. "Easy") × 3 (Lag: 80, 240, 560 ms) repeated measures analysis of variance (ANOVA). This analysis revealed a significant main effect of Difficulty, $F(1, 23) = 58.13$, $p < .001$, confirming that overall T1 accuracy was poorer in the "hard" condition. There was also a significant effect of Lag, $F(2, 46) = 125.24$, $p < .001$, confirming that T1 performance varied with lag. The interaction between Difficulty and Lag was not significant, $F(2, 46) = 2.67$, $p = .08$.

Mean T2 accuracy levels were calculated as a function of lag and T1 difficulty. These means are shown in Panel A of Figure 2. Only trials on which T1 was identified correctly were included in these calculations on the grounds that when T1 was not identified correctly, it was impossible to determine whether it was attended. Inspection of the graph suggests that T2 accuracy followed a lag-dependent trend indicative of an AB regardless of T1 difficulty. More importantly, consistent with an influence of T1 difficulty on the AB, T2 accuracy was lower when T1 was "hard."

To confirm these impressions, mean T2 accuracy was analyzed in a 2 (T1 Difficulty) x 3 (Lag) repeated measures ANOVA. This analysis revealed a significant main effect of Lag, $F(2, 46) = 12.76$, $p < .001$, confirming that accuracy improved across lags as in the conventional AB. More importantly, there was also a main effect of Difficulty, $F(1, 23) = 7.93$, $p < .02$, and an interaction between Lag and Difficulty, $F(2, 46) = 3.31$, $p < .05$. The latter indicated that T2 accuracy was reduced in the "hard" task, yielding a correspondingly greater attentional blink.

The significant influence of T1 difficulty on T1 accuracy is consistent with previous findings (McLaughlin et al., 2001; Ward, Duncan, & Shapiro, 1997), and confirms that manipulation of mask-T1 ISI successfully influenced identification accuracy. More importantly, the significant effect of T1 difficulty on AB magnitude indicates that data-limited manipulations of T1 difficulty do influence the AB.

This result contrasts with the findings of McLaughlin et al. (2001) who did not obtain an effect of their T1 masking manipulation on the AB. However, one key difference between the present experiment and that of McLaughlin et al. (2001) is that they presented a mask after T1 which may have affected stimulus quality but also interrupted T1 processing. To test whether interruption masking might modulate the relationship between data-limited manipulations of T1 difficulty and the AB, we replicated Experiment 1, with the addition of a mask after T1. If interruption of T1 processing is a critical factor, then the addition of the mask should eliminate the effect of T1 difficulty on the AB found in Experiment 1.

Experiment 2

Participants

Twenty-four undergraduate students (19 female) participated for course credit or a small honorarium ($10). All participants reported normal or corrected-to-normal vision. None had participated in the previous experiment.

Apparatus and Stimuli

Apparatus and stimuli were identical to Experiment 1.

Design and Procedure

The design and procedure were identical to Experiment 1, except that a symbol mask was presented after T1 on trials on which the T1-T2 lag was 240 or 560 ms This mask was presented for 10 ms, and was separated from T1 by an ISI of 70 ms during which the screen was blank.

Results & Discussion

Responses to T1 and T2 were recorded as correct regardless of order of report. Mean T1 accuracy levels were calculated as a function of lag and T1 difficulty. These means are plotted in Panel B of Figure 1. Inspection of the graph suggests that T1 accuracy was poorer in the "hard" condition than in the "easy" condition.

To confirm this impression, mean T1 accuracy was analyzed in a 2 (T1 Difficulty) × 3 (Lag) repeated-measures ANOVA. This analysis revealed a significant main effect of Difficulty, $F(1, 23) = 107.82$, $p < .001$, confirming that overall T1 performance was poorer in the "hard" condition. No other effects were significant ($p >$ .17).

Mean T2 accuracy levels were calculated as a function of lag and T1 difficulty. These means are shown in Panel B of Figure 2. Inspection of the graph suggests that T2 accuracy followed a lag-dependent trend indicative of an AB regardless of T1 difficulty. Moreover, while difficulty modulated T2 accuracy at the shortest lag, there was no influence of difficulty at later lags. To confirm these impressions, mean T2 accuracy was analyzed in a 2 (T1 Difficulty) × 3 (Lag) repeated-measures ANOVA. This analysis revealed only a significant main effect of Lag, $F(2, 46) = 30.03$, $p < .001$, consistent with the presence of an AB across conditions. Importantly, no other effects were significant ($p > .12$). Moreover, effect sizes were less than .09, suggesting that our failure to find an effect of T1 difficulty was not due to a lack of statistical power. Finally, a planned comparison at the shortest lag revealed a significant difference in T2 accuracy, $t(23) = 1.87$, $p < .04$ (one-tailed).

At first glance, the fact that T1 difficulty influenced AB magnitude at the shortest lag in the present experiment might seem to countermand the importance of T1 masking in modulating the influence of difficulty. However, it is important to note that the presentation conditions at this lag were identical in both Experiment 1 and 2 (i.e., T1 premask, T1, T2) and thus similar effects should have arisen in both experiments. That said, persistent effects of T1 difficulty at the shortest lag are noteworthy because they illustrate the differential effects of target and nontarget trailing items on T1 processing. When T2 is presented directly after T1, it competes for attentional resources (e.g., Potter, Staub, & O'Conner, 2002; Visser et al., 1999), leading to Lag-1 sparing (Potter, Chun, Banks, & Muckenhoupt, 1998) as well as generally more pronounced T1 accuracy deficits relative to later lags. In contrast, when a nontarget (i.e., a mask) is presented after T1, it interrupts T1 processing, leading to reduced T1 accuracy relative to when T1 is not masked.

The present results support the hypothesis that McLaughlin et al.'s (2001) failure to find an effect of T1 difficulty on the AB was due to interruption masking of T1, rather than the use of a data-limited manipulation of difficulty per se. On this account, while McLaughlin et al.'s data-limited manipulation did influence T1 processing time, these differences were negated by interruption of T1 processing. This outcome is also consistent with earlier findings by Visser (in press), which demonstrated that the presence of a mask after T1 eliminated the influence of T1 difficulty on the AB when T1 was a difficult size discrimination task. Taken together, these results strongly imply that interruption masking of T1 obviates the influence of T1 difficulty on the AB whether difficulty manipulations are data-limited, such as in the present work, resource-limited (Shore, McLaughlin, & Klein, 2001; Ward et al., 1997), or involve intertarget switches in task, stimulus, or spatial location (Visser, in press).

General Discussion

According to bottleneck theories of the AB, the duration of T1 processing should be related to AB magnitude, such that longer T1 processing times should yield a larger AB. A number of experiments have tested this prediction by manipulating T1 difficulty and observing its effects on T2 accuracy (e.g., McLaughlin et al., 2001; Shore et al., 2001; Ward et al, 1997). These efforts have yielded mixed results with evidence both for (e.g., Jolicoeur & Dell'Acqua, 1998) and against (e.g., McLaughlin et al., 2001) a link between T1 difficulty and the AB.

In light of these differences, it is desirable to determine factors that mediate the relationship between T1 difficulty and the AB. One factor that has been suggested by McLaughlin et al. (2001) is the use of either resource-limited or data-limited manipulations of difficulty. They argued that while resource-limited manipulations will influence AB magnitude, data-limited manipulations will not. This followed from their failure to find modulations in T2 performance when difficulty was varied using a mask presented after T1.

The present work examined whether data-limited manipulations of T1 difficulty influenced AB magnitude, and whether previous attempts to evaluate this question (McLaughlin et al., 2001) did not show difficulty effects due to interruption masking of T1. On this account, data-limited manipulations of T1 difficulty should modulate AB magnitude when there is no mask presented after T1 to interrupt processing, but not when such a mask is present. Our results supported this conjecture: T2 accuracy varied as a function of T1 difficulty in Experiment 1, when no mask was presented after T1. On the other hand, T1 difficulty had no effect on T2 accuracy in Experiment 2, when a mask was presented after T1.

One question that arises from the present work concerns the nature of processing interrupted by the mask presented after T1. As discussed earlier, bottleneck models of the AB propose that incoming stimuli are processed in two broad stages at which stimulus representations vary in their vulnerability to masking. In Stage 2, representations are invulnerable to masking; in Stage 1, representations are vulnerable both to decay and masking. On the basis of this distinction, Visser (in press) suggested that a mask presented after T1 terminates perceptual processing of T1 at Stage 1. This, in turn, has two effects. First, it reduces T1 accuracy by preventing the visual system from processing the target sufficiently for accurate identification. This effect is clearly revealed in the present work in the reduced levels of T1 accuracy in Experiment 2 where T1 was masked by a trailing item relative to Experiment 1 where the trailing item was omitted. Second, and more relevant for the AB, by terminating perceptual processing of T1, the mask effectively negates differences in T1 processing time that would normally arise from variations in T1 difficulty. This, in turn, eliminates the influence of T1 difficulty on AB magnitude.

With respect to the implications of the present results for theoretical models of the AB, it is clear that our results confirm predictions of bottleneck models. These accounts posit that T1 processing difficulty (Chun & Potter, 1995) should be strongly related to AB magnitude. In turn, this implies that increases in difficulty that increase T1 processing time (Visser, in press) will yield a larger AB. This pattern of results was demonstrated in Experiment 1. Our results also suggest a potential explanation for previous failures to find a relationship between T1 difficulty and AB magnitude (e.g., McLaughlin et al., 2001; Ward et al., 1997). In these experiments, T1 was always followed by a trailing mask that interrupted T1 processing. The findings in Experiment 2 suggest that this interruption may have negated the effect of their difficulty manipulations by equating T1 processing time across levels of difficulty. Finally, our results are also consistent with the "temporary loss of control" notion advanced by Di Lollo, Kawahara, Ghorashi, & Enns, 2005). According to these authors, observers in an AB task establish an attentional set in order to selectively attend to targets while ignoring distractors. Because maintenance of this set requires attentional resources, however, it is vulnerable to being disrupted if a distractor is presented while T1 is being attended. In turn, disruption of the attentional set will impair T2 processing. Such disruptions might also account for the overall reduction in T2 accuracy in Experiment 2 relative to Experiment 1 when no mask intervened between targets.

In summary, it is clear that a relationship between T1 difficulty and the AB can be shown when difficulty is manipulated via data-limitation or resource-limitation (e.g. Shore et al., 2001; Visser, in press). This supports the validity of bottleneck models in explaining the AB across a variety of experimental conditions, and helps to account for previous discrepant findings in the AB literature.

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All correspondence should be addressed to Troy A. W. Visser, Psychology Department,University of British Columbia - Okanagan, 3333 University Way, Kelowna, British Columbia V1Y 1V7 Canada (Phone: 1 250 762-5445; E-mail: troy.visser@ubc.ca).

References

Arnell, K. M., & Jolicoeur, P. (1999). The attentional blink across stimulus modalities: Evidence for central processing limitations. *Journal of Experimental Psychology: Human Perception & Performance*, *25*, 630-648.

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.

Dell'Acqua, R., Turatto, M., & Jolicoeur, P. (2001). Cross-modal attentional deficits in processing tactile stimulation. *Perception and Psychophysics*, *63*, 777-789.

Di Lollo, V., Kawahara, J., Ghorashi, S. M. S., & Enns, J. T. (2005). The attentional blink: Resource depletion or temporary loss of control? *Psychological Research*, *69*, 191-200.

Jolicoeur, P., & Dell' Acqua, R. (1998). The demonstration of short-term consolidation. *Cognitive Psychology*, *36*, 138-202.

Joseph, J. S., Chun, M. M., & Nakayama, K. (1997). Attentional requirements in a preattentive feature search task. *Nature*, *387*, 805-808.

Loftus, G. R., & Masson, M. E. J. (1994). Using confidence intervals in within-subject designs. *Psychonomic Bulletin and Review*, *1*, 476-490.

McLaughlin, E. N., Shore, D. I., & Klein, R. M. (2001). The attentional blink is immune to masking-induced data limits. *Quarterly Journal of Experimental Psychology*, *54A*, 169-196.

Neurobehavioral Systems (2004). Presentation Version 0.91 [online]. Available from: www.neuro-bs.com [2004, December, 28].

Norman, D. A., & Bobrow, D. G. (1975). On data-limited and resource-limited processes. *Cognitive Psychology*, *7*, 44-64.

Potter, M. C., Chun, M. M., Banks, B.S., & Muckenhoupt, M. (1998). Two attentional deficits in serial target search: The visual attentional blink and an amodal task-switch deficit. *Journal of Experimental Psychology: Learning, Memory, and Cognition*, *24*, 979-992.

Potter, M. C., Staub, A., & O'Connor, D. H. (2002). The time course of competition for attention: Attention is initially labile. *Journal of Experimental Psychology: Human Perception and Performance, 28*, 1149-1162.

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.

Ross, N. E., & Jolicoeur, P. (1999). Attentional blink for color. *Journal of Experimental Psychology: Human Perception and Performance*, *25*, 1483-1494.

Shore, D. I., McLaughlin, E. N., & Klein, R. M. (2001). Modulation of the attentional blink by differential resource allocation. *Canadian Journal of Experimental Psychology*, *55*, 318-324.

Turvey, M. T. (1973). On peripheral and central processes in vision: Inferences from an information-processing analysis of masking with patterned stimuli. *Psychological Review*, *80*, 1-52.

Visser, T. A. W. (in press). Masking T1 difficulty: Processing time and the attentional blink. *Journal of Experimental Psychology: Human Perception and Performance*.

Ward, R., Duncan, J., & Shapiro, K. (1997). Effects of similarity, difficulty, and nontarget presentation on the time course of visual attention. *Perception & Psychophysics*, *59*, 593-600.