



When motion and color compete for selective attention, motion induces a stronger distraction

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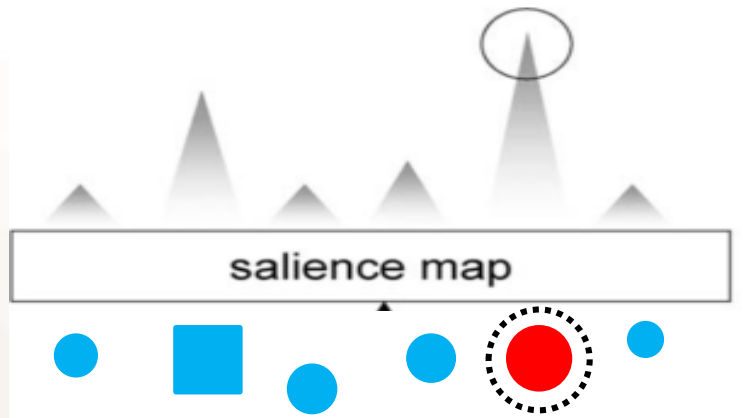


INTRODUCTION

- Distraction ?
 - Regan et al. (2011): “Driver Diverted Attention”
 - “(...) **away** from activities critical for safe driving toward a **competing activity** (...) insufficient or no attention to activities critical for safe driving”
 - Involuntary shift toward an irrelevant stimulus
 - Influence of salient dynamic feature on distraction
 - Motion (dynamic) vs Color (static)


INTRODUCTION

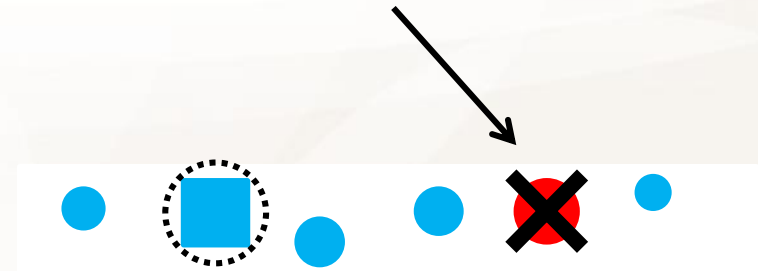
- Saliency-based selection
(Theeuwes, 2010)



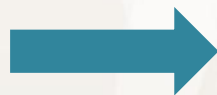
Capture at first by the most salient

- Contingent capture
(Folk et al. 1992)

If looking for 
top-down control



Prevent capture when no shared feature



What about dynamic stimuli ?

INTRODUCTION

- Distraction and dynamics stimuli

- Applied studies

- Outside

Digital billboards, video advertising (Belyusar et al., 2016; Chattington et al., 2009 ; Decker et al., 2014; ...)



INTRODUCTION

- Distraction and dynamics stimuli
 - Applied studies
 - Inside
 - In-Vehicle Technologies: Assistance or Infotainment Systems (Strayer et al. 2015)

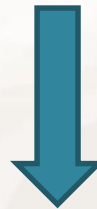


INTRODUCTION

- Distraction and dynamics stimuli
 - **Lab studies:** Abrams & Christ, 2003 ; Al-Aidroos et al., 2010 ; Christ & Abrams, 2008 ; Franconeri & Simons, 2003; Kawahara et al., 2012 ...



Particularly salient, behaviorally relevant



Automatic capture ?

INTRODUCTION

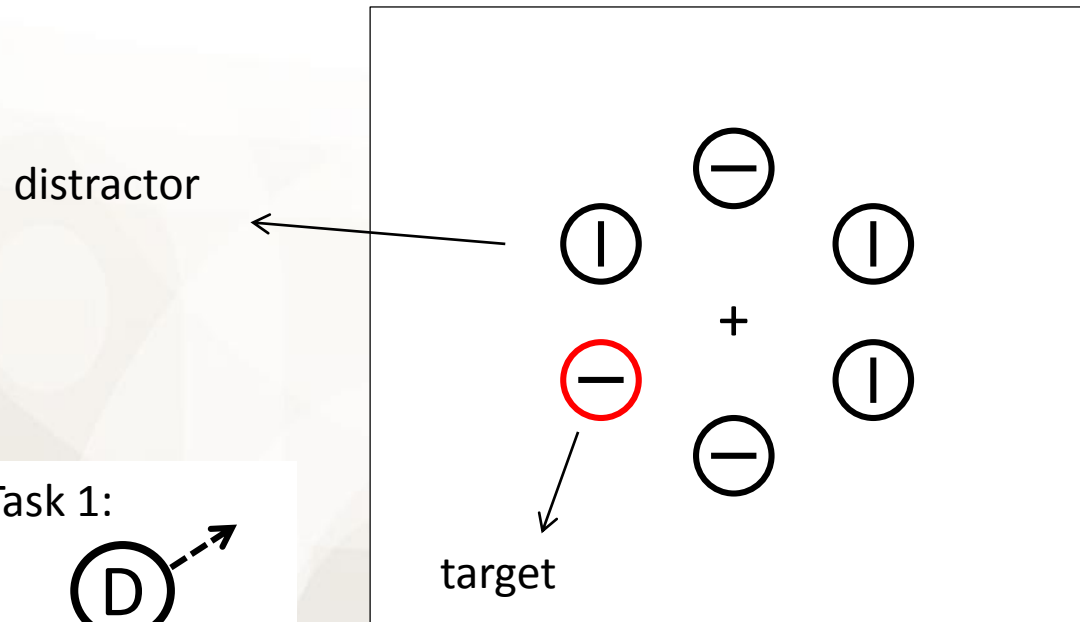
- Nevertheless:
 - Often **no competition** between dynamic vs static salient stimuli for selective attention
 - Could a salient static distractor capture attention when looking for dynamic stimulus ?
 - Can attentional capture by irrelevant dynamic distractor be prevented ?
 - Task demands or context influence ?

OBJECTIVES

- Two highly salient stimuli (with a dynamic one) competing for attentional selection:
 - Saliency-based selection or contingent capture hypothesis ?
 - When target = motion, sufficient to prevent capture by static color-distractor ?
- First step to a **further integration** of:
 - Time pressure
 - Perceptual and Cognitive Load
 - Emotional distractors
 - Cognitive age-related characteristics

METHOD

- Visual search task: *additional-singleton paradigm* (Theeuwes, 1992)



Task 1:

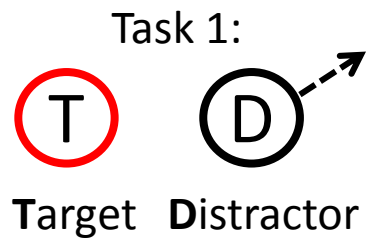
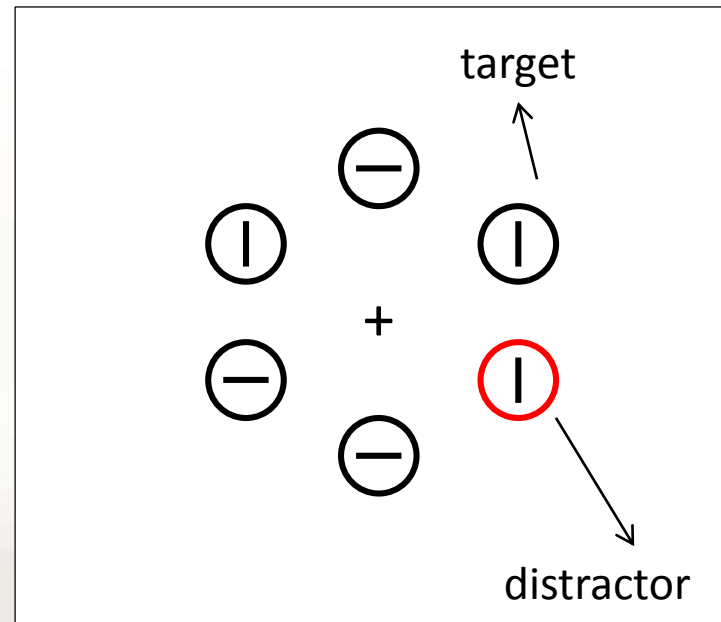


Target Distractor

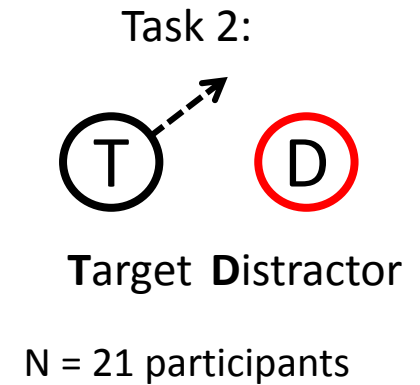
N = 21 participants

METHOD

- Visual search task: *additional-singleton paradigm* (Theeuwes, 1992)



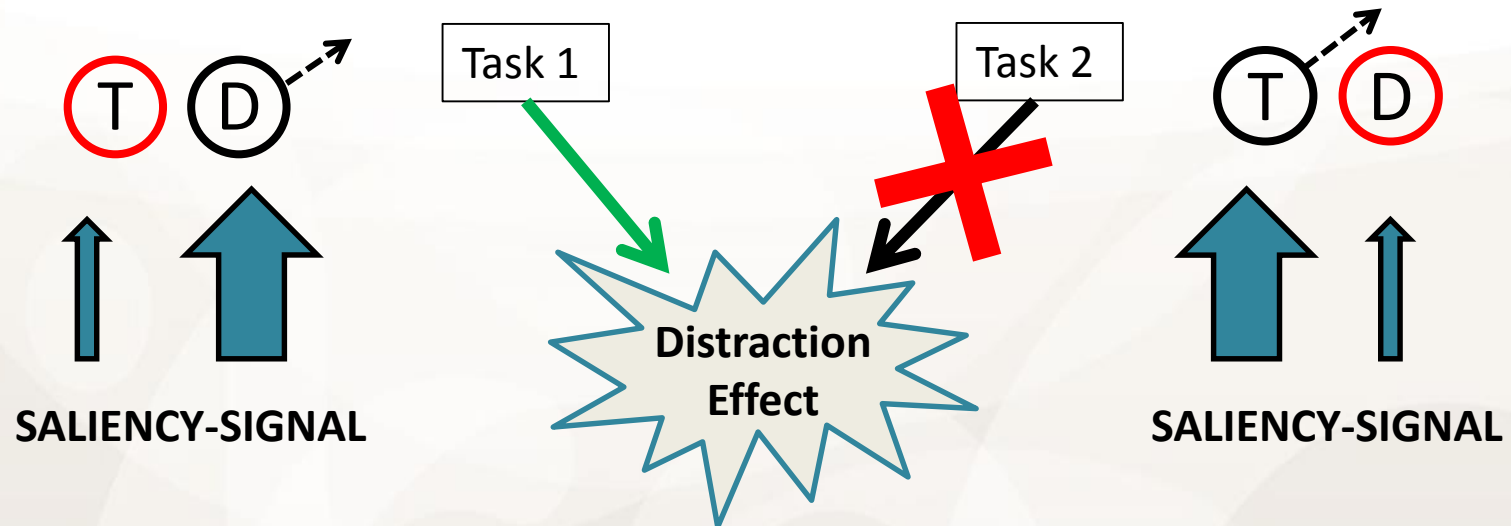
N = 21 participants



HYPOTHESIS

- Distraction effect (RTs: Distractor Absent vs Present)

- Saliency-based selection hypothesis

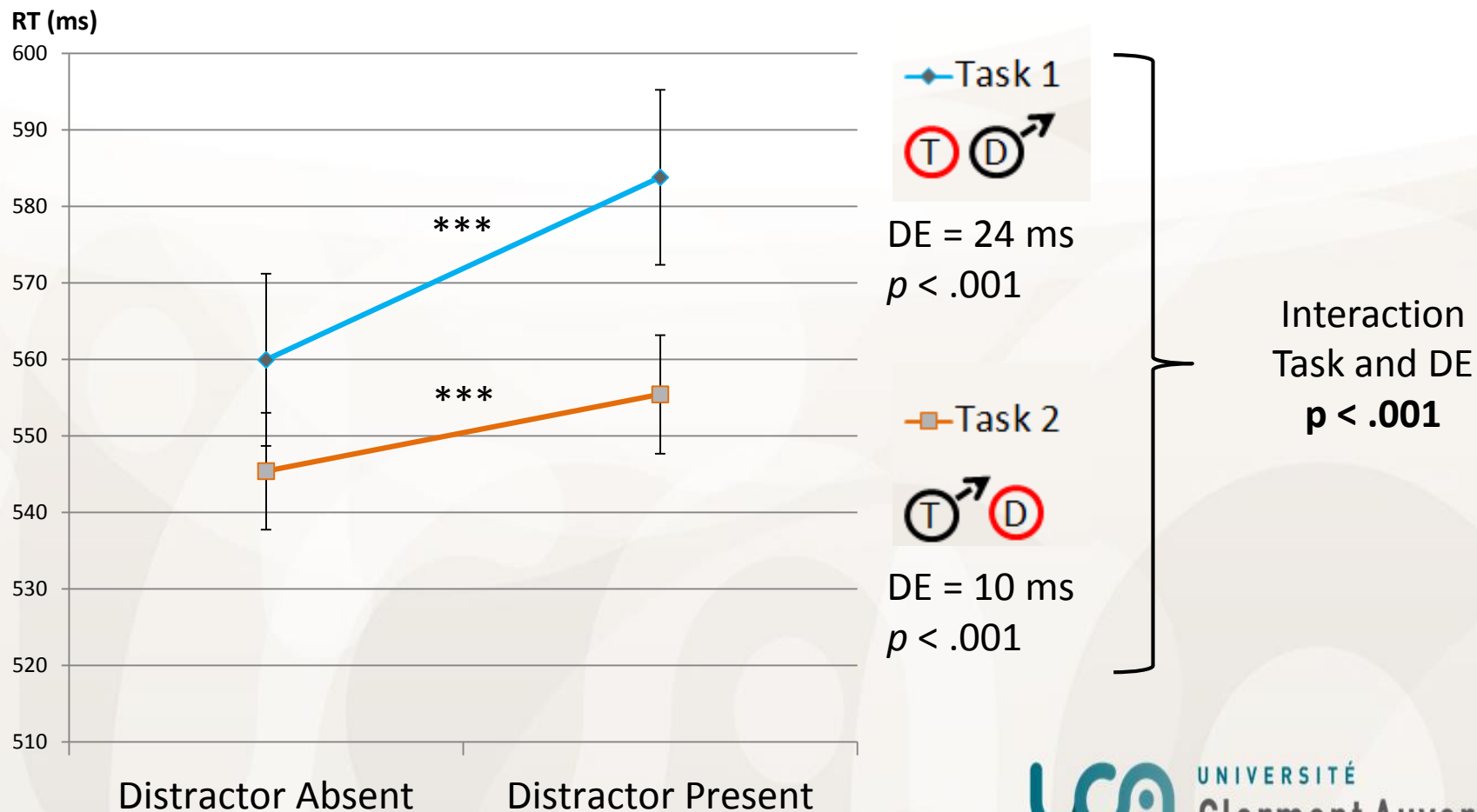


- Contingent capture hypothesis

- **Never observed** because target and distractor do not share any feature

RESULTS

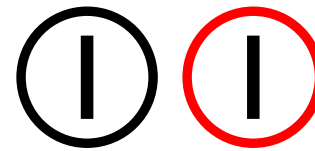
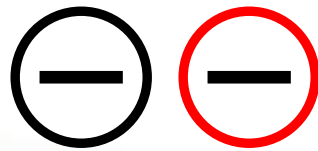
- Distraction Effect (DE)



HYPOTHESIS

- Compatibility effect (RTs: Distractor Compatible vs Incompatible)

= *Compatible* :



= *Incompatible* :

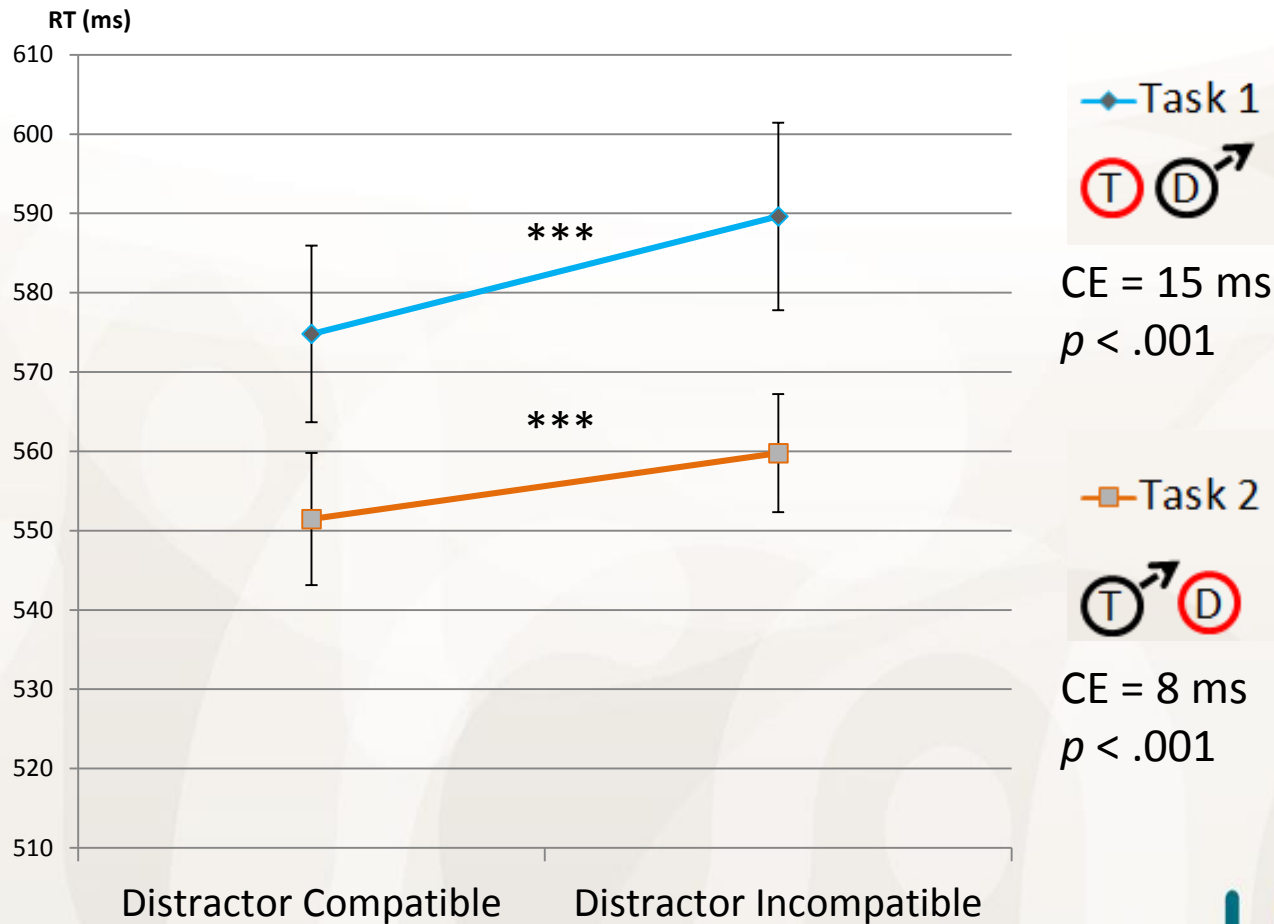


faster RTs
than

- To confirm attentional capture and distractor processing (Becker, 2007 ; Folk, 2013)
- Should be observed only if there is a distraction effect

RESULTS

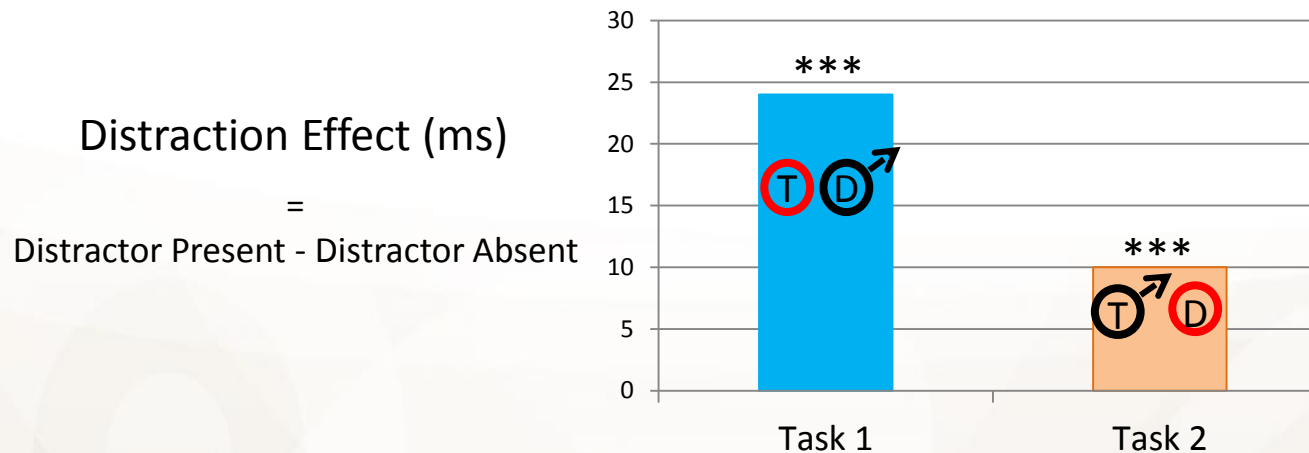
- Compatibility Effect (CE)



Interaction
Task and CE
 $p < .05$

DISCUSSION

- Distraction effect significant in both tasks



- A static color-distractor captures attention even if the target is a dynamic stimulus (Task 2) \textcircled{T} \textcircled{D}
- A motion-distractor produces a stronger capture than a color-distractor (Task 1 vs Task 2)

DISCUSSION

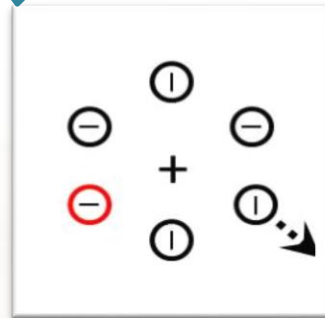
- What those results tell us about saliency role?
 - Do not support any of the hypothesis
 - Saliency computation = stochastic process
 - Support dynamic neural field models of attention (Rougier & Vitay, 2006)
 - Relevant for computational models
 - N-SEEV - onset and offset (Steelman-Allen et al. 2009)
 - Automatic estimation of road signs saliency (Simon et al., 2007, 2010)
 - Advance Driver Assistance Systems
 - Traffic Signs Recognition (Eichner & Breckon, 2008; Stallkamp et al., 2012)

DISCUSSION

- Further integration:



Time pressure



Perceptual Load



Dual-task



Emotional content

DISCUSSION



Thank you for your attention

REFERENCES

- Abrams, R. A., & Christ, S. E. (2003). Motion onset captures attention. *Psychological Science, 14*(5), 427–432. <http://doi.org/10.1111/1467-9280.01458>
- Al-Aidroos, N., Guo, R. M., & Pratt, J. (2010). You can't stop new motion: Attentional capture despite a control set for colour. *Visual Cognition, 18*(6), 859–880. <http://doi.org/10.1080/13506280903343085>
- Becker, S. I. (2007). Irrelevant Singletons in Pop-Out Search: Attentional Capture or Filtering Costs? *Journal of Experimental Psychology. Human Perception and Performance, 33*(4), 764–87. <http://doi.org/10.1037/0096-1523.33.4.764>
- Belyusar, D., Reimer, B., Mehler, B., & Coughlin, J. F. (2016). A field study on the effects of digital billboards on glance behavior during highway driving. *Accident Analysis & Prevention, 88*, 88–96. <http://doi.org/10.1016/j.aap.2015.12.014>
- Chattington, M., Reed, N., Basacik, D., Flint, A., & Parkes, A. (2009). *Investigating driver distraction: the effects of video and static advertising*. London: TRL Limited. Retrieved from <http://www.trl.co.uk/reports-publications/report/?reportid=6575>
- Christ, S. E., & Abrams, R. A. (2008). The attentional influence of new objects and new motion. *Journal of Vision, 8*(3), 27.1-8. <http://doi.org/10.1167/8.3.27>
- Decker, J. S., Stannard, S. J., McManus, B., Wittig, S. M. O., Sisiopiku, V. P., & Stavrinou, D. (2015). The impact of billboards on driver visual behavior: a systematic literature review. *Traffic Injury Prevention, 16*, 234–9. <http://doi.org/10.1080/15389588.2014.936407>
- Eichner, M. L., & Breckon, T. P. (2008). Integrated speed limit detection and recognition from real-time video. In *2008 IEEE Intelligent Vehicles Symposium* (pp. 626–631). IEEE. <http://doi.org/10.1109/IVS.2008.4621285>
- Folk, C. L. (2013). Dissociating compatibility effects and distractor costs in the additional singleton paradigm. *Frontiers in Psychology, 4*(JUL), 1–10. <http://doi.org/10.3389/fpsyg.2013.00434>
- Folk, C. L., Remington, R. W., & Johnston, J. C. (1992). Involuntary covert orienting is contingent on attentional control settings. *Journal of Experimental Psychology: Human Perception and Performance, 18*(4), 1030–1044. <http://doi.org/10.1037/0096-1523.18.4.1030>

REFERENCES

- Franconeri, S. L., & Simons, D. J. (2003). Moving and looming stimuli capture attention. *Perception & Psychophysics*, *65*(7), 999–1010. <http://doi.org/10.3758/BF03194829>
- Kawahara, J., Yanase, K., & Kitazaki, M. (2012). Attentional capture by the onset and offset of motion signals outside the spatial focus of attention. *Journal of Vision*, *12*(12), 1–13. <http://doi.org/10.1167/12.12.10>
- Regan, M. A., Hallett, C., & Gordon, C. P. (2011). Driver distraction and driver inattention: Definition, relationship and taxonomy. *Accident Analysis & Prevention*, *43*(5), 1771–1781. <http://doi.org/10.1016/j.aap.2011.04.008>
- Rougier, N. P., & Vitay, J. (2006). Emergence of attention within a neural population. *Neural Networks : The Official Journal of the International Neural Network Society*, *19*(5), 573–81. <http://doi.org/10.1016/j.neunet.2005.04.004>
- Simon, L., Tarel, J.-P., & Brémond, R. (2007). A new paradigm for the computation of conspicuity of traffic signs in road images. In *Proceedings of the 26th session of Commission Internationale de L'éclairage (CIE'07)* (Vol. 2, pp. 161–164). China.
- Simon, L., Tarel, J., & Brémond, R. (2010). A model for automatic diagnostic of road signs saliency. In *Proceedings of Transport Research Arena (TRA'10)* (pp. 1–6). Brussels, Belgium.
- Stallkamp, J., Schlipsing, M., Salmen, J., & Igel, C. (2012). Man vs. computer: Benchmarking machine learning algorithms for traffic sign recognition. *Neural Networks*, *32*, 323–332. <http://doi.org/10.1016/j.neunet.2012.02.016>
- Steelman-Allen, K. S., McCarley, J. S., Wickens, C., Sebok, A., & Bzostek, J. (2009). N-SEEV: A Computational Model of Attention and Noticing. *Proceedings of the Human Factors and Ergonomics Society Annual Meeting*, *53*(12), 774–778. <http://doi.org/10.1177/154193120905301203>
- Strayer, D. L. (2015). Is the Technology in Your Car Driving You to Distraction? *Policy Insights from the Behavioral and Brain Sciences*, *2*(1), 157–165. <http://doi.org/10.1177/2372732215600885>
- Theeuwes, J. (1992). Perceptual selectivity for color and form. *Perception & Psychophysics*, *51*(6), 599–606. <http://doi.org/10.3758/BF03211656>
- Theeuwes, J. (2010). Top-down and bottom-up control of visual selection. *Acta Psychologica*, *135*(2), 77–99. <http://doi.org/10.1016/j.actpsy.2010.02.006>