A Review that should Capture your Attention: Commentary on Ruz & Lupianez

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The paper of Maria Ruz and Juan Lupianez on attentional capture is excellent for at least three reasons. First, they succeeded in describing very clearly the results of almost two decades of research after attentional capture (AC) even when produced in complicated paradigms. Second, their timing of a thorough and critical review on the role of automaticity and endogenous control in AC is accurate as more and more models incorporate endogenous modulations on low-level information processing levels. Finally, the insights provided in this review on attentional capture are also very meaningful for other paradigms used to study the processes of visual attention.

Relevance for other attentional paradigms: Attentional Blink

We would like to begin where Ruz & Lupianez finished their review, namely the observation that several theories recently state that early low-level information processing stages of visual perception can be governed by the very endogenous control settings. There is accumulating evidence for the view that humans are able to transfer a relevant stimulus modality from the top to the bottom into the earliest processing levels in such a way that these relevant endogenous settings capture attention and that irrelevant singleton stimulus modalities do no longer capture attention 'automatically'. For instance, Visser, Bischof, & DiLollo (1999) came to a similar conclusion on basis of a review of the data of the 'Attention Blink' (AB) phenomenon. AB emerges when subjects have to report a second target within 200 to 500 ms. after a first target in a stream of stimuli. That is, under these circumstances subjects fail to report the second target in ca 80 % of the cases. Interestingly, when the second target is presented within 200 ms. this failure is sometimes absent. This Lag-1 Sparing, as Visser et al called it, was absent when target 1 and 2 differed in a) location or b) stimulus modality (for example, color and movement). This led them to conclude that a low-level processing stage can be set by endogenous control that opens a door for further processing in a later stage. This ‘door’ shuts immediately for stimuli presented elsewhere or in another modality, but remains open for still 200 ms. more when on the same location another target emerges in the same modality.

Back to Attentional Capture

In the paradigm of Folk et al. (1992) paradigm, to recapitulate, two consecutive frames in which the first was irrelevant and the second contained a target (see Fig 3. in Ruz & Lupianez). The first frame contained an irrelevant singleton. In some blocks these singletons occupied the same location as the targets (valid trails), in other blocks they were presented on different locations (invalid trails). The second frame contained a target either overlapping or non-overlapping the dimension of the singleton. The invalid condition (singletons and targets were presented on different locations) singletons with no dimensional overlap with the target did not induce RT-costs. However, this would be expected if all singletons capture attention automatically. Theeuwes, Atchley, & Kramer (2000) used Theeuwes' (1991a, 1992) Visual Search paradigm. Subjects had to ignore a color singleton distractor presented at different stimulus onset asynchronies (SOA's) prior to the search display in which they had to search

for a shape singleton target. When presented simultaneously the irrelevant color singleton disrupted search performance, indicating an involuntary orienting reaction. This effect was eliminated when the SOA was 150 ms. or longer. They concluded singletons do initially capture attention and soon after attention is disengaged from that location. Apparently, Theeuwes et al. 's study shows that a singleton attracts attention for a short time (for 150 ms.) even when the singleton and target do not overlap dimensionally. This is different in the case that the subject has to report the first stimulus too. That is, the study of Visser et al., described above, did show that there is no Lag-1 Sparing when target 1 and 2 differ in stimulus dimension. In addition, the Folk and Remington (1998) study shows that a spatial capture paradigm is more sensitive for attentional control settings than is the visual search paradigm of Theeuwes (1991a, 1992) (p. 26). Attentional capture effects on the target are only measured when a target appears in the same location and in the same modality as the preceding singleton. Similarly, Lag-1 Sparing is only seen when the first and the second target overlap in location and stimulus dimension.

ERP's

There are some basic problems with solving the debate of AC with using RT-measures only. In fact, Folk and Remington (1998) on the one hand state that RT-effects 'should not invariably lead to an attentional orienting interpretation' (p. 23) while Theeuwes, Atchley, and Kramer (2001) on the other hand state that 'a null reaction time effect does not necessarily rule out that a singleton has captured attention' (p. 26). In other words, reaction time is not the most powerful tool to determine whether the automaticity in attentional capture is a hard-wired bottom-up effect in its origin or that its 'defaults' can be overcome by endogenous settings. An alternative promising method is to measure the event related potential (ERP) during visual processing in time. For example, Arnott et al. (2001) used the Folk et al (1992) paradigm and showed that the N100 components was modulated by stimuli sharing task-relevant attributes only, and singletons that showed capture effects in RT evoked a negative modulation before presentation of the target compared to singletons that did not show capture effects in RT. This finding indicates that at least in the Folk et al. (1992) paradigm the 'task set modulates processing of cues at early stages of sensory processing' (p. 19). Other ERP data not directly testing the hypotheses discussed here can be useful too. Luck and Hillyard (1994) carried out an ERP study that focused on pop-out stimuli (singletons) in visual search, very similar to the Theeuwes' paradigm.). They showed in four experiments that certain ERP components were enhanced when subjects were presented with displays with pop-outs (contralateral P1 and the anterior N2), these did not reflect a fully automatic pop-out detection processes. They showed, however, that specific components were enhanced when the pop out happened to be the target. This indicates that pop-out induce no (early) component modulation on it self per se (which would be expected when pop-outs were processed in separate, hard-wired routes), rather, these components are modulated according to the relevancy of the pop-outs. This finding mirrors the contingent involuntary orienting hypothesis. ERP data in both paradigms (i.e. Spatial Cuing and Visual Search) tend to subscribe the notion that singletons are not processed in hard-wired highway to attention and these findings can play a decisive role in this theoretical discussion. Thus, the combination of behavioral studies in terms of RT and the use of brain-imaging methods with a high temporal resolution like ERP and MEG seems to be a promising way to resolve some long-standing issues in the attentional literature so far. Of course, in these combined research approach, experimenters should still be well aware of the dangers that have also haunted classical RT-research. For instance, 'the research method chosen to explore attentional capture can have

consequences for the inferences that are drawn' as Ruz and Lupianez legitimately finish their review (p.27).

Conclusion

As more and more models on visual attention currently state, we are inclined towards a view that automaticity can be governed by endogenous control. This and other insights as derived from the now overwhelming amount of literature on Attentional Capture can and should facilitate the research on other attentional phenomena as Attentional Blink. In addition, experimental research on Attentional Capture can and has to be inspired by new research methods and existing models of visual attention. Furthermore, we suggest that psychophysiological methods like ERP can calibrate the interpretations of the fragile RT-effects. To conclude, not only because of its importance for overviewing the literature on AC, but also for the insights it provides about the processes of visual attention in general, the review of Ruz and Lupianez is one which should capture your attention (but not fully automatically).

Additional Literature.

Visser, T. A. W., Bischof, W. F., and DiLollo, V. (1999). Attentional Switching in Spatial and Nonspatial Domains: Evidence From the Attentional Blink. Psychological Bulletin, 125 (4), 458-469.

Luck, S. J., and Hillyard, S. A. (1994). Electrophysiological correlates of feature analysis during visual search. Psychophysiology, 31, 291-308.

Vogel, E. K., Luck, S. J., and Shapiro, K. L. (1998). Electrophysiological Evidence for a Postperceptual Locus of Suppression During the Attentional Blink. Journal of Experimental Psychology: Human Perception and Performance, 24 (6), 1656-1674.