6. What grabs us: Comment on Ruz & Lupianez

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Ruz & Lupiáñez provide a broad, thorough overview of our present understanding of visual attentional capture, that is, of the tendency of visual events to attract our attention. They come to the conclusion that events commonly attract attention by virtue of their fit with our current task goals and task-related strategies, and the attentional selection criteria defined by them. Only in rare, exceptional cases will purely bottom-up attentional capture occur, such as when "no clear attentional set is established".

The picture Ruz & Lupiáñez draw fits nicely into the zeitgeist one can observe in cognitive psychology these days. Since the 1950s, when the interest in cognition was revived by information-processing approaches, human performance was often considered to be stimulus-driven (Hommel, Müsseler, Ascherleben & Prinz, in press). This legacy from the behavioristic tradition shines through in sometimes more, sometimes less obvious ways—the perhaps most famous example of the latter being Neisser's (1967) definition of cognitive psychology as the study of the "fate of the input". In recent years, however, cognitive processes that precede and, indeed, sometimes even produce, stimulation have attracted more and more interest. The emergence of attentional-set approaches discussed by Ruz & Lupiáñez are but one example, others are the study of task set in conflict tasks (e.g., Cohen, Braver & O'Reilly, 1998; Cohen, Dunbar & McClelland, 1990) and in task-switching performance (e.g., Allport, Styles & Hsieh, 1994; Meiran, 1996; Rogers & Monsell, 1995), demonstrations of the role of intentions in stimulus-response compatibility (e.g., Hommel, 1993), and investigations of the linguistic control of spatial attention (e.g., Logan, 1995; Spivey, Tyler, Eberhard & Tanenhaus, 2001) and of motor performance (e.g., Gentilucci, Benuzzi, Bertolani, Daprati & Gangitano, 2000).

As exemplified by Ruz & Lupiáñez' discussion, the picture emerging from these investigations is not simple. And it is certainly not well captured by the opposition of automatic versus intentional, or bottom-up versus top-down processes. Rather, it seems that goal states lead to the implementation of *conditionally automatic* (Bargh, 1992) cognitive processes that transform the processing system into something like a *cognitive reflex* machinery (Hommel,

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2000). Indeed, this is what Ruz & Lupiáñez conclude: Task-specific goals enable a set of automatically-running processes that under particular circumstances may process unwanted stimuli. From this perspective, research on attentional capture promises to extend our insights into the interaction of goals and the processes they affect. To do so more optimally, however, some challenges are to be met on both theoretical and empirical sides.

Theoretical challenges

A number of non-trivial theoretical problems remain to be addressed and solving them may well resolve at least some of the apparent empirical discrepancies Ruz & Lupiáñez identify. What we for instance do not yet really understand is, if attentional sets determine stimulus selection to a large degree, how do they do that? Logan and Gordon (2001) have claimed that an attentional set can be established by specifying or changing a single control parameter. If so, how is this parameter translated into a "set", on what types of stimulus codes ("physical", "phonological", or "semantic"; V1, V2, or "higher") does it operate? And what are the conditions under which a set is implemented? Is there just one level of sets (e.g., for color or for shape) or is there a hierarchy of sets with low-level, task-specific sets coexisting with higher-level, general goals (e.g., avoidance of life-threatening and unpleasant events, seeking events that make us happy and satisfy basic needs). I find this latter possibility very reasonable, but it would allow a set-theoretical post-hoc account of almost any demonstration of attentional capture one can think of without contributing anything to our insights on how attention works (see Gibson, 1941, for an early warning). The challenge to be met here is to specify in more detail exactly what an attentional set may be, how it may work, and on which conditions its implementation may depend.

On the other hand, the concept of "saliency" rests almost entirely on intuition and it is often used in a way that comes close to circularity. Everyone would agree that a single red circle among 20 green circles is somehow salient. But what if we increase the number of red circles to four, say. Is *red* still salient? Are the red *circles* salient? If we consider saliency as a continuous variable of which stimuli can possess more or less, what then is the relationship between saliency and attentional capture? Hard to believe it is linear. Indeed, the saliency concept is only clear in the extreme cases that are commonly investigated, so that post-hoc accounts in terms of "not enough" or "too much saliency" are always difficult to rule out. Unfortunately, it is these two concepts—attentional set and saliency—that represent the backbones of the two types of approaches to attentional capture. Hence, as long as they are as fuzzy as they are now it is not likely that the research based on them will reach some sort of final conclusion.

Empirical Challenges

Apart from these theoretical issues there are also some more empirical weaknesses Ruz & Lupiáñez' overview can be taken to point at. Although being motivated by the rather general question of whether and how endogenous and exogenous sources of attentional control interact the majority of actual empirical research focuses on a single aspect of this question: *under what circumstances is searching for a feature singleton affected by the presence of another, irrelevant singleton*. This empirical self-restriction brings with it a whole bunch of theoretical limitations, which in several ways confine our insights into attentional control to situations that are not really, or at least not fully, representative for the everyday use of attentional capabilities.

First, although there are certainly situations in which people scan their environment for the occurrence of one particular feature, many other circumstances are likely to require the search for feature conjunctions—just think of looking for a friend of yours in a crowd, going shopping, or searching for a textbook suited for your introductory class. As the research on attentional capture focuses almost exclusively on feature search tasks (with the few exceptions Ruz & Lupiáñez discuss in their section on salience), there is not much we know about whether and when irrelevant singletons distract our attention under conjunction search. In view of the limited evidence for true capture in singleton-search tasks and the entire absence of capture in the few studies on conjunction search, there is some reason to worry about the relevance of attentional capture for understanding the nature of human attention.

Second, whether attentional capture can count as strictly automatic or not, it seems clear that events attract our attention the more the more salient they are. However, in capture research the saliency of a given stimulus is (implicitly) defined with respect to the other, currently available stimuli only. True, it is intuitively obvious that one or a few oddballs may attract attention merely by being different, but objects and events may be odd for other reasons than possessing a feature that other, simultaneously presented stimuli do not. A number of examples for that stem from Berlyne's extensive work on the effects of novelty and oddity on visual attention (e.g., Berlyne, 1960), which is widely ignored by the capture literature. For instance, stimuli are fixated more likely and longer the more irregular their shape, the more, and the more heterogeneous, their elements and, in the case of pictures, the more they distort the object they depict (Berlyne, 1958). Expectations are also important, as suggested by the observation that stimuli are identified more easily if they appear in a new color (Berlyne & Ditkofsky, 1976). These and other findings demonstrate that events can grab our visual attention by virtue of their particular visual structure alone—independent of their oddity with respect to other, competing attentional targets—and they do so to the degree that they surprise us, hence, if they violate our expectations. These kinds of effects are of obvious importance for a whole range of everyday situations, whether we talk of advertisement, fashion, art, or safety in car driving, so that one would expect research on attentional capture to address them in one or the other way.

Third, a somewhat related issue, attentional capture is commonly investigated without any consideration of the history of both target and distractor stimuli. Given the broad and solid evidence that the degree to which stimuli capture attention varies with their novelty (Cowan, 1997; Sokolov, 1963), it is surprising to see that studies on capture use singletons or other distractors over and over again, and commonly do not even assess possible habituation effects. Lorch and colleagues have investigated the impact of habituation to picture distractors in a speeded classification task (Lorch, Anderson & Well, 1984; Lorch & Horn, 1986), and they did find some reduction of interference after a few pre-exposure trials already. Thus, it is not unreasonable to assume that at least part of the capture effect can be eliminated by some practice and/or by using predictable distractors.

Finally, it is interesting to note that attentional capture is almost exclusively measured in terms of distraction, that is, as interference with ongoing information processing. As most methods such an approach has its strengths and weaknesses. *If* stimuli can be demonstrated to distract attention even if they are entirely irrelevant to the task at hand (which to determine the discussion about attentional sets has shown to be difficult, however), then we indeed have very good reasons to believe that capture is truly automatic. But this is a rather strong test and it does not tell us a lot about what grabs our attention if we are not currently busy with a demanding reaction-time task. Again, some consideration of Berlyne's (1960) approach to curiosity may provide some guidance to overcome this limitation.

To sum up, Ruz & Lupiáñez sketch a research field in progress: Approaches are in the process of overcoming the (probably too simplistic) binary questions that seem to be typical for the initial steps of most research (Newell, 1973) and move towards a more integrative view. To the degree that this process is completed we can expect interesting contributions to more general questions of how human behavior integrates bottom-up processing and top-down control, hence, how performance can be intentional and adaptive at the same time.

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