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Press Release

Tiny eye movements highlight the world around us

Tübingen neuroscientists investigate how these movements help control visual input into the brain

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Without us being aware of it, our eyes constantly perform tiny corrections of their viewing direction. Until recently, the purpose of these corrections was not well understood. A group of Tübingen researchers at the Werner Reichardt Centre for Integrative Neuroscience (CIN) and the Hertie Institute for Clinical Brain Research (HIH) has now tackled this problem. They have discovered a direct link between tiny eye movements and the focusing of attention needed to perceive our visual environment.

Our sensory organs constantly receive a vast amount of information, and our brain continuously sorts through this storm of sensory stimuli – be it to appreciate a painting, hear a warning shout, navigate a room, or shape a pot of clay. This is most readily apparent in our sense of vision. Only a very small area of our field of view is actually perceived clearly and in focus. As a result, fast movements of the eye muscles – movements known as saccades – periodically direct the angle of viewing to any points that seem interesting. The brain puts these points together and constructs an unbroken image. Saccades take place 3-5 times per second – much faster than our heart beats. For example, when we look at a face, our gaze quickly dances across the eyes, nose, mouth, chin, and forehead, to provide the pieces from which the whole face is assembled in our mind.

However, there are times in which we focus on a single spot, for example when threading a needle. This requires tremendous focus of the eyes on the “eye” of the needle. But even during intense concentration on such a small point in space, the brain still keeps up awareness of the periphery, so we can react to anything happening in our broader field of view. Tübingen investigators led by Dr. Ziad Hafed (CIN) have now analyzed data collected in collaboration with the team of Prof. Dr. Peter Thier (HIH) to uncover how this peripheral awareness functions: rather than completely eliminating all eye movements while focusing on the needle, the brain instead makes use of tiny, almost imperceptible eye movements – mere fractions of a degree in size. Hafed and his team found that these

tiny eye movements play a major role in “highlighting” sensory information in our periphery –without us even being aware of them.

These very small eye movements are called microsaccades. In contrast to normal saccades, which let us look at a new object or part of it in our field of view, microsaccades only result in what seem at first glance to be negligible readjustments. However, in their investigation, Dr. Hafed and his team were able to detect an increase in neuronal activity immediately before the occurrence of each microsaccade – evidence of heightened attention and a highlighting of the visual scene.

Microsaccades follow a recognizable, quick rhythm, undulating several times per second. Even points far away from the eye’s focus are “highlighted” when microsaccades increase attention. This mechanism allows our brain to “keep an eye out” even when our eyes are busy, keeping tabs on the environment, warning of danger, and thus allowing our active perception to rapidly re-focus on anything that might happen.

Hafed and his team’s results potentially open the door to future engineering applications. For example, if computer interfaces were to track computer users’ microsaccades with cameras, computers could predict when the users’ brains may be more or less sensitized to new stimuli. Such “smart” user interfaces could thus optimize on a millisecond basis when and where to provide visual feedback to their users to maximize work efficiency.

Publication:

Chih-Yang Chen, Alla Ignashchenkova, Peter Thier & Ziad Hafed: Neuronal Response Gain Enhancement Prior to Microsaccades. *Current Biology* (2015), 16 July 2015 (online publication)

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