Platypus Electroreception

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We understandably focus on our five senses: sight, hearing, smell, taste, and touch. We've long been aware, however, that other animals are not limited to the Big 5. Whales and dolphins can use echolocation in their aquatic realm, bats employ a similar technique to navigate and hunt in the dark on the wing. Pythons and vipers use the heat emanating from rodents to "see" them as an infrared image. As documented in *It's Sensitive. Really,* some claim that the narwhal uses its tusk to reveal all sorts of information about its Arctic habitat. While these special senses seem better suited to XMen than Animal Planet, they pale in comparison to those of the strange but wonderful Platypus.

The platypus is both marvel and mystery. It is classified as a Monotreme, among the most primitive of mammals, because it uses just one orifice to serve as anus, urethra and, for females, vagina. With dense, dark fur, in some ways it looks like a typical mammal despite its prominent bill. . Naturalists quickly discovered capabilities that are rare (egg laying, an ability only shared with the Echidna), even unique (poisonous spurs) among mammals. Digging in even deeper to its very genetic core, there is evidence of both reptilian and avian DNA and characteristics. As if that wasn't enough, platypuses have five sex chromosomes, instead of the two. No one knows how this affects their behavior and sexuality.

Recently scientists began to appreciate another spectacular talent, *electroreception* - the ability to perceive electrical stimuli biologically. Platypus are energetic and persistent hunters, spending over 40% of each night skimming along the bottoms of their home range creeks and ponds, searching for food. Electroreception allows platypuses to hunt for small shrimp, fish and crustaceans in these murky environments, without using their senses of sight, hearing or smell. This was first discovered in demonstrations where platypuses unfailingly turned over the one rock, among many, that covered a small battery.

Scientists studying this phenomenon have labeled this ability as "bill sense" since the mechanism involves the use of some 40,000 mucous gland electroreceptors strategically placed along the unique bill. While physiologists like Dr. Uwe Proske, of Monash University in Clayton, Australia, still lack a complete understanding of how these amazing sensors work, Proske and his colleagues know that they do more than just locate prey. They also detect the ambient electrical field emanating from underwater objects like rocks or other obstacles. With this skill the web-footed platypus can paddle downstream as smoothly as the current.

But that's not all. The bill also has 50,000 or more movable *mechanoreceptors* which can detect an impact as faint as the sensation of water displaced by a shrimp tail flick from a meter or two away, somewhat similar to how human's feel a faint breeze on their skin through the sense of touch. With these novel sensory systems working in parallel, the platypus can determine where its prey is and then go get it.

The sophistication of this dual sensory capability becomes even more evident when we look in depth at its somatosensory cortex. Both type of receptors connect with it through the trigeminal nerve which typically works the nerves and the muscles of the face. Neurons in the cortex which use the electrical information are intertwined like interlocked fingers with neurons which use the mechanoreceptor info. This allows the platypus to determine, with precision, exactly where its prey is. The platypus can even pick up both alternating and direct current. No wonder two-thirds of its somatosensory cortex handles the bill alone.

Turning towards the mystery of consciousness, the intermeshed nature of these sensory inputs has lead Dr Proske to wonder, "So does the platypus feel touch when it detects an electrical field?"

When in pursuit of prey, the platypus swings its head (and bill) back and forth. This allows both electrical and water disturbance data to be experienced in rapid-fire sequence by differing parts of the bill, which have differing degrees of sensitivity to these inputs. The bill is "striped" with these receptors in just such a manner as to enhance this effect.

Putting all these abilities together, the platypus can detect the presence of its prey, immediately turn towards it in pursuit, all the while picking up additional information every time the prey discharges even tiny amounts of electricity contracting its muscles or even minutely disturbs the water as it attempts to escape. These inputs get even stronger as the platypus closes in until it secures and devours it. All this is done in the dark, in muddy, clouded water.

It's a real life animal with science fiction-like abilities. As it swims, head shaking back and forth, eyes, ears and nose closed tight, it projects before it an invisible field that is incredibly sensitive to movement, water disturbances and obstructions. Flowing water has its own electrical qualities which the adept platypus can "read" providing it a rapidly unfolding 3D map. While several species of fish, including sharks, have electroreception capabilities, they lack the mechanoreceptors and consequently, the ability to precisely locate prey in a three dimensional world. The platypus, on the other hand, after picking up even the faintest of sensations, can turn immediately and make a dead shot towards its unsuspecting prey.

Ironically, the platypus's acute electrical sensitivity explains why they fare so poorly in captivity. The aquariums they are placed in filter their water with powerful electrical pumps. They wreak havoc with the platypus's electroreceptors and brain, eventually killing them.

In the wild waterways of Eastern Australia and Tasmania the platypus relies on every bit of its high tech sensory gear. It needs to catch and eat ½ of its body weight in shrimp, snails and crayfish, every night just to survive. It takes a lot of energy to keep those amazing sensors ready.

Imagine, just for a second, how differently from us the platypus' world is as it paddles along its riparian bottoms, maneuvering skillfully through rocks, downed trees, and sandbars. It senses a barely perceptible tail flip of a tiny shrimp, instantly orients to it, thrusts towards it with its powerful tail,

catches, crunches and swallows it. All these sophisticated abilities and complex behaviors, without any use of the senses we are helpless without – sight, hearing, and smell. Life on Earth involves a wide palette of perceptual experiences and, consequently, diverse and extraordinary streams of consciousness.