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Visual attention

The cognitive system is remarkable at completing tasks without the direct involvement of attention. These tasks range from extracting basic visual features such as colour and orientation, to complex rules such as reliable patterns in the environment.

One type of tasks that the visual system completes without attention is mapping basic visual features. Oddities in basic features such as colour, orientation, and size can be quickly detected by the visual system (Wolfe & Holowitz, 2017). These features are salient because the they often guide attention rapidly (Wolfe, 1994). Using results of basic visual features, the distribution of features across the entire visual field can be computed, and areas that will likely draw attention can be mapped (Itti, Koch, & Niebur, 1998). Writing systems have long exploited the salience of basic visual features, and important messages are often **bolded** or painted with a different colour to highlight their importance and draw readers' attention.

The cognitive system is also capable of extracting rules and regularities without the direct involvement of attention. The visual system can incidentally pick up the context in which an event is likely to occur (Chun & Jiang, 1998; Jiang, Swallow, & Rosenbaum, 2013). Furthermore, the visual system can pick up more abstract regularities. The likelihood of object co-occurrences can be incidentally and effortlessly extracted by the visual system (Turk-Browne, Junge, & Scholl, 2005). Participants were not told to pay attention to any rules or regularities in either aforementioned task. Interestingly, such abstract rules and regularities can draw attention (Zhao, Al-Aidroos, & Turk-Browne, 2013). While attention to learned regularities can help reinforce existing knowledge, they are also helpful in visual designs. For example, consistent layout of newspapers can quickly guide readers to the sections they are interested in. Reliable object co-occurrences such as salt and pepper shakers can quickly direct customers to the appropriate section of the table if they want more flavours in their dishes.

Non-attentional processes are capable of simple and complex computations. But as previously discussed, they usually interact with attention, informing the visual system of where the most important information is. Does this mean that attention can accomplish something unique that the non-attentional processes are uncapable of? One classical account is that attention binds basic visual features to form the representation of objects (Treisman & Gelade, 1980). This is supported by change blindness (Simons & Rensink, 2005), where disruption in attention can cause a major change in an object to go unnoticed. This is also supported by inattentional blindness, where a physically salient object is missed if attention is directed elsewhere (Simons & Chabris, 1999). These classical findings become incredibly helpful to the emerging field of virtual reality (VR). VR technology requires high resolution and massive 3D modelling for objects. Both types of computations need immense graphic processing powers. Some VR goggles started including rudimentary eye-tracking devices in them, and overt attention can be estimated from the resulting eye-tracking data. With estimates of attention, parts of the visual field that are not attended can be simplified: objects do not need to be modelled in detail, and only their basic visual features need to be kept. By deploying such selective processing, VR technology can become more cost-effective without sacrifices in user experience.

The visual system can process various kinds of information. Non-attentional processes often complete background tasks, whether simple or complicated. Consequently, the visual system can select the most interesting information for further processing through attention.

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