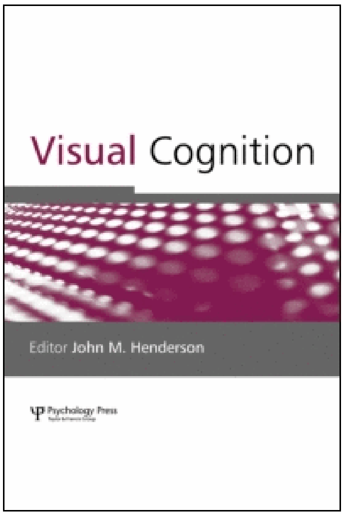
This article was downloaded by: *[CDL Journals Account]*
On: *24 March 2009*
Access details: *Access Details: [subscription number 786945862]*
Publisher *Psychology Press*
Informa Ltd Registered in England and Wales Registered Number: 1072954 Registered office: Mortimer House, 37-41 Mortimer Street, London W1T 3JH, UK



Visual Cognition
Publication details, including instructions for authors and subscription information:
http://www.informaworld.com/smpp/title~content=t713683696

Target-target similarity and the attentional blink: Task-relevance matters!

Jocelyn L. Sy [a]; Barry Giesbrecht [a]
[a] University of California, Santa Barbara, CA, USA

First Published on: 01 September 2008

To cite this Article Sy, Jocelyn L. and Giesbrecht, Barry(2008)'Target-target similarity and the attentional blink: Task-relevance matters!',Visual Cognition,17:3,307 — 317

To link to this Article: DOI: 10.1080/13506280802349746

URL: http://dx.doi.org/10.1080/13506280802349746

PLEASE SCROLL DOWN FOR ARTICLE

Full terms and conditions of use: http://www.informaworld.com/terms-and-conditions-of-access.pdf

This article may be used for research, teaching and private study purposes. Any substantial or systematic reproduction, re-distribution, re-selling, loan or sub-licensing, systematic supply or distribution in any form to anyone is expressly forbidden.

The publisher does not give any warranty express or implied or make any representation that the contents will be complete or accurate or up to date. The accuracy of any instructions, formulae and drug doses should be independently verified with primary sources. The publisher shall not be liable for any loss, actions, claims, proceedings, demand or costs or damages whatsoever or howsoever caused arising directly or indirectly in connection with or arising out of the use of this material.

VISUAL COGNITION, 2009, 17 (3), 307–317

Psychology Press
Taylor & Francis Group

Target–target similarity and the attentional blink: Task-relevance matters!

Jocelyn L. Sy and Barry Giesbrecht
University of California, Santa Barbara, CA, USA

Studies of the attentional blink (AB) indicate that similarity modulates the magnitude of the impairment in reporting the second of two masked targets. The present experiments tested whether similarity-based modulations of the AB are determined by all object dimensions or by task-relevant dimensions only. Similarity between target faces was manipulated on two dimensions, only one of which was task relevant. The results indicated that similarity on the task-relevant dimension modulated the AB, whereas similarity on task-irrelevant dimension did not. These results suggest that selection during the AB can occur on the level of task-relevant dimensions.

Keywords: Attentional blink; Similarity; Relevance; Faces; Emotion

Attention facilitates the selective processing of information that is relevant to one's behavioural goals. Although this selectivity supports coherent behaviour, the capacity of these attentional mechanisms is limited. For instance, when objects are presented in rapid serial visual presentation (RSVP) and two task-relevant objects are to be identified, there is a severe deficit in reporting the second target (T2) if it is presented within 200–500 ms after the first attended target (T1; e.g., Raymond, Shapiro, & Arnell, 1992). This deficit is known as the attentional blink (AB; Raymond et al., 1992).

The AB has been used as a tool to investigate the temporal distribution of selective attention by investigating the factors that determine the severity of the T2-deficit. One key factor that modulates the AB is the similarity between the items in the RSVP stream. For instance, *target–distractor* similarity modulates the AB, such that high perceptual or categorical similarity leads to a more severe deficit (Chun & Potter, 1995; Maki, Bussard, Lopez, & Digby, 2003; Shapiro, Raymond, & Arnell, 1994).

Please address all correspondence to Jocelyn L. Sy, Department of Psychology, University of California, Santa Barbara, CA 93106, USA. E-mail: sy@psych.ucsb.edu

We thank Ed Awh, Bruno Breitmeyer, and an anonymous reviewer for their constructive comments. Support was provided by NIH grant R03MH070638.

http://www.psypress.com/viscog DOI: 10.1080/13506280802349746

Borrowing from classic competition-based models of visual search that emphasize target–distractor similarity at the object level (e.g., Duncan & Humphreys, 1989), classic AB models posit that potential target objects compete for access to (Chun & Potter, 1995), or retrieval from (Raymond, Shapiro, & Arnell, 1995; Shapiro et al., 1994), resource-limited processing stages. Critically, because selection occurs at the object level, increased target–distractor similarity on any object dimension increases competition and results in a larger AB.

More recently, it has been demonstrated that *target–target* similarity also modulates the AB, such that the deficit is more severe when both targets demand the same type of processing compared to when the targets do not require the same type of processing (Awh et al., 2004). The modulation of the AB by target–target similarity has been explained within the context of the multiple-resource channel hypothesis (MRCH; Awh et al., 2004). According to the MRCH, target–target similarity magnifies the AB because the processing requirements of the targets overlap, therefore taxing the same mechanisms and, in effect, creating multiple bottlenecks prior to consolidation for report. When the targets are dissimilar, the overlapping processing demands are reduced, thereby reducing the likelihood of introducing multiple bottlenecks in processing.

The purpose of the present set of experiments was to test the influence of target–target similarity on task-relevant and task-irrelevant dimensions on the AB. Although models of the AB that explain the influence of *target–distractor* similarity (e.g., Chun & Potter, 1995; Shapiro et al., 1994) specify that all object dimensions should be important, models that explain the influence of *target–target* similarity (i.e., Awh et al., 2004) are not completely specified because manipulations of similarity have been typically on dimensions that are task relevant (i.e., dimensions that either define the target or require a response). Therefore, based on these studies alone, the influence of similarity on task-irrelevant dimensions is unclear. We report two experiments that manipulated T1–T2 similarity on task-relevant and task-irrelevant object dimensions. In each experiment, subjects viewed RSVP streams of faces that varied in their gender and valence. In Experiment 1, gender was task relevant and valence was task irrelevant. In Experiment 2, gender was relevant and valence was irrelevant for half of the experiment, whereas in the other half of the experiment, valence was relevant and gender was irrelevant. In both experiments, T1 and T2 were defined as targets by a coloured border that surrounded each face. Thus, unlike previous studies, the manipulation of similarity was done on object dimensions (i.e., gender and valence) that were orthogonal to the feature that defined T1 and T2 as targets (i.e., colour). If similarity on all object dimensions modulates the severity of the AB, then T2-report should be most impaired when the targets are similar on both gender and valence dimensions relative to when the targets are dissimilar on both dimensions. In addition, T2-report should fall between these two extremes when the targets are the same in one dimension and different in the other, regardless of task relevance. In contrast, if similarity on task-relevant dimensions is the key factor in influencing the AB, then the most severe impairments in T2-report should be observed when the targets are the same on the task-relevant dimension independent of the similarity on the task-irrelevant dimension. To anticipate the findings, T2-report was modulated by target similarity on the task-relevant dimension, but not similarity on the task-irrelevant dimension. These results are inconsistent with the notion that selection during the AB occurs at the object level only, but rather suggest that the processing limitation that gives rise to the AB can be based on the selective processing of task-relevant object dimensions.

EXPERIMENT 1

Participants viewed RSVP streams of faces that varied independently on two dimensions: Gender and valence. Participants were instructed to discriminate only the face gender of T1 and T2; face valence was not mentioned. Thus, gender was task relevant and valence was task irrelevant. If all object dimensions are selected for access to resource-limited stages of processing, then similarity on both task-relevant gender and task-irrelevant valence dimensions should modulate the AB. However, if task-relevant dimensions are the key factor in determining the effect of target–target similarity, then only similarity on the relevant gender dimension should modulate the AB.

Method

Participants. Fifty-three undergraduates (36 females) volunteered for class credit.

Stimuli. Pictures of neutral, happy, and fearful male and female faces were selected from the Pictures of Facial Affect Database (Ekman & Freisen, 1976). All pictures were $4.16^\circ \times 2.86^\circ$ and surrounded by a 0.91° frame. Grey frames marked the distractors (grey values were randomized). A pink frame bordered T1 and a green frame bordered T2. All stimuli were presented on 19-inch colour monitors with a black background and viewed from a distance of 110 cm.

Procedure. Participants initiated each trial by pressing the spacebar on the keyboard. Fifteen faces were presented sequentially at fixation (duration = 80 ms; ISI = 80 ms). The sequences were constrained so that: 2–5 items were presented before T1, distractor faces were never the same identity as the targets, targets were never the same identity, and no face was repeated within three stream items. The trial sequence is illustrated in Figure 1.

Participants indicated the gender of T1 and T2 at the end of each trial. T1 and T2 responses were mapped onto separate pairs of keys on a number pad (4–6 and 2–8) and the mapping was counterbalanced across subjects. To minimize response biases, participants were explicitly instructed that all possible combinations of T1–T2 gender were equally probable. After the unspeeded responses were recorded, the participants initiated the next trial when ready.

Design. There were three factors. First, T1–T2 similarity on the task-relevant dimension was manipulated such that the targets could be the same

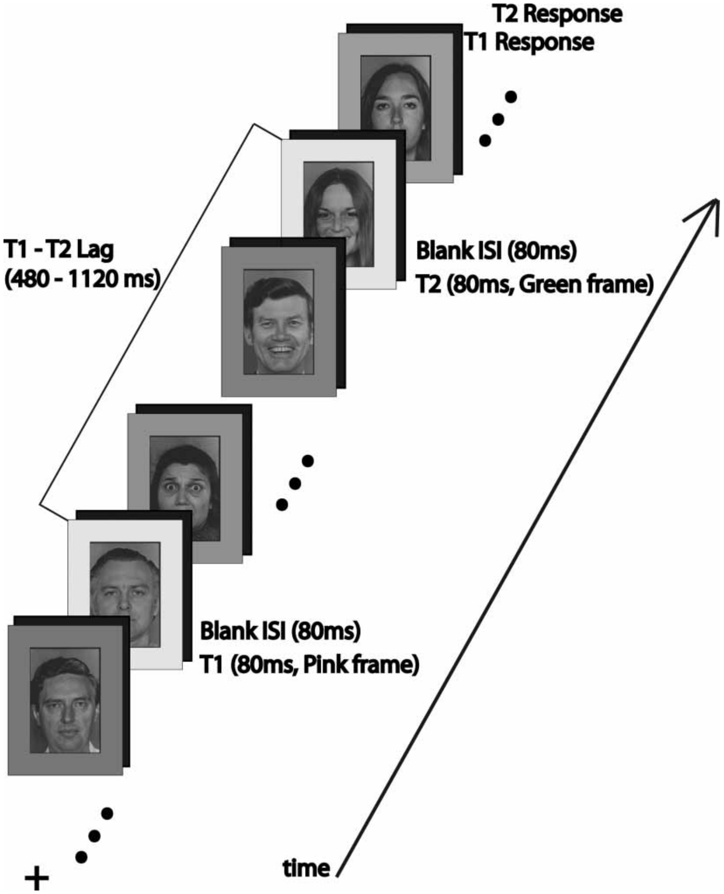


Figure 1. Sample trial sequence.

(e.g., T1-female/T2-female) or different (e.g., T1-male/T2-female). Second, T1–T2 similarity on the task-irrelevant dimension was manipulated such that targets could be the same (e.g., T1-fearful/T2-fearful) or different (e.g., T1-fearful/T2-neutral). Finally, the T1–T2 lag was manipulated such that T2 was either the third (lag 3) or the seventh (lag 7) item after T1. There were 20 trials per condition.

Results and discussion

Six participants were excluded from the analysis because of low T1-accuracy (>3 *SD* below the mean). The remaining 47 participants were included in all analyses. Overall mean proportion of T1-correct responses was .91.

Mean proportion of T2-correct responses on trials in which T1 was reported correctly (T2|T1) is shown in Figure 2 as a function of T1–T2 lag, T1–T2 similarity on the task-relevant dimension, and T1–T2 similarity task-irrelevant dimension. Overall, T2-accuracy was lower at lag 3 than lag 7, $F(1, 46) = 138.82$, $MSE = 1.19$, $p < .001$, indicative of a robust AB. Accuracy was also lower when targets were the same gender (mean = 0.84) than when targets were different genders (mean = 0.91), $F(1, 46) = 43.35$, $MSE = 0.47$, $p < .001$. Critically, there was a significant interaction between task-relevant similarity and lag, such that the AB was largest when targets were the same gender than when they were different genders, $F(1, 46) = 26.36$, $MSE = 0.22$, $p < .001$. Notably, there was no influence of task-irrelevant (valence) similarity on T2-accuracy, $F(1, 46) = 0.02$, $MSE = 0.00003$, $p > .90$, and no Task-irrelevant similarity × Lag interaction, $F(1, 46) = 0.36$, $MSE = 0.001$, $p > .55$.

The presence of the interaction between T1–T2 gender similarity and lag combined with the absence of an interaction between valence similarity and lag is consistent with the hypothesis that modulation of the AB by similarity is not driven by all object dimensions, but rather can be limited to task-relevant dimensions only. However, there are two alternative hypotheses that must be addressed. The first is that the performance decrement observed when T1 and T2 were the same gender is caused by repetition blindness (RB; e.g., Kanwisher, 1987) rather than by a bottleneck in processing task-relevant dimensions. Although T1 and T2 repeated genders, an RB account of the similarity effect observed here is unlikely because T1 and T2 were never repetitions of the exact same face and their distinctiveness was made more apparent by the use of different selection features (i.e., coloured border). Moreover, a RB explanation would posit that similarity on the task-irrelevant dimension should influence performance, but in contrast to this prediction, similarity on the task-irrelevant dimensions did not modulate the AB. A second alternative is that the reduced performance in the same gender

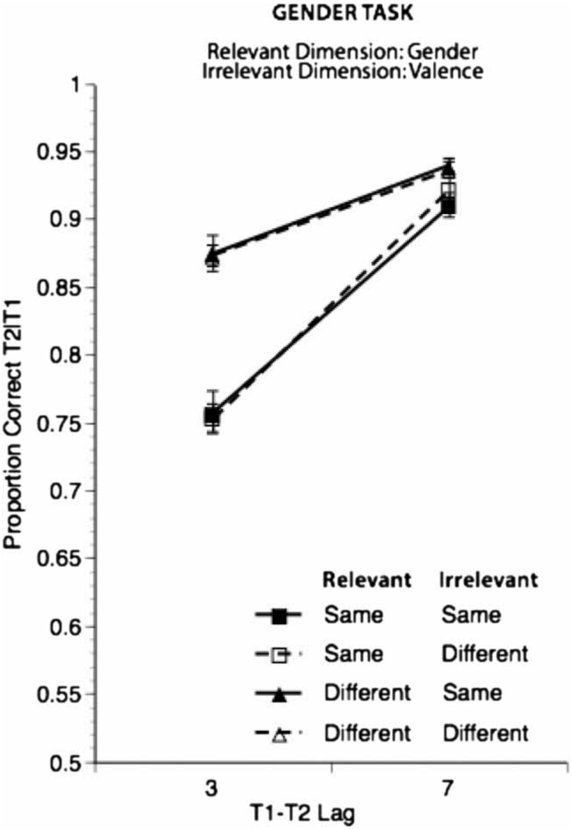


Figure 2. Experiment 1. T2|T1 accuracy as a function of lag, T1–T2 task-relevant dimension similarity, and T1–T2 task-irrelevant dimension similarity.

condition is caused by a bias against giving the same response for T1 and T2. Although this alternative cannot be ruled out completely, a response bias account is also unlikely because participants were explicitly instructed that trials with similar targets were equally likely as trials with dissimilar targets. Moreover, a response bias account would predict that performance should be modulated by similarity both during the AB and outside the AB, where responses biases were equivalent; however, the convergence of performance across conditions at lag 7 demonstrates that this is not the case. Thus, in contrast to these alternative hypotheses, we propose that the modulation of the AB by T1–T2 gender similarity, but not by valence similarity, is evidence that the influence of T1–T2 similarity on the AB can be constrained to task-relevant dimensions that compete for access to limited capacity processing stages.

EXPERIMENT 2

Experiment 2 tested whether the effect of target–target similarity observed in experiment 1 was specific to the gender dimension rather than the selection of relevant information per se. To address this possibility, participants performed a gender *and* a valence task. If task-relevant similarity accounts for the modulation of the AB, then similarity on either task-relevant dimension should modulate T2-report. However, if the modulation of the AB was specific to the gender dimension, then target–target similarity on the gender dimension should influence the AB regardless of its relevance.

Method

Participants. Thirty-four undergraduates (23 females) volunteered for class credit.

Stimuli, procedure, and design. There were two methodological changes from Experiment 1. First, neutral faces were omitted. Second, in separate blocks participants discriminated either the gender or valence of the target faces. Task order was counterbalanced across participants. These changes resulted in a design with four independent variables: Task (gender/valence), relevant relationship (same/different), irrelevant relationship (same/different), and lag (3/7).

Results

Two participants were excluded because of poor T1-accuracy (>3 *SD* from the mean). The remaining 32 participants were included in all analyses. The mean proportion of T1-correct responses was .84. There was a main effect of task, $F(1, 31) = 88.90$, $MSE = 1.18$, $p < .001$, such that T1-accuracy was lower on the valence task (mean = 0.78) than on the gender task (mean = 0.90).

Analysis of the mean proportion of correct T2|T1 responses (Figure 3) revealed a significant effect of lag, indicative of an AB, $F(1, 31) = 98.49$, $MSE = 2.356$, $p < .001$. Task did not interact with lag, $F(1, 31) = 1.81$, $MSE = 0.02$, $p > .18$. As with Experiment 1, there was a significant main effect of task-relevant similarity, such that accuracy was lower when targets were the same (mean = 0.77) than when the targets were different (mean = 0.82), $F(1, 31) = 10.85$, $MSE = 0.35$, $p < .003$. There was an interaction between task-relevant similarity and task, such that the effect of task-relevant similarity was smaller in the valence task than in the gender task, $F(1, 31) = 4.42$, $MSE = 0.09$, $p < .05$. There was also a three-way

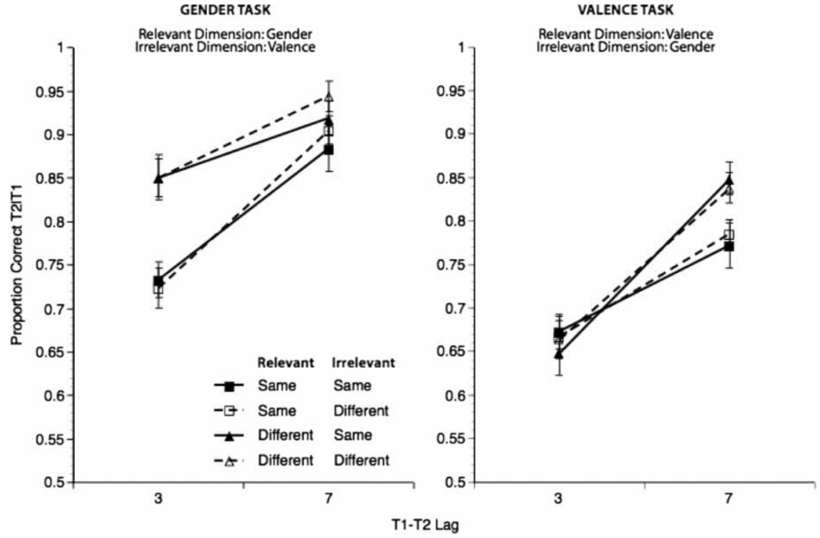


Figure 3. Experiment 2. T2|T1 accuracy in (A) gender and (B) valence tasks as a function of lag, T1–T2 task-relevant dimension similarity, and T1–T2 task-irrelevant dimension similarity.

interaction between task, lag, and task-relevant similarity, $F(1, 31) = 18.08$, $MSE = 0.22$, $p < .001$. This interaction was such that overall accuracy in the gender task was worse and AB magnitude was largest when targets were the same than when targets were different on the task-relevant gender dimension, thus replicating Experiment 1. Similarly, valence task performance was modulated as a function of target similarity on the relevant valence dimension; however, the effect was largest at lag 7.

Separate repeated measures ANOVAs were conducted for each task. Both analyses revealed an interaction between lag and task-relevant similarity: Gender, $F(1, 31) = 7.98$, $MSE = 0.12$, $p < .01$; and valence, $F(1, 31) = 6.03$, $MSE = 0.10$, $p < .02$. In both tasks, the accuracy deficit was greater when the targets were similar on the task-relevant dimension compared to when the targets were dissimilar. There was no main effect of task-irrelevant similarity in either task: Gender, $F(1, 31) = 0.87$, $MSE = 0.006$, $p > .35$; valence, $F(1, 31) = 0.05$, $MSE = 0.0007$, $p > .82$, and no interactions between task-irrelevant similarity and lag in either task: Gender, $F(1, 31) = 1.57$, $MSE = 0.01$, $p > .22$; valence, $F(1, 31) = 0.26$, $MSE = 0.0002$, $p > .87$. The pattern of results in the valence task indicates the similarity effects found in Experiment 1 were not specific to the gender dimension, but that similarity between targets on the task-relevant dimensions is a key factor in influencing the AB.

GENERAL DISCUSSION

The present experiments investigated the extent to which task relevance and similarity impact the AB. The results indicated that target–target similarity on the task-relevant dimension influenced T2-accuracy, but similarity on the task-irrelevant dimension did not. These results are consistent with the hypothesis that the effects of T1–T2 similarity on the AB are not solely driven by all object dimensions, but rather can be restricted to task-relevant dimensions.

Although the present experiments were not specifically designed to discriminate between all models of the AB, the results can nevertheless be brought to bear on those models that explain effects of similarity.[1] The MRCH (Awh et al., 2004) is the most germane to the present work because it emphasizes similarity between T1 and T2 processing demands. According to the MRCH, the severity of the AB depends on the extent to which T1 and T2 processing taxes the same mechanisms: As the processing mechanisms required for T2 discrimination increase in overlap with those required for T1 discrimination, the severity of the AB also increases. Although according to this scheme similarity in processing demands plays a key role in determining the magnitude of the AB, there is a key distinction between this model and the present experiments: The MRCH emphasizes processing overlap for *different* types of perceptual discriminations, whereas the present experiments emphasize importance of processing overlap on task-relevant and task-irrelevant dimensions of the *same* perceptual discrimination. Therefore, the present results suggest a modification of the MRCH that specifies that similarity between the task-relevant dimensions required for the T1 and T2 discriminations is also a key factor that determines processing overlap.

The present results are also relevant for classic resource-limited models of the AB that have explained the effects of similarity by relying on competition-based models of attention that posit that selection is based on all object-dimensions (e.g., Chun & Potter, 1995; Raymond et al., 1995; Shapiro et al., 1994). For instance, the interference model (Raymond et al., 1995; Shapiro et al., 1994), suggests that increased similarity, particularly between the first post-T1 item and T2, decreases the amount of resources required for T2-processing in visual short-term memory (VSTM) resulting

---

[1] This discussion excludes models that posit that the AB represents a limitation in the formation and control of target templates (DiLollo, Kawahara, Ghorashi, & Enns, 2005; Nieuwenstein, Chun, van der Lubbe, & Hooge, 2005) or object files (Kellie & Shapiro, 2004; Raymond, 2003). Rather than emphasizing similarity, these models emphasize task-relevance because the templates (object files) are defined by what is task-relevant. However, because these models claim that the post-T1 items are critical for disrupting the T2 template, they do not readily account for the present finding that target–target similarity influences the AB.

in a larger AB deficit. The two-stage model (Chun & Potter, 1995) suggests that increased similarity, particularly between T1 and the distractors, increases the duration of T1-processing resulting in a prolonged bottleneck that prevents T2 access to VSTM. Since the key factor in these models is similarity between a target (T1 or T2 depending on the model) and one or more distractors on the object level, these models do not readily account for the finding that target–target similarity on task-relevant dimensions modulates the AB while similarity on task-irrelevant dimensions does not.

CONCLUDING REMARKS

Although the present findings suggest that selection occurs on task-relevant dimensions, it is unlikely that this is always the case. Indeed, in contrast to the present findings, several studies have shown that task-irrelevant information is processed during the AB (Arend, Johnston, & Shapiro, 2006; Jiang & Chun, 2001). This discrepancy between studies of the AB is paralleled by conflicting findings in the face processing literature, which demonstrate that under some conditions task-irrelevant dimensions of faces modulate cortical activity (Ganel, Valyear, Goshen-Gottstein, & Goodale, 2005), whereas under other conditions task-irrelevant dimensions of faces do not modulate activity (Pessoa, McKenna, Gutierrez, & Ungerleider, 2002). These discrepancies can be reconciled by recent studies of the AB showing that the extent to which information is processed during the AB, both task-relevant and task-irrelevant, depends on task demands (Giesbrecht, Sy, & Elliott, 2007; Giesbrecht, Sy, & Lewis, in press) and by studies of spatial attention demonstrating that the extent to which task-irrelevant information is processed depends on task demands (e.g., Lavie, 1995; Wei & Zhou, 2006). Thus, within this broader context, the present results support the notion that selective attention may not only filter irrelevant objects, but may also filter irrelevant object dimensions, thereby constraining similarity effects on behaviour to dimensions relevant to the task at hand.

REFERENCES

Arend, I., Johnston, S., & Shapiro, K. (2006). Task-irrelevant visual motion and flicker attenuate the attentional blink. *Psychological Bulletin and Review, 13*(4), 600–607.

Awh, E., Serences, J., Laurey, P., Dhaliwal, H., van der Jagt, T., & Dassonville, P. (2004). Evidence against a central bottleneck during the attentional blink: Multiple channels for configural and featural processing. *Cognitive Psychology, 48*(1), 95–126.

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*(1), 109–127.

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*(3), 191–200.

Duncan, J., & Humphreys, G. W. (1992). Beyond the search surface: Visual search and attentional engagement. *Journal of Experimental Psychology: Human Perception and Performance*, *18*(2), 578–589.

Ekman, P., & Friesen, W. V. (1976). *Pictures of facial affect*. Palo Alto, CA: Consulting Psychologists Press.

Ganel, T., Valyear, K. F., Goshen-Gottstein, Y., & Goodale, M. A. (2005). The involvement of the "fusiform face area" in processing facial expression. *Neuropsychologia*, *43*, 1645–1654.

Giesbrecht, B., Sy, J. L., & Elliott, J. C. (2007). Electrophysiological evidence for both perceptual and postperceptual selection during the attentional blink. *Journal of Cognitive Neuroscience*, *19*(12), 2005–2018.

Giesbrecht, B., Sy, J. L., & Lewis, M. K. (in press). Personal names do not always survive the attentional blink: Behavioral evidence for a flexible locus of selection. *Vision Research*, doi: 10.1016/j.visres.2008.02.013 (e-pub ahead of print).

Jiang, Y., & Chun, M. M. (2001). The influence of temporal selection on spatial selection and distractor interference: An attentional blink study. *Journal of Experimental Psychology: Human Perception and Performance*, *27*(3), 664–679.

Kanwisher, N. G. (1987). Repetition blindness: Type recognition without token individuation. *Cognition*, *27*, 117–143.

Kellie, F. J., & Shapiro, K. L. (2004). Object file continuity predicts attentional blink magnitude. *Perception and Psychophysics*, *66*(4), 692–712.

Lavie, N. (1995). Perceptual load as a necessary condition for selective attention. *Journal of Experimental Psychology*, *21*, 451–468.

Maki, W. S., Bussard, G., Lopez, K., & Digby, B. (2003). Sources of interference in the attentional blink: Target–distractor similarity revisited. *Perception and Psychophysics*, *65*(2), 188–201.

Nieuwenstein, M. R., Chun, M. M., van der Lubbe, R. H., & Hooge, I. T. (2005). Delayed attentional engagement in the attentional blink. *Journal of Experimental Psychology: Human Perception and Performance*, *31*(6), 1463–1475.

Pessoa, L., McKenna, M., Gutierrez, E., & Ungerleider, L. G. (2002). Neural processing of emotional faces require attention. *Proceedings of the National Academy of Sciences*, *99*, 11458–11463.

Raymond, J. E. (2003). New objects, not new features, trigger the attentional blink. *Psychological Science*, *14*(1), 54–59.

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*(3), 849–860.

Raymond, J. E., Shapiro, K. L., & Arnell, K. M. (1995). Similarity determines the attentional blink. *Journal of Experimental Psychology: Human Perception and Performance*, *21*(3), 653–662.

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*(2), 357–371.

Wei, P., & Zhou, X. (2006). Processing multidimensional objects under different perceptual loads: The priority of bottom-up perceptual saliency. *Brain Research*, *1114*(1), 113–124.

Manuscript received January 2008
Manuscript accepted July 2008
First published online September 2008