Mind the snake: Fear detection relies on low spatial frequencies

Nuno Gomes[1], Sandra C. Soares[2,3,4], Samuel Silva[5], Carlos F. Silva[2,3]

1 — William James Center for Research, ISPA University Institute, Portugal
2 — Department of Education and Psychology & William James Center for Research, University of Aveiro
3 — Department of Education and Psychology & CINTESIS, University of Aveiro
4 — Department of Clinical Neuroscience, Division for Psychology, Karolinska Institutet, Sweden
5 — Department of Electronics, Telecommunication and Informatics & IEETA, University of Aveiro

The privileged processing of threat stimuli, even in the absence of visual awareness, has been associated with a subcortical superior colliculus (SC) – pulvinar pathway to the amygdala, bypassing the visual cortex. Relying on slower cortical visual activity would have dire consequences, with the subcortical visual system functioning, instead, as a rapid detector and first responder when time is of the essence. Although this notion is supported by a large bulk of studies with both non-human primates and humans, other research, using social stimuli (fearful faces), has shown evidence that cortical processing may not be ruled out from this fast-initial processing of threat-related stimuli. In the current study, we used an approach based on the tuning properties of cells in the different visual structures, while manipulating the spatial frequency of the stimuli and testing whether the advantage of snakes – a prototypical threat-inducing stimuli – in accessing visual awareness relies on high or low spatial frequencies (i.e., fine or coarse visual details, respectively). To that effect, we used an interocular suppression paradigm – Continuous Flash Suppression (CFS) – , and recorded the time needed for stimuli showing three different levels of spatial frequency information – broad (unfiltered), low, and high spatial frequencies, to break the suppression caused by the CFS (breaking-CFS). Our results showed a snake advantage (compared to bird control stimuli) in accessing visual awareness only for low spatial frequencies, which argues in favor of the role of a subcortical pathway (superior colliculus – pulvinar) to the amygdala in threat detection, thought to be sensitive to coarse, but not to fine detailed information. Our research work also highlights that social and predatory fear stimuli may have distinctive neuronal signatures, given their different biological relevance.