Cognitive psychology is mapping the capabilities we are unaware we possess

By Christof Koch | Scientific American

Sigmund Freud popularized the idea of the unconscious, a sector of the mind that harbors thoughts and memories actively removed from conscious deliberation. Because this aspect of mind is, by definition, not accessible to introspection, it has proved difficult to investigate. Today the domain of the unconscious?described more generally in the realm of cognitive neuroscience as any processing that does not give rise to conscious awareness?is routinely studied in hundreds of laboratories using objective psychophysical techniques amenable to statistical analysis. Let me tell you about two experiments that reveal some of the capabilities of the unconscious mind. Both depend on "masking," as it is called in the jargon, or hiding things from view. Subjects look but don't see.

**Unconscious Arithmetic**
The first experiment is a collaboration among Filip Van Opstal of Ghent University in Belgium, Floris P. de Lange of Radboud University Nijmegen in the Netherlands and Stanislas Dehaene of the Collège de
France in Paris. Dehaene, director of the INSERM-CEA Cognitive Neuroimaging Unit, is best known for his investigations of the brain mechanisms underlying counting and numbers. Here he explored the extent to which a simple sum or an average can be computed outside the pale of consciousness. Adding 7, 3, 5 and 8 is widely assumed to be a quintessential serial process that requires consciousness. Van Opstal and his colleagues proved the opposite in an indirect but clever and powerful way.

A quartet of single-digit Arabic numbers (1 through 9, excluding the numeral 5) are projected onto a screen. Volunteers had to indicate as quickly as possible whether or not the average of the four projected numbers exceeded 5. Every trial was preceded by a hidden cue that could be valid or invalid. The cue consisted of a very brief flash of another set of four numbers whose average was either smaller or larger than 5. These were preceded and followed by hash marks at the location of the flashed numbers. The marks effectively masked the cue so that no subject ever consciously saw this quartet. Forcing them to guess whether the average of the four hidden numbers was less than or greater than 5 did not work either: they were at chance.

Yet the cue still influenced the subject's reaction to the main response. If the implicit cue was valid, the response to the target was consistently faster than if the cue was invalid. In the illustration, the mean of the four invisible cues (3.75) is less than 5, whereas the average of the visible target numbers is greater than 5. Resolving this conflict demands additional processing time (about 1\,40 of a second). That is, the cue triggers neural activity representing the assertion "less than 5," which interferes with the rapid establishment of a coalition of neurons representing "greater than 5." That invisible and undetectable cues influence behavior implies that the unconscious can somehow estimate the average of four single digits. It is unlikely that it does so following the precise, algebraic rules children learn in grade school. Instead it may rely on heuristics: for example, for each number larger than 5, increase the probability of pushing the greater than 5 button.

This is just the latest in a flurry of experiments demonstrating so-called ensemble coding, the ability of the mind to guesstimate the dominant emotional expression of a crowd of faces or the approximate size of a bunch of dots even though the individual faces or dots are not consciously perceived.

**What's Wrong with this Picture?**

Liad Mudrik and Dominique Lamy of Tel Aviv University and Assaf Breska and Leon Y. Deouell of the Hebrew University in Jerusalem set out to test the extent to which the unconscious can integrate all the information in any one picture into a unified and coherent visual experience. Giulio Tononi and I had proposed in the last Consciousness Redux column [September/October 2011] that the ability to rapidly integrate all the disparate elements within a scene and place them into context is one of the hallmarks of consciousness.

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