# Receptive Fields of Awake Animals Free-Viewing Natural Time-Varying Images

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One of the major aims of neuroscience is to understand how neurons code sensory input of an animal's natural environment. The basic approach has been the usage of a neuron's receptive field, which is extended over space, time and other sensory input dimensions to predict responses of a neuron to sensory input by a weighted summation or filtering of the input.

Most of the existing understanding of sensory systems are derived from measurements made using unnatural stimuli, and animals that were paralyzed and/or anesthetized. It is questionable whether the receptive field measured this way can describe the neuronal responses to natural stimuli experienced by awake behaving animals. In fact, receptive fields are dynamic (non-stationary), adapt to sensory input statistics, and change with behavioral state. Prior investigations did not employ natural stimuli because their importance was not understood, nor were approaches to analyses of their statistical properties readily apparent. Furthermore, it is technically demanding to use awake behaving animals where eye movements have to be tracked to analyze receptive fields.

We demonstrate that it is not only possible to derive the receptive fields this way but also essential when studying neurons whose receptive field structure is unknown. In particular, we recorded in the lateral geniculate nucleus (LGN), visual cortex (V1/V2), middle temporal (MT), and pulvinar (Pul) areas. We verify that our method and random-dots sequence both derive LGN receptive fields. However, it is not straightforward to design other simple stimuli to derive receptive fields in V1/V2, MT, and Pul areas — unless one has more knowledge about their receptive field properties. Yet our method worked for the other areas just as LGN, mainly because neurons are activated during free-viewing natural time-varying images. The neurons without activity are probably not visual or are not important in natural vision.

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