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Seeing movement: Why the world in our head stays still when we move our eyes

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Scientists from Germany discovered new functions of brain regions that are responsible for seeing movement.

When observing a fly buzzing around the room, we should have the impression that it is not the fly, but rather the space that lies behind it that is moving. After all, the fly is always fixed in our central point of view. But how does the brain convey the impression of a fly in motion in a motionless field? With the help of functional magnetic resonance imaging (fMRI) scientists from the Werner Reichardt Centre for Integrative Neuroscience and the Max Planck Institute for Biological Cybernetics in Tübingen have identified two areas of the brain that compare the movements of the eye with the visual movements cast onto the retina so as to correctly perceive objects in motion.

The two areas of the brain that are particularly good at reacting to external movements, even during eye movements, are known as V3A and V6. They are located in the upper half in the posterior part of the brain. Area V3A shows a high degree of integration: it reacts to movements around us regardless of whether or not we follow the moving object with our eyes. But the area does not react to visual movements on the retina when eye movements produce them. Area V6 has similar characteristics. In addition, it can perform these functions when we are moving forwards. The calculations the brain has to perform are more complicated in this case: the three-dimensional, expanding forward movement is superimposed onto the two-dimensional lateral movements that are caused by eye movements.

The scientists Elvira Fischer and Andreas Bartels from the Werner Reichardt Centre for Integrative Neuroscience and the Max Planck Institute for Biological Cybernetics have investigated these areas with the help of functional magnetic resonance imaging (fMRI). fMRI is a procedure that can measure brain activity based on local changes in blood flow and oxygen consumption. Participants in the study were shown various visual scenarios whilst undergoing fMRI scanning. For example, they had to follow a small dot with their eyes while it moved across a screen from one side to the other. The patterned background was either stationary or moved at varying speeds, sometimes slower, faster or at the same speed as the dot. Sometimes the dot was stationary while only the background moved. In a total of six experiments the scientists measured brain activity in more than a dozen different scenarios. From this they have been able to discover that V3A and V6, unlike other visual areas in the brain, have a pronounced ability to compare eye movements with the visual signals on the retina. "I am especially fascinated by V3A because it reacts so strongly and selectively to movements in our surroundings. It sounds trivial, but it is an astonishing capability of the brain", explains Andreas Bartels, project leader of the study.

Whether it is ourselves who move or something else in our surroundings is a problem about which we seldom think, since at the subconscious level our brain constantly calculates and corrects our visual impression. Indeed, patients who have lost this ability to integrate movements in their surroundings with their eye movements can no longer recognize what it is that ultimately is moving: the surroundings or themselves. Every time they move their eyes these patients feel dizzy. Studies such as this bring us one step closer to an understanding of the causes of such illnesses.

More information: Elvira Fischer, Heinrich H. Bülthoff, Nikos K. Logothetis, Andreas Bartels (2012) Human areas V3A and V6 compensate for self-induced planar visual motion, *Neuron*,

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