Poster #53.405

Global/Local Attentional Effects on Low Prevalence Search

Charlotte M. Kelly & Juan D. Guevara Pinto

Rollins College

Rollins DEPARTMENT OF PSYCHOLOGY

Abstract

There are many difficulties when it comes to finding illegal items in security screening, with the leading difficulty being the Low Prevalence Effect (LPE). This is when there is a very low likelihood of a target item being present, and thus searchers miss it when it actually does appear[1]. As shown in various studies, it is incredibly difficult to mitigate the effects of the LPE and increase participant accuracy at finding target items[1-4]. The way we attempted to mitigate the effect was by inducing an attentional shift from a global, "big picture" processing bias, to a local, detail-oriented one[5], thus increasing the number of item fixations and decreasing error[1]. In this experiment, we used a form of number identification task called the Navon Task[6] to train participants to adopt either a global or local spread of attention, alongside a control group that received a task that did not affect attention. Then the participants completed a search task composed of "T"s and "L"s in which the target item "T" either had a high chance (80%) or a low chance (20%) of being present. Search task prevalence were counterbalanced across participants, with a repeated Navon Task training session in between. The results showed that we replicated the LPE, but we did not mitigate it. The global training condition did lead to a trend of lower performance, as predicted, but the results were not significant.

The Low Prevalence Effect

The Low Prevalence Effect (LPE) – Infrequent search targets are missed more often than frequent ones [1-5].

What is this caused by?

- A reduction of search-termination thresholds during low prevalence conditions is know to be one of the primary sources of errors [1-2].
- This is reflected not only by higher miss rates but also shorter target-absent RTs and fewer fixations [3-5].

Role of Attentional "Spread"?

- Given the reduction in eye-movements during low prevalence searches, it may be possible that the LPE is also characterized by the adoption of global processing bias[5].
- If so, the LPE may be mitigated by implicitly biasing observers to engage in *local* processing, which is know to increase eye-movement in visual search[6].

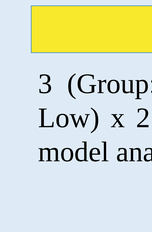
Predictions

- In a search task where the prevalence of the target item is low, participants should have lower hit rates, shorter RTs, and a smaller number of items inspected compared to those who completed a high prevalence search task.
- Participants biased to engage in global processing should have lower hit rates, shorter RTs, and inspect less items than participants in a control condition, particularly when target prevalence is *high*.
- Participants biased to engage in local processing should have higher hit rates, longer RTs, and inspect more items than participants a control condition, particularly when target prevalence is *low*.

General Method

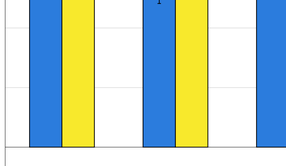
1) Demographics Survey, Practice Trials, and Eye-tracker Calibration

2) Random Assignment to a Navon Task Group (60 trials):



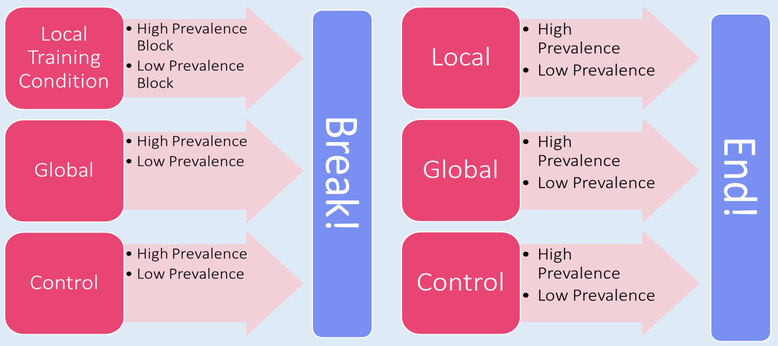
- Local Navon (N = 15) – Indicate parity of smaller numbers
- Global Navon (N = 15) – Indicate parity of larger numbers
- Control (N = 12) – Indicate parity of numbers presented auditorily

3) Random Assignment to a Prevalence Block:
   - High Prevalence – Target is present for 80% of the trials and absent for 20%
   - Low Prevalence – Target is present for 20% of the trials and absent for 80%



Ts and Ls Search
- 24 item search array
- 100 trials per block

4) Repeat Navon Task and Search Task
   - Same Navon Task as assigned previously
   - Counterbalanced Target Prevalence



Analyses

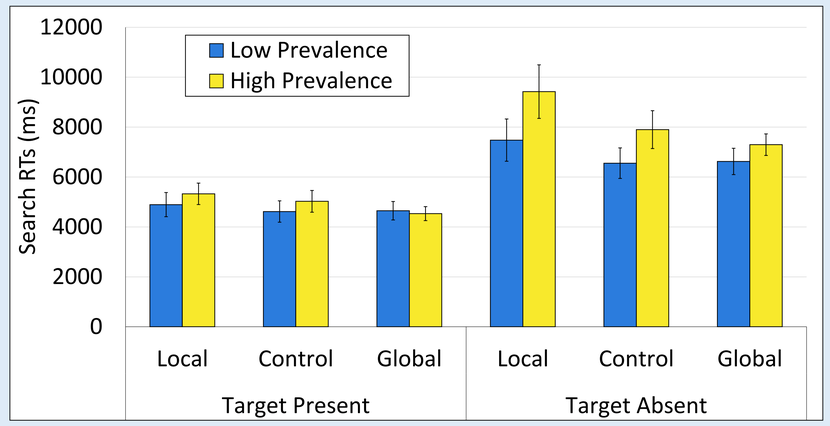
3 (Group: Global, Local, Control) x 2 (Prevalence: High, Low) x 2 (Trial Type: Target-Present, Target-Absent) mixed model analyses of the variance (ANOVAs)

Search Performance

Target Prevalence: $F(1,37) = 10.91$, $p = .002$, $\eta_p^2 = .009$
Trial Type: $F(1,37) = 265.88$, $p < .001$, , $\eta_p^2 = .671$
Prevalence x Trial Type: $F(1,37) = 25.59$, $p < .001$, $\eta_p^2 = .022$

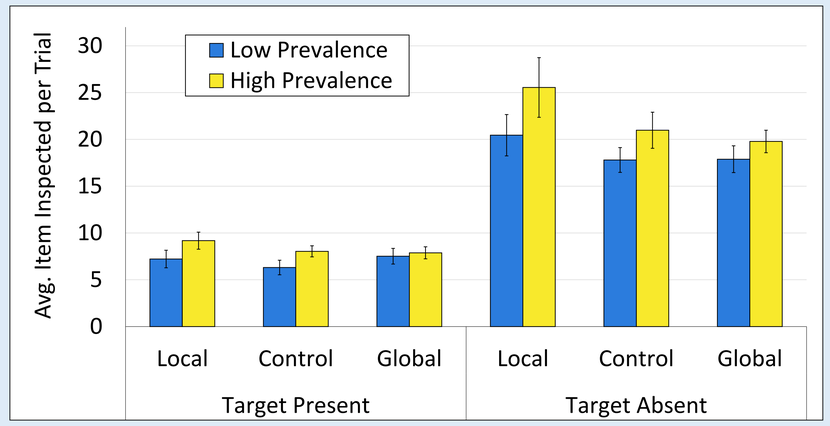
Results

Search RTs



Target Prevalence: $F(1,37) = 27.73$, $p < .001$, $\eta_p^2 = .022$
Prevalence x Group: $F(2, 37) = 3.29$, $p = .048$, $\eta_p^2 = .005$
Trial Type: $F(1,37) = 144.73$, $p < .001$, , $\eta_p^2 = .267$
Prevalence x Trial Type: $F(1,37) = 28.91$, $p < .001$, $\eta_p^2 = .011$

Eye-Movements



Target Prevalence: $F(1,37) = 27.41$, $p < .001$, $\eta_p^2 = .019$
*Prevalence x Group: $F(2,37) = 2.48$, $p = .09$, $\eta_p^2 = .003$
Trial Type: $F(1,37) = 273.76$, $p < .001$, , $\eta_p^2 = .546$
Prevalence x Trial Type: $F(1,37) = 11.48$, $p = .002$, $\eta_p^2 = .04$

Discussion

- The LPE was successfully replicated across conditions, as indicated by the significant Prevalence x Trial Type interaction present in the search performance, RTs, and item inspection analyses.
- Unlike demonstrated in previous research, no statistically significant effect of biasing condition was observed.
- In general, local processing bias seem to produce a more *exhaustive* search, relative to the control condition, particularly when target prevalence is high.

*References are available on separate handout

Corresponding author: jguevarapinto@rollins.edu

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Charlotte M. Kelly & Juan D. Guevara Pinto
Rollins College

References

1) Wolfe, J. M., Horowitz, T. S., Van Wert, M. J., Kenner, N. M., Place, S. S., & Kibbi, N. (2007). Low target prevalence is a stubborn source of errors in visual search tasks. *Journal of Experimental Psychology: General*, *136*(4), 623-638.

2) Wolfe, J. M., & Van Wert, M. J. (2010). Varying target prevalence reveals two dissociable decision criteria in visual search. *Current Biology*, *20*, 121-124.

3) Godwin, H. J., Menneer, T., Cave, K. R., Thaibsyah, M., & Donnelly, N. (2014). The effects of increasing target prevalence on information processing during visual search. *Psychonomic Bulletin & Review*, *22*, 469-475.

4) Hout, M. C., Walenchok, S. C., Goldinger, S. D., & Wolfe, J. M. (2015). Failures of perception in the low-prevalence effect: Evidence from active and passive visual search. *Journal of Experimental Psychology: Human Perception and Performance*, *41*, 977-994.

5) Peltier, C., & Becker, M. W. (2016). Decision processes in visual search as a function of target prevalence. *Journal of Experimental Psychology: Human Perception and Performance*, *42*(9), 1466-1476.

6) Wen, W., & Kawabata, H. (2018). Impact of navon-induced global and local processing biases on the acquisition of spatial knowledge. *SAGE Open*, 1-9.

7) Navon, D. (1977). Forest before trees: The precedence of global features in visual perception. *Cognitive Psychology*, *9*, 353-383.

*References are available on separate handout

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