Sensorimotor Integration of Camouflage Body Patterning in Cuttlefish

(Talk #6)

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Recent research on the visual mechanisms of rapid adaptive camouflage in cuttlefish (Cephalopoda; Mollusca) will be presented. These neurophysiologically complex marine invertebrates can camouflage themselves against almost any background, a feat well appreciated by Aristotle, and one never mastered by any land animal. Yet their ability to quickly (0.5-2 sec) alter their body patterns on different visual backgrounds poses a vexing challenge: how to pick the correct body pattern amongst their repertoire. The ability of cuttlefish to change appropriately requires a visual system that can rapidly assess complex visual scenes and produce the motor responses - the neurally controlled body patterns - that achieve camouflage. Using specifically designed visual backgrounds (both natural and artificial) and assessing the corresponding body patterns quantitatively (akin to visual psychophysics with human participants), we and others have uncovered several aspects of scene variation that are important in regulating cuttlefish patterning responses. These include spatial scale of background pattern, background intensity, background contrast, object edge properties, object contrast polarity, object depth, and the presence of 3D objects. Moreover, arm postures and skin papillae (3D bumps in their skin) are also regulated visually for additional aspects of concealment. By integrating these visual cues, cuttlefish are able to rapidly select appropriate body patterns for concealment throughout diverse natural environments. This sensorimotor approach of studying cuttlefish camouflage thus provides unique insights into the mechanisms of visual perception in non-human invertebrates.