Article

PERCEPTION

Perception
2016, Vol. 45(3) 255–264

DOI: 10.1177/0301006615607121
pec.sagepub.com
SAGE

Priming of Visual Search Facilitates Attention Shifts: Evidence From Object-Substitution Masking

Árni Kristjánsson
Department of Psychology, School of Health Sciences, University of Iceland, Reykjavik, Iceland

Abstract
Priming of visual search strongly affects visual function, releasing items from crowding and during free-choice primed targets are chosen over unprimed ones. Two accounts of priming have been proposed: attentional facilitation of primed features and postperceptual episodic memory retrieval that involves mapping responses to visual events. Here, well-known masking effects were used to assess the two accounts. Object-substitution masking has been considered to reflect attentional processing: It does not occur when a target is precued and is strengthened when distractors are present. Conversely, metacontrast masking has been connected to lower level processing where attention exerts little effect. If priming facilitates attention shifts, it should mitigate object-substitution masking, while lower level masking might not be similarly influenced. Observers searched for an odd-colored target among distractors. Unpredictably (on 20% of trials), object-substitution masks or metacontrast masks appeared around the target. Object-substitution masking was strongly mitigated for primed target colors, while metacontrast masking was mostly unaffected. This argues against episodic retrieval accounts of priming, placing the priming locus firmly within the realm of attentional processing. The results suggest that priming of visual search facilitates attention shifts to the target, which allows better spatiotemporal resolution that overcomes object-substitution masking.

Keywords
Vision, attention, priming, masking

Introduction

Our visual system is typically biased toward items of recent interest. We tend to reorient attention to items, features, and locations recently attended to (see e.g., Kristjánsson, 2006; Kristjánsson & Jóhannesson, 2014). Such priming of attention shifts has large effects upon

Corresponding author:
Árni Kristjánsson, Department of Psychology, School of Health Sciences, University of Iceland, Oddi v. Sturlugötu (#113), Reykjavik 101, Iceland.
Email: ak@hi.is

perception, releasing items from crowding (Kristjánsson et al., 2013) and determining free choice between primed versus unprimed stimuli (Brascamp, Blake, & Kristjánsson, 2013; Chetverikov & Kristjánsson, 2015). Priming involves an efficient way of using finite resources, since behaviorally relevant stimuli in our environment are usually relatively stable, and therefore, it makes good sense to use the past to predict the present, prioritizing task-relevant stimuli. Conversely, good evidence does indeed show that switching attentional priorities between features or items is effortful (Allport, Styles, & Hsieh, 1994; Kristjánsson, Wang, & Nakayama, 2002; Logan, 2005; Maljkovic & Nakayama, 1994; Rogers & Monsell, 1995).

A large part of the evidence for such temporal dependencies comes from studies of priming effects in visual search (see Lamy & Kristjánsson, 2013 for review), but other such dependencies occur for various visual phenomena (Chopin & Mamassian, 2012; Cicchini, Anobile, & Burr, 2014; Fischer & Whitney, 2014), suggesting that such history dependence is a general principle in perception.

Given the dominating effect priming has on visual function, it is of great interest to understand it, and the nature of such priming has, therefore, been under considerable debate. On one hand, priming has been thought to reflect postperceptual facilitation, based on episodic memory retrieval, where responses are mapped to visual scenes or episodes (Hillsstrom, 2000; Hommel, 1998, 2004; Huang, Holcombe, & Pashler, 2004; Thomson & Milliken, 2011). An opposing view is that priming involves facilitated processing of recently attended features (Ásgeirsson, Kristjánsson, & Bundesen, 2014, 2015; Kristjánsson, 2006; Maljkovic & Nakayama, 1994). Maljkovic and Nakayama (1996) likened this to the operation of a capacitor that stores "feature charge" as features are repeated. The long lag times seen for priming effects (lasting up to at least 8 trials, Maljkovic & Nakayama, 1994, or even up to 16 trials, Thomson & Milliken, 2012) support this notion.

Separate and dissociable priming effects of target and distractor sets argues against the episodic view (Kristjánsson & Driver, 2008; Lamy, Antebi, Aviani, & Carmel, 2008; Saevarsson, Jóelsdóttir, Hjaltason, & Kristjánsson, 2008; Wang, Kristjánsson, & Nakayama, 2005), and priming of different aspects of a single display argues against holistic accounts such as the episodic view. Maljkovic and Nakayama intended their capacitor analogy to apply to separate features or locations. On the other hand, Huang and Pashler (2005) argued that there was no priming effect of repeated targets for brief masked displays and that this argued against any explanation for priming based on attentional facilitation of features and that priming was postperceptual. Thomson and Milliken (2011) then reported that a higher order switch in task mitigated priming effects, supporting episodic retrieval accounts. This issue is, therefore, far from decided.

Masking: Object Substitution and Metacontrast

Phenomena from the literature on visual masking have for a long time been used to constrain theories of vision (Breitmeyer, 1980; Enns & DiLollo, 2000) and may aid in attempts to constrain the locus of priming. Enns and DiLollo (1997) tested masking effects from two mask types, a metacontrast mask (MCM) that snugly fits around a target diamond but never touches it (with a one pixel line separating target and mask), and a mask consisting of four dots that appeared evenly around the target diamond but were displaced from it by ~20 arc min (object-substitution mask, OSM). Both masks affected the visibility of a parafoveal target among distractors, but importantly for the current purpose, the effects of the OSM were modulated to a far larger degree by attentional manipulations. They were strengthened by a set-size manipulation (with added distractor items), even when the target appeared at screen center, whereas an MCM at center had an effect independently of surrounding distractors (Di Lollo, Enns, & Rensking, 2000; Neill, Hutchison, & Graves, 2002). Further evidence indicated that the OSM was not effective if attention was drawn to the target with a precue, which was not the case for the MCM (Di Lollo et al., 2000). Note that Filmer, Mattingley & Dux (2014) argued that OSM is not an attentional effect since its effects were not modulated by set-size manipulations to the same degree as Enns and Di Lollo claimed. Whether this is true or not may be irrelevant; however, as the doubtful assumption that set-size effects are reliable indicators of attentional processing is made which cannot be considered a general principle and various results cast serious doubt on this (Bravo & Nakayama, 1992; Wang et al., 2005; see e.g., Wolfe, 1998 for discussion).

To explain this difference between OS and MC masking effects, Enns and DiLollo (2000) suggested that the four-dot mask is ineffective if attention is directed to the target before the target representation is replaced by the mask alone representation (see also Enns, 2004) invoking the concept of reentrant processing (Lamme & Roelfsma, 2000; see General Discussion). Attention does not have the same benefits for the MCM, possibly because this type of mask reflects lower level stimulus interactions. If priming does indeed reflect influences on attention, we may, therefore, expect OSM to be influenced by priming.

Current Aims

In what follows, the effects of repetition priming in visual search on object-substitution masking and metacontrast masking are investigated. If priming affects attention shifts, a clear prediction is that object-substitution masking will be affected. Furthermore, MC masking should not be affected to the same degree. If priming allows objects in the visual field to escape OS masking, this would be a particularly compelling finding, given the relation of OS masking and attention. This would suggest that priming affects attentional priorities to the recently attended features, supporting the claim that priming facilitates attentional processing of features. Conversely, this would not be support for episodic retrieval views of priming since such accounts do not predict any differential effects of priming on masking since it influences processes that follow masking.

Methods

Observers

Eight observers with normal or corrected-to-normal visual acuity (22–28 years of age; 4 females) participated in 800 trials each, run in 8 blocks of 100 trials. The design yielded 80 trials for each mask type for each observer, and 61 to 75 trials (for individual observers) for no search repetition, 36 to 47 for 1 repetition, and 48 to 62 trials for 2 or more repetitions.

Equipment

The experimental displays were programmed in C and presented on a 75-Hz CRT.

Stimuli and procedure

The stimuli and experimental procedure are depicted in Figure 1. Each trial started with the presentation of a white (56.6 cdm^{-2}) fixation cross for 800 to 1,400 ms on a black background (0.5 cdm^{-2}), followed by a search display containing three diamond shapes (each sized $2.1^{\circ} \times 2.1^{\circ}$, at 5.8° from screen center) on the same background. Viewing distance was

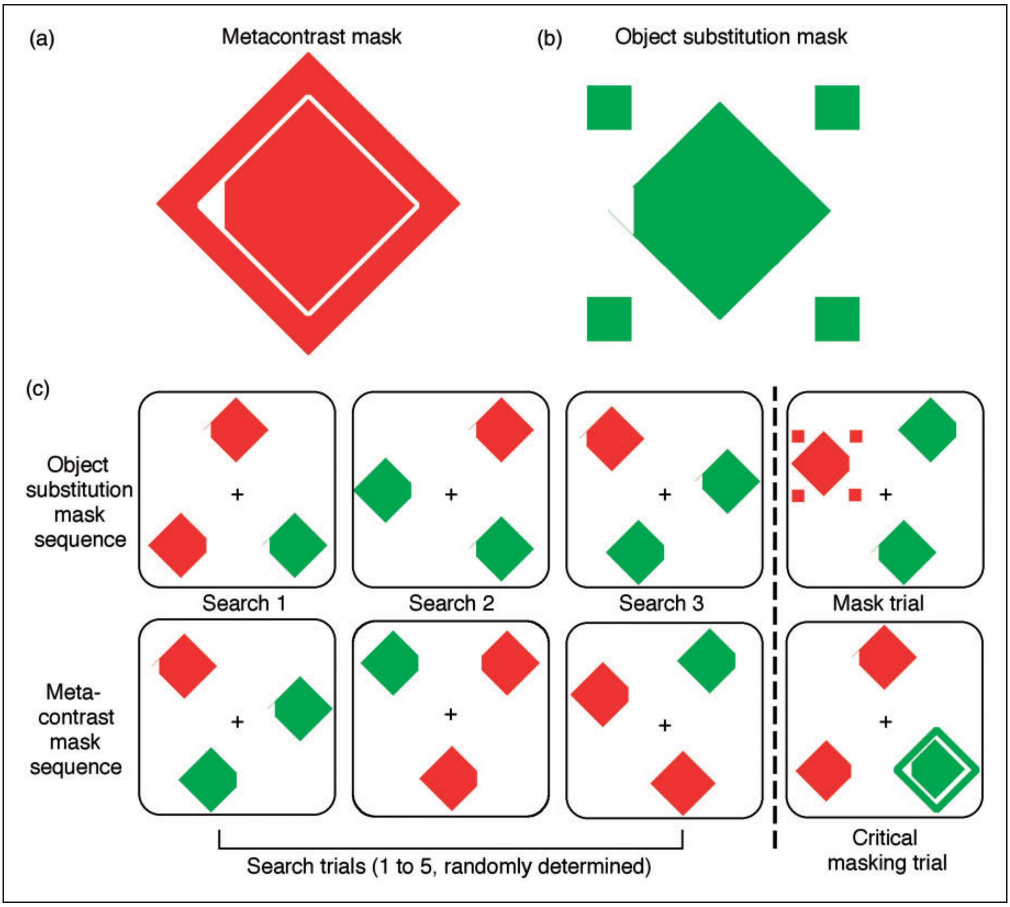

Figure 1. Mask types and experimental procedure. (a) Metacontrast mask (MSM) around a diamond target. (b) Object-substitution mask (OSM) around a diamond target. (c) Experimental procedure: 1 to 5 search trials (3 shown in figure) preceded each mask display. The target on each trial was the oddly colored diamond. Mask displays appeared around the target randomly on 20% of trials (10% OSM; 10% MCM). Note that display items are not drawn to scale.

60 cm. The centers of each of the three diamonds always formed an imaginary equilateral triangle, while its radial position around fixation was randomly determined for each trial. The diamonds were always at maximum distance from one another. The singleton target was either a red (22.7 cdm^{-2}) target among two green distractors (27.6 cdm^{-2}) or vice versa. Observers were instructed to search for the odd-colored diamond and judge (by keypress) whether it had a 15-arc min notch at top or bottom. On search-only trials, the target and distractors were visible until observers responded. On 20% of trials (determined randomly), a mask (OS or MC mask on 10% of trials each) appeared 52 or 104 ms following the target. The masks always had identical colors to the target. The MCM surrounded the target snugly (separated from the target by 6 arc min). The OSM involved four square dots (45 by 45 arc min) that appeared at four locations around the diamonds, the closest corner 18 arc min away from the closest edge of the diamond. After 120 ms, the target and distractors disappeared and the masks disappeared 50 ms later. The observers' task was the same on both mask trial types and the search only trials, to judge the location of the notch on the

target. Response accuracy was the main dependent measure on the masking trials while response times (along with error rates) were used to measure performance on the search trials. Observers were instructed to perform as correctly as possible on the masking trials, but otherwise, no specific instructions were given. Note that repetition of the task feature (the location of the notch) was orthogonal to the critical manipulations.

Results

Masking as a Function of Search Repetition

Figure 2 shows percent correct for the metacontrast mask as a function of how often the same target color was repeated (0, 1, or 2 or more times) on the left and comparable results for the OSM are shown on the right. The figure shows that only the effect of the OSM was influenced by search repetition, while the MCM effect is modulated only by stimulus onset asynchrony (SOA), which is not the case for the OSM. A three-way ANOVA (3 [search repetition] by 2

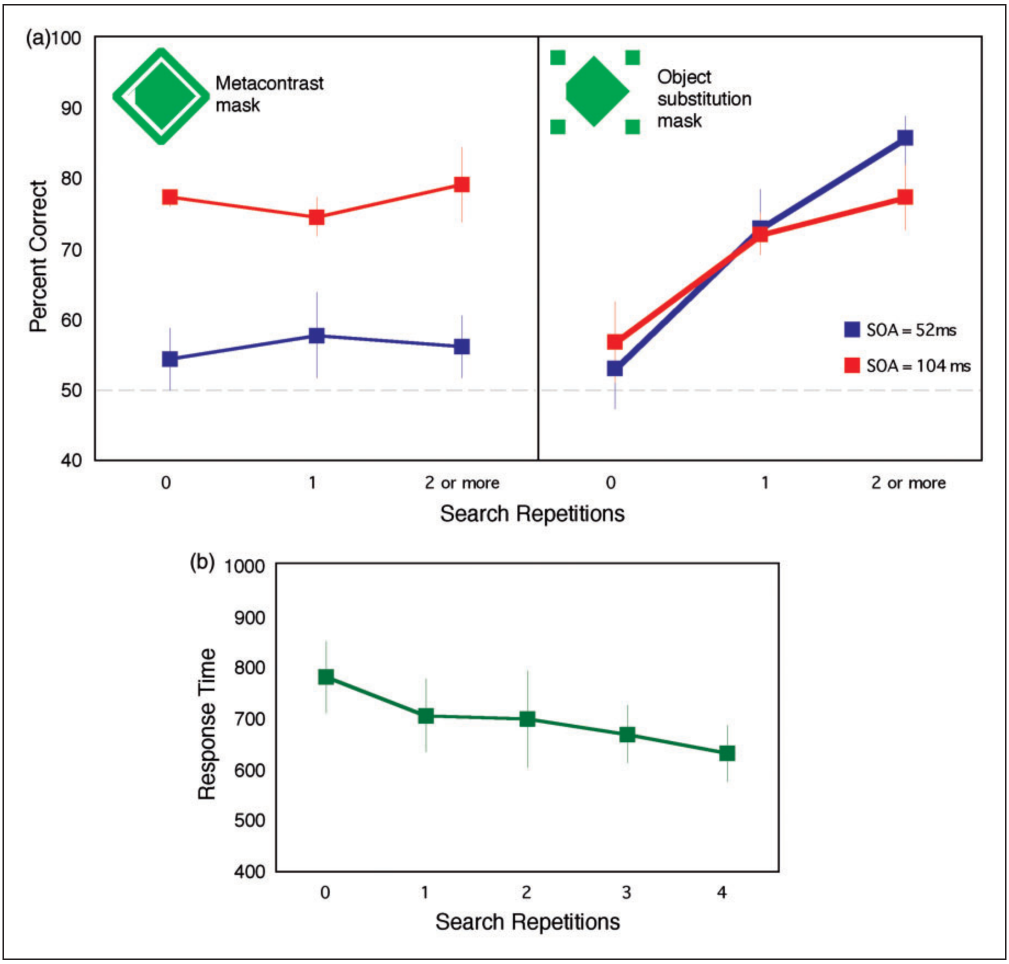

Figure 2. The experimental results. (a) The results for the metacontrast mask trials as a function of search repetition on the left and for the object-substitution mask trials as a function of search repetition on the right. (b) Response times on the search task as a function of search repetition. Error bars show the *SEM*s.

[SOA] by 2 [mask type]) showed a significant effect of repetition, $F(2, 14) = 9.14$, $p = .003$, $\eta_{partial\_squared} = 0.57$, and a significant main effect of target/mask SOA, $F(1, 7) = 10.7$, $p = .014$, $\eta_{partial\_squared} = 0.6$, but the main effect of mask type, $F(1, 7) = .982$, $p = .355$, $\eta_{partial\_squared} = 0.12$, was not significant (but see interactions below). A significant two-way interaction of repetition and mask type, $F(2, 14) = 11.61$, $p < .001$, $\eta_{partial\_squared} = 0.62$, reflects that search repetition had a large effect on the influence of the OSM but not the metacontrast mask. There was also a significant interaction between mask type and target/mask SOA, $F(1, 7) = 18.8$, $p < .001$, $\eta_{partial\_squared} = 0.73$), indicating that only the MCM was noticeably affected by SOA, with performance becoming far better at the longer SOA (100 ms) which was not the case for the OSM. Neither the two-way interaction between SOA and repetition, $F(2, 14) = .956$, $p = .408$, $\eta_{partial\_squared} = 0.12$, nor the three-way interaction between all three factors, $F(2, 14) = .638$, $p = .533$, $\eta_{partial\_squared} = 0.086$, were significant. Post-hoc tests revealed that the effect of no repetition versus 1 repetition was significant for the OSM ($p < .01$) but not for the MCM (p > .5) and that the effect of 1 versus 2 repetitions was again significant for the OCM ($p < .05$) but not the MCM ($p > .4$). Figure 2(a) suggests that the priming effect is slightly larger for the OCM for the 52 ms SOA than the 104 ms SOA, but post-hoc tests did not support this (*p*'s > .3). Similar analyses for response times on masking trials revealed no significant differences (all *p*'s > .27) which is perhaps not surprising since accuracy was emphasized on masking trials.[1]

Accuracy on the masking trials clearly shows that only the OSM was influenced in any way by search repetition, and presumably by search priming. The MCM was only affected by SOA on the other hand. The results support the notion that priming causes facilitated attention shifts. They provide no support for episodic retrieval accounts, as they do not predict any differences for different mask types. Object-substitution masking is considered to reflect coarse spatiotemporal resolution under inattention (Enns & DiLollo, 2000), and under episodic accounts priming should not influence early temporal integration processes, whereas the results are easily accounted for by an attentional facilitation view of priming. Faster and more efficient attention shifts to the target that is then masked, allow higher resolution attentional processing at the target location, which prevents object substitution.[2]

Priming Effects on Search-Only Trials

As seen in previous studies with search paradigms like the one used here (Goolsby & Suzuki, 2001; Kristjánsson, Saevarsson, & Driver, 2013; Maljkovic & Nakayama, 1996), there was a strong and significant priming effect with response times decreasing strongly from the first presentation of a color arrangement of target and distractors to five or more repetitions, $F(4, 28) = 9.4$, $p < .001$, $\eta_{partial\_squared} = 0.57$. The priming effects were, in other words, very similar to what has been observed in previous studies, as is their temporal build-up (see e.g., Brascamp, Pels, & Kristjánsson, 2011; Martini, 2010).

Error Rates

Error rates on the search-only trials were 1.5% to 8.9% for individual observers (mean 4.5%) and did not change significantly as a function of repetition ($p > .4$).

Discussion

The results show how effects of OSMs are attenuated the more often the same search is repeated. This was not the case for metacontrast masks. Any reduction of OS masking from priming of visual search places priming firmly in the realm of visual attention contrary to the predictions of episodic retrieval accounts of priming. The results support the notion that priming affects the attentional priorities of the repeated features. There are at least two alternatives regarding how this facilitation may come about: priming might recruit more attentional resources, perhaps expressed as increased spatial or temporal resolution, or it could speed attention shifts to the target location, or may even cause a combination of both. In either case, the results support the view that priming increases saliency of primed features. Favored here is the intriguing capacitor analogy of Maljkovic and Nakayama (1996): Different features build-up their own representations over time with increased feature-charge as target features remain constant. The build-up of charge is faster than its decay if target identity repeats, as reflected in the gradual influence on performance as search is increasingly often repeated. Maljkovic and Nakayama suggested that priming may help with continuous tasks (see e.g., Ballard et al., 1992) such as chopping carrots where the color orange is the relevant feature allowing observers to reorient quickly to the task-relevant stimuli. Subsequent switching to chopping vegetables of a different color leads to increased charge for that color as the charge for orange dissipates.

OS Masking and the Effects of Priming

OS masking is typically considered to reflect that the brain confuses two visual events for one. The reason is that they are encoded with low spatiotemporal resolution, since attentional resources are not available for high-definition processing. According to Enns (2004; see also Dux, Visser, Goodhew, & Lipp, 2010), focal attention prevents this confusion. This invokes the concept of reentrant processing (Lamme & Roelfsma, 2000): Multiple feedback loops in the brain such as from anterior regions to posterior visual regions build increasingly detailed representations of objects in the visual field through iterative feedback and OS masking may reflect confusion under inattention and that the mask overwrites the target representation. Enns (2004) argued that OSM reflects that backward masking is minimized when attention is allocated to the location of the target. Metacontrast masks, are, on the other hand, thought to reflect inhibitory contour interactions and therefore do not depend on coarse spatiotemporal integration under inattention, to be effective (Enns & DiLollo, 2000). According to Kristjánsson and Campana (2010), attention shifts to primed targets are speeded. Priming may therefore allow more efficient attention shifts to the target so that object substitution does not occur since higher resolution processing from increased attention through priming prevents OS masking. Local contour interactions that underlie MC masking do not benefit in the same way from prior attentional focus (Enns, 2004).

There is a potential thorn in this logic, however. Ásgeirsson et al. (2014, 2015) found that priming improves performance in partial report with brief presentation (~70 ms) and a subsequent pattern mask (see also Sigurðardóttir, Kristjánsson, & Driver, 2008; Yashar & Lamy, 2010). On the surface, this may seem inconsistent with the argument made here. But then one may always wonder whether the pattern masks were “pure”, having *no* object-substitution component. There may be remnants of object substitution involved in the effects of pattern masking, and MC masks may cause a purer perceptual masking effect. While there is at present no clear answer, MC masks may kick in even earlier than pattern masks. This may be consistent with the claim that for all masks other than OSMs, there are at least two components, an early or fast-acting component associated with object formation and a later or slower acting component associated with object substitution (Enns, 2004). Note also that I am not claiming that MCM is in no way influenced by attention. Neumann and Scharlau (2007) have, for example, proposed that MCM involves an attentional component.

My point is simply that OSMs have been shown to be strongly affected by attention and to a much greater extent than MCMs and that their modulation by color repetition here (far above any effect on MCMs) suggests that priming is an attentional effect reflecting facilitated attention shifts to repeated task-relevant items.

Conclusions

The results show a clear dissociation between effects of repetition priming on object-substitution masking effects on one hand and metacontrast masking effects on the other. This supports proposals that priming of visual search facilitates attentional selection of repeated features, arguing against postperceptual, or decisional accounts of priming.

Declaration of Conflicting Interests

The author(s) declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

Funding

The author(s) disclosed receipt of the following financial support for the research, authorship, and/or publication of this article: This article is supported by grants from the Research Fund of the University of Iceland, the Icelandic Research Office (*Rannís*), and the European Research Council.

Notes

1. Note that repetition of response (and therefore response feature) did not affect the critical response patterns. There was no difference between percent correct on masking trials depending on whether response and task feature repeated or not. Mask type by response/task repetition ANOVA showed no effect of repetition versus no repetition, nor importantly any interaction with mask type, while the main effect of mask type was again not significant (all p's $> .2$).
2. A reviewer noted that the SOAs used (50 and 100 ms) might be too far apart and that MCM results were either at floor or at ceiling. This is highly unlikely since performance for the longer SOA hovers around 80% correct, leaving plenty of room for improvement.

References

Allport, A., Styles, E. A., & Hsieh, S. (1994). Shifting intentional set: Exploring the dynamic control of tasks. In C. Umilta, & M. Moscovitch (Eds.), *Attention and Performance XV* (pp. 421–452). Hillsdale, NJ: Erlbaum.

Ásgeirsson, Á. G., Kristjánsson, Á., & Bundesen, C. (2014). Independent priming of location and color in identification of briefly presented letters. *Attention, Perception, & Psychophysics*, *76*, 40–48.

Ásgeirsson, Á. G., Kristjánsson, Á., & Bundesen, C. (2015). Repetition priming in selective attention: A TVA analysis. *Acta Psychologica*, *160*, 35–42.

Ballard, D. H., Hayhoe, M. M., Li, F., Whitehead, S. D., Frisby, J. P., Taylor, J. G., . . . Fisher, R. B. (1992). Hand-eye coordination during sequential tasks. *Philosophical Transactions of the Royal Society of London, Series B: Biological Sciences*, *337*, 331–339.

Brascamp, J. W., Blake, R., & Kristjánsson, Á. (2011). Deciding where to attend: priming of pop-out drives target selection. *Journal of Experimental Psychology: Human Perception & Performance*, *37*, 1700–1707.

Brascamp, J. W., Pels, E., & Kristjánsson, Á. (2011). Priming of pop-out on multiple time scales during visual search. *Vision Research*, *51*, 1972–1978.

Bravo, M. J., & Nakayama, K. (1992). The role of attention in different visual-search tasks. *Perception & Psychophysics*, *51*, 465–472.

Breitmeyer, B. G. (1980). Unmasking visual masking: A look at the ''why'' behind the veil of the ''how''. *Psychological Review*, *87*, 52.
Chetverikov, A., & Kristjánsson, Á. (2015). History effects in visual search as reflected in reaction times, choice biases, and liking. *Attention, Perception & Psychophysics*, *77*, 402–412.
Chopin, A., & Mamassian, P. (2012). Predictive properties of visual adaptation. *Current Biology*, *22*, 622–626.
Cicchini, G. M., Anobile, G., & Burr, D. C. (2014). Compressive mapping of number to space reflects dynamic encoding mechanisms, not static logarithmic transform. *Proceedings of the National Academy of Sciences*, *111*, 7867–7872.
Di Lollo, V., Enns, J. T., & Rensink, R. A. (2000). Competition for consciousness among visual events: the psychophysics of reentrant visual processes. *Journal of Experimental Psychology: General*, *129*, 481.
Dux, P. E., Visser, T. A., Goodhew, S. C., & Lipp, O. V. (2010). Delayed reentrant processing impairs visual awareness an object-substitution-masking study. *Psychological Science*, *21*, 1242–1247.
Enns, J. T. (2004). Object substitution and its relation to other forms of visual masking. *Vision research*, *44*, 1321–1331.
Enns, J. T., & Di Lollo, V. (1997). Object substitution: A new form of masking in unattended visual locations. *Psychological Science*, *8*, 135–139.
Enns, J. T., & Di Lollo, V. (2000). What's new in visual masking? *Trends in Cognitive Sciences*, *4*, 345–352.
Filmer, H. L., Mattingley, J. B., & Dux, P. E. (2014). Size (mostly) doesn't matter: the role of set size in object substitution masking. *Attention, Perception, & Psychophysics*, *76*, 1620–1629.
Fischer, J. T., & Whitney, D. (2014). Serial dependence in perception. *Nature Neuroscience*, *17*, 738–743.
Goolsby, B. A., & Suzuki, S. (2001). Understanding priming of color-singleton search: Roles of attention at encoding and ''retrieval.''. *Perception & Psychophysics*, *63*, 929–944.
Hillsstrom, A. P. (2000). Repetition effects in visual search. *Perception & Psychophysics*, *62*, 800–817.
Hommel, B. (1998). Event files: Evidence for automatic integration of stimulus-response episodes. *Visual Cognition*, *5*, 183–216.
Hommel, B. (2004). Event files: Feature binding in and across perception and action. *Trends in Cognitive Sciences*, *8*, 494–500.
Huang, L., Holcombe, A. O., & Pashler, H. (2004). Repetition priming in visual search: Episodic retrieval, not feature priming. *Memory & Cognition*, *32*, 12–20.
Huang, L., & Pashler, H. (2005). Expectation and repetition effects in searching for featural singletons in very brief displays. *Perception & Psychophysics*, *67*, 150–157.
Kristjánsson, Á. (2006). Rapid learning in attention shifts—A review. *Visual Cognition*, *13*, 324–362.
Kristjánsson, Á., & Campana, G. (2010). Where perception meets memory: A review of priming in visual search. *Attention, Perception & Psychophysics*, *72*, 5–18.
Kristjánsson, Á., & Driver, J. (2008). Priming in visual search: Separating the effects of target repetition, distractor repetition and role-reversal. *Vision Research*, *48*, 1217–1232.
Kristjánsson, Á., Heimisson, P. R., Róbertsson, G. F., & Whitney, D. (2013). Attentional priming releases crowding. *Attention, Perception & Psychophysics*, *75*, 1323–1329.
Kristjánsson, Á., & Jóhannesson, Ó. I. (2014). How priming in visual search affects response time distributions: Analyses with ex-Gaussian fits. *Attention, Perception & Psychophysics*, *76*, 2199–2211.
Kristjánsson, Á., Saevarsson, S., & Driver, J. (2013). The boundary conditions of priming of visual search: From passive viewing through task-relevant working memory load. *Psychonomic Bulletin & Review*, *20*, 514–521.
Kristjánsson, Á., Wang, D., & Nakayama, K. (2002). The role of priming in conjunctive visual search. *Cognition*, *85*, 37–52.
Lamme, V. A., & Roelfsema, P. R. (2000). The distinct modes of vision offered by feedforward and recurrent processing. *Trends in Neurosciences*, *23*, 571–579.
Lamy, D., Antebi, C., Aviani, N., & Carmel, T. (2008). Priming of pop-out provides reliable measures of target activation and distractor inhibition in selective attention. *Vision Research*, *48*, 30–41.

Lamy, D., & Kristjánsson, Á. (2013). Is goal-directed attentional guidance just intertrial priming? A review. *Journal of Vision*, *13*, 14.

Logan, G. D. (2005). The time it takes to switch attention. *Psychonomic Bulletin & Review*, *12*, 647–653.

Maljkovic, V., & Nakayama, K. (1994). Priming of pop-out: I. Role of features. *Memory & Cognition*, *22*, 657–672.

Maljkovic, V., & Nakayama, K. (1996). Priming of pop-out: II. The role of position. *Perception & Psychophysics*, *58*, 977–991.

Martini, P. (2010). System identification in priming of pop-out. *Vision Research*, *50*, 2110–2115.

Neill, W. T., Hutchison, K. A., & Graves, D. F. (2002). Masking by object substitution: dissociation of masking and cuing effects. *Journal of Experimental Psychology: Human Perception and Performance*, *28*, 682.

Neumann, O., & Scharlau, I. (2007). Experiments on the Fehrer-Raab effect and the 'Weather Station Model' of visual backward masking. *Psychological Research*, *71*, 667–677.

Rogers, R. D., & Monsell, S. (1995). Costs of a predictable switch between simple cognitive tasks. *Journal of Experimental Psychology: General*, *124*, 207–231.

Saevarsson, S., Jóelsdóttir, S., Hjaltason, H., & Kristjánsson, Á. (2008). Repetition of distractor sets improves visual search performance in hemispatial neglect. *Neuropsychologia*, *45*, 1161–1169.

Sigurðardóttir, H. M., Kristjánsson, Á., & Driver, J. (2008). Repetition streaks increase perceptual sensitivity in brief visual search displays. *Visual Cognition*, *16*, 643–658.

Thomson, D. R., & Milliken, B. (2011). A switch in task affects priming of pop-out: Evidence for the role of episodes. *Attention, Perception, & Psychophysics*, *73*, 318–333.

Thomson, D. R., & Milliken, B. (2012). Perceptual distinctiveness produces long-lasting priming of pop-out. *Psychonomic Bulletin & Review*, *19*, 170–176.

Wang, D., Kristjánsson, Á., & Nakayama, K. (2005). Efficient visual search without top-down or bottom-up guidance. *Perception & Psychophysics*, *67*, 239–253.

Wolfe, J. (1998). Visual search. In H. Pashler (Ed.), *Attention* (pp. 13–73). London, England: University College London Press.

Yashar, A., & Lamy, D. (2010). Intertrial repetition affects perception: The role of focused attention. *Journal of Vision*, *10*, 1–8.