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The visual brain colours black and white photos

Scientists at the University of Tübingen explore how prior knowledge influences our visual senses

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The perception and processing of colour has fascinated neuroscientists for a long time, as our brain influences colour perception to such a degree that colours could be called an illusion. However, what happens in the brain when we look at black-and-white photos of objects has so far remained unknown: do our brains fill in the colours?

Neuroscientists Michael Bannert and Andreas Bartels from the Bernstein Center and the Werner Reichardt Centre for Integrative Neuroscience in Tübingen addressed just this question. In their work, to be published in the leading scientific journal Current Biology, they showed their study participants black-and-white photos of bananas, broccoli, strawberries, and of other objects that have a typical colour associated with them (yellow, red and green in the examples above). While doing so, they recorded their subjects' brain activity using functional imaging. The true purpose of the study was unknown to the subjects, and to distract their attention they were shown slowly rotating objects and told to report the direction in which they were moving.

After recording brain activity to the black and white objects, the scientists presented real colours to their subjects, in the shape of yellow, green, red and blue rings. This allowed them to record the activity of the brain as it responded to different, real colours.

It turned out that the mere sight of black-and-white photos automatically elicited brain activity patterns that specifically encoded colours. These activity patterns corresponded to those that were elicited when the ob-

servers viewed real colour stimuli. These patterns encoded the typical colour of the respective object seen, even though it was presented in black and white. The typical colours of the presented objects could therefore be read out from the brain's activity, even though they were shown without colour.

"It was particularly interesting that the colours of the objects were only encoded in the primary visual cortex", says Michael Bannert. The primary visual cortex is a very early region, which is assumed to represent the physical properties of the stimuli that fall into our eyes. It is unable to recognize objects or to store colour knowledge associated with objects. "This result shows that higher-level prior knowledge – in this case of object-colours – is projected onto the earliest stages of visual processing", according to Andreas Bartels.

This study represents a significant contribution towards answering the question of how prior knowledge contributes to perception on a neuronal basis. The projection of prior knowledge onto the earliest processing stages of the visual brain may facilitate the recognition of objects in difficult and noisy environments, such as in fog, and be relevant for colours in changing light conditions over the course of the day, when the weather is overcast, when we are in rooms and so on. On the other hand, if prior knowledge or expectations have too much influence on early visual processing stages, this may account for hallucinations and the pathological perception of illusions.

Original Publication:
Michael Bannert and Andreas Bartels (Vision and Cognition Lab, CIN, University of Tübingen) "Decoding the yellow of a gray banana" Current Biology, October 31 2013.

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