Sensory Processes of Florida Manatees: A Review

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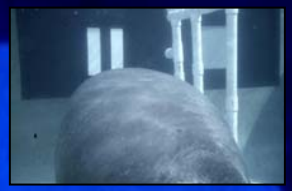
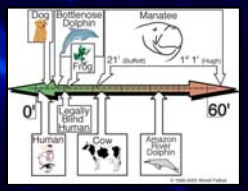
Manatees are tactile/auditory specialists, with limited visual acuity, a pattern consistent with the frequently turbid, underwater environment they inhabit. Neuroanatomical data suggest their chemical senses are of secondary importance.

Visual Acuity

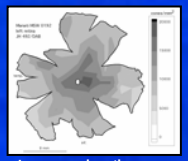
Underwater visual acuity at one meter was investigated using vertical and horizontal grating stimuli in a free-swimming, two-alternative, forced-choice discrimination procedure. Buffett demonstrated a minimum angle of resolution (MAR) of 21′, comparable to the 20′ visual acuity estimated from physiological measures. Hugh had visual acuity over a degree and was probably visually impaired. Buffett was also tested at a closer distance with no improvement in resolution, suggesting that manatees are not myopic.



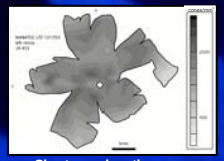


Color Vision

Anti-photopigment labeling identified two cone types. This is consistent with previous morphological observations, which identified two cone types, and behavioral assessment that demonstrated dichromatic color vision in the blue and green range.



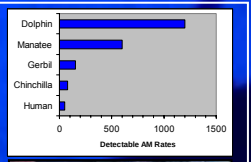
Long wavelength cones



Short wavelength cones

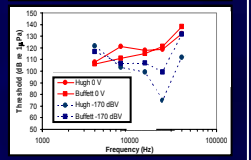
Auditory Temporal Processing

Auditory temporal processing was assessed with an evoked potential procedure using an envelope-following technique. The processing rate was high, 600 Hz, exceeding that for humans by a factor of 10. High auditory temporal processing could be an adaptive characteristic underwater where sound travels about five times faster than in air.



Audiogram

An auditory evoked potential (AEP) audiogram indicated detection of sound frequencies up to at least 40 kHz, with peak sensitivity around 24 kHz. Peak and upper limit of the frequency range was consistent with previously reported behavioral measures of manatee hearing. The lower frequency hearing limit could not be reliably determined with our AEP technique.

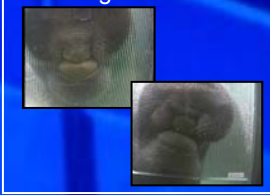


Sound Localization

Underwater sound localization abilities are remarkable, given that sound travels at 1,500 m/s underwater, five times faster than in air. This reduces the inter-aural time delay, which is the most important cue for sound localization in mammals. These results suggest that manatees should be able to localize the directions of oncoming boats and con-specific vocalizations.
(See Colbert et al. poster for details)

Tactile Discrimination

Using the vibrissae-rich facial area, manatees demonstrated tactile discrimination of texture gratings at a level comparable to human index finger performance. The manatees were trained to be blindfolded and discriminate between a 2 mm grating stimulus and broader width gratings in a two-alternative, forced choice procedure. Buffett had an interpolated threshold (75% correct) of 2.05 mm (Weber fraction = .025) and Hugh had a threshold of 2.15 mm (Weber fraction = .075).



Species	Weber Fraction
Asian elephant	0.14
Antillean manatee	0.14
Harbor Seal	0.09
Florida manatee (Hugh)	0.075
Human (index finger)	0.04
Florida manatee (Buffett)	0.025

Vibrotactile Sensitivity

Preliminary tests indicate manatees detect low frequency vibrations between 5 and 50 Hz, presumably through hydrodynamic sensation involving their vibrissae. Behavioral tests examined the vibrissae on the facial region. Anatomical studies suggest that the vibrissae that cover the post-facial portion of their bodies can functionally detect water movements, which will be examined in the next phase of the research.
(See Gaspard et al. presentation for details)