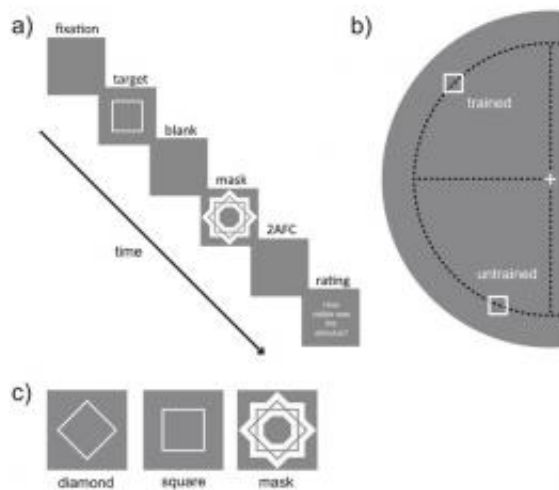


Learning to see consciously

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Training for conscious perception: A. Subjects are presented with geometric forms in rapid succession. After 10 milliseconds the forms were masked to render them invisible. The task of the subjects was to judge their visibility. B. Location of form and mask on the screen. C. A square and a diamond serve as the visual cues, a star as a mask. Credit: PNAS Early Edition, doi: 10.1073/pnas.1009147108

Our brains process many more stimuli than we become aware of. Often images enter our brain without being noticed: visual information is being processed, but does not reach consciousness, that is, we do not have an impression of it. Then, what is the difference between conscious and unconscious perception, and can both forms of perception be changed through practice? These questions are important not only for basic research, but also for the treatment of patients with perceptual deficits

due to brain lesions e.g. following a stroke. Scientists at the MPI for Brain Research in Frankfurt/Main could now show that seeing can be trained. Their tests revealed that the brain regions underlying the learning effects on conscious perception are different than the ones underlying the learning effects on the mere processing of stimuli.

Visual stimuli undergo a series of processing stages on their journey from the eye to the [brain](#). How [conscious perception](#) can arise from the activity of [neurons](#) is one of the mysteries that the neurophysiologists at the MPI for Brain Research seek to solve. “Today, we know that the processing of stimuli in the cortex remains extremely plastic, or malleable, even in adults,” explains Caspar Schwiedrzik who investigates the neural mechanisms of visual perception with his Max Planck colleagues Wolf Singer and Lucia Melloni. In their current study, the scientists examined whether perception can be influenced by long-term and systematic training and whether such training does not only change the processing, but also affects whether the stimulus can be consciously perceived.

It is known from clinical studies that some stroke patients who suffer partial blindness as a result of damage to the visual cortex can discriminate between stimuli that fall into their blind visual field. This unconscious discrimination ability can be improved through training. Nevertheless, the patients report that they do not see the images. In a few cases, however, conscious perception of the stimuli could be improved with training. Is it maybe possible to learn to “see consciously”?

To investigate this question in healthy subjects, the Frankfurt scientists developed an experimental set up with which different learning effects on perception could be measured. The subjects were shown images of two different geometric forms – a square and a diamond – on a screen in rapid succession and in a random sequence, and were asked to discriminate between them. The visibility of the images was limited by

presenting a mask shortly after each image, which rendered the shape invisible.

The experiment was designed such that the subjects could initially not discriminate between the images and that they were also subjectively invisible. The subjects were then trained for several days. Each round of the training involved the presentation of images followed by the mask. As soon as the subject indicated by pressing a button which form had been shown and how clearly he or she had seen the form, the next stimulus and the next mask were shown. This process was repeated 600 times per day. After several days, the subjects could better discriminate between the target stimuli. From the ratings of the visibility of the stimuli, the scientists could further conclude that the participants' subjective perception had increased as well: the images now entered [consciousness](#). Thus, the scientists succeeded in demonstrating that it is also possible to learn to see consciously.

The question remained, however, as to how objective and not necessarily conscious processing of stimuli and their subjective, conscious perception are linked. To gain a better understanding of the individual processing steps and to localize them in the brain, the experiment was repeated once more. This time, the image and mask were shown on a different part of the screen, and were thus processed by a different part of the brain. "The results were revealing," explains Lucia Melloni: "While the learning effect for the pure processing of the stimuli, that is the discrimination of the shape, was lost with the spatial rearrangement of the stimuli, the clearer visibility of the images, that is the learning effect in terms of conscious seeing, remained." Therefore, objective processing and subjective perception of the stimuli seem to be less closely linked than previously assumed. The two training effects appear to be based on two different areas of the brain.

"Our experiments have shown that the neuronal processes that underlie

conscious perception are very flexible,” Schwiedrzik concludes. The findings provide important insights for medical applications, in particular for the rehabilitation of people suffering from perceptual deficits caused by [brain lesions](#).

More information: Caspar M. Schwiedrzik, et al. Subjective and objective learning effects dissociate in space and in time. *PNAS Early Edition*, [doi:10.1073/pnas.1009147108](https://doi.org/10.1073/pnas.1009147108)

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