Literature Review 4: Topic Dissemination
ZOOL 567 - Animal Behavior
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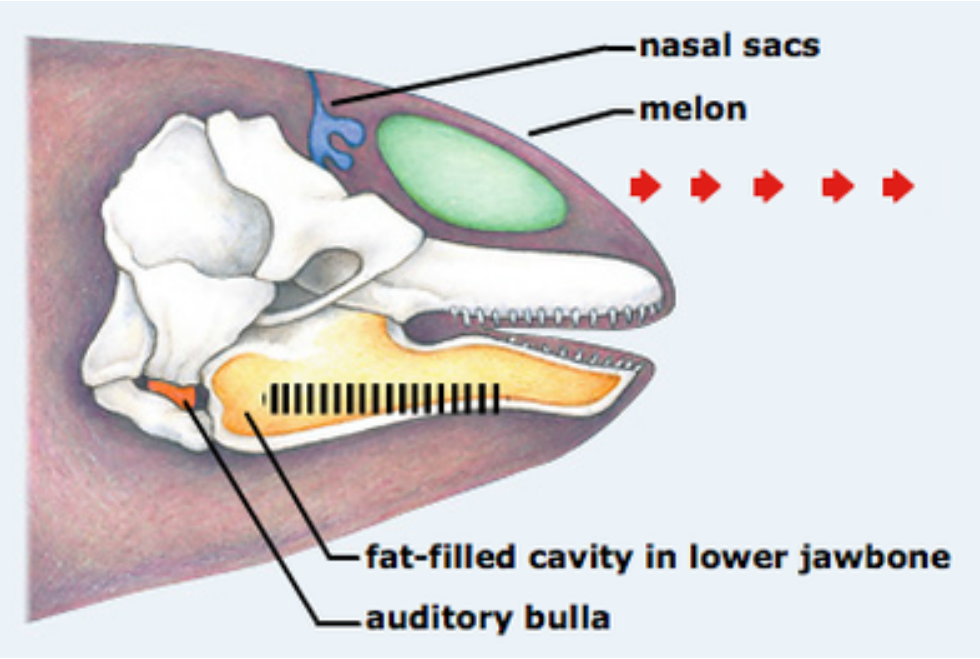
Orca Vocalization

(Photo by Robert Pittman NOAA)

Language as a predominant form of communication has been studied at nauseam within academia. From linguistics - which looks at the development of specific language patterns - to cultural anthropology - which seeks to identify the origins of language of social groups - speech, and communication have always been intriguing to study. While there are large chunks missing from our entire history of language development, looking at communication in different social mammals and animals can give a clue to how communication is developed, and how interactions shape the way communication changes. These findings can also be used to increase the mapping of communication signatures to specific social groupings and gain an in-depth view of an individual animal's behaviour both individually and as cohorts.

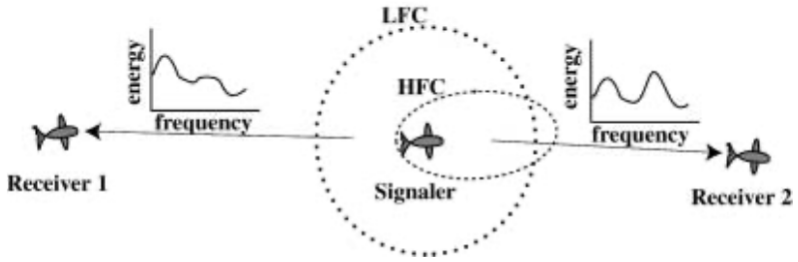
The killer whale (*Orcinus orca*) has one of the most well established and diverse call repertoire of any marine mammal. As a part of the delphinidae family, communication in orcas is very similar to oceanic dolphins, and other toothed whales (Janik 2009). The vocalizations currently used by killer whales have been classified into three different types: whistles, clicks and burst-pulsed signals. Whistles are high pitch short range sound that is performed in close proximity to one another, while clicks are most likely assumed to be echolocation based signalling. Burt-pulsed signals - also known commonly as an orca's 'call' - is highly ranged, in both tones, locality, and usage. Burst - pulsed sounds are highly studied in bioacoustic study, as the context, frequency, and specification are highly varied across groups (Janik 2009).

So how do orca's produce sound? Especially in an environment that has lots of acoustic drag? Auditory organs are highly specialized in orcas and their fellow delphinidae counterparts. A transmission organ is located in the nasal sac that can produce the entire sound range for all three differentiated calls. Whistles range between 7 - 15 kHz, and are commonly identified as high pitch, medium length sounds (Janik 2009). Clicks range from anywhere between 0.1 - 45 kHz, and can be produced rapidly to create click trains and sequences of clicks (Janik 2009). Clicks are most commonly used in echolocation and are the quickest, shortest of the calls orcas and other delphinids can use. Burst-pulse calls can range between 25 kHz to 500 kHz and are the most variable and wide ranging call orcas can utilize for signalling (Miller et al 2004). Sound would leave from the nasal sac and radiate from the fatty deposit (called a melon) located in the forehead that acts as an acoustic lens that can adjust and amplify sound in water. Acoustic signals can be received through an acoustic bulla that is located by the fat filled jaw area (which acts to concentrate sound to the receiving organ). This makes communication highly efficient and important to orcas as a type of signalling (Riesch et al 2006).



(Photo from Stella Peng. Echolocation: Orca Whales)

Directionality with this type of calling is highly studied in orcas. Initially, calls were thought to be omni-directional, and produced readily as it had a lower energy expenditure compared to producing highly specialized directional calling (Miller 2002). However, this does not appear to be the case. A study conducted in 2002 by researcher Patrick Miller found that varied multi-directional calling plays a major part in vocal signalling within orcas (Miller 2002). To decrease the amount of interception of predation calls, and for decreasing the amount of eavesdropping by other whales or scavenging species, orcas can conduct their calls by facing in the direction of the intended revier and concentrating sound through their acoustic lenses. Orcas can also use less concentrated general calling to display territoriality and warning of obstacles to orcas of close relation immediately. This gives a much more complex understanding of how specialization in calls may have come about, and how signalling is used in both honest and dishonest communication to fellow orcas and other proximate species (Miller 2002).



(Photo taken from Miller 2002)

Vocalization is also mapped, depending on type. Language - or the type of specialized set of calls that orcas use - is a taught behaviour. The ability of learning in regard to vocal signalling allows for dialects to arise, and different groups of killer whales can be studied to see their interactions to identify how much learning is happening across groups (Riesch et al 2006). Each individual has their own ‘fingerprint’ like signature call that is established to help identify who they are within a group. Communication like this is still being studied today in orcas, as context based calling is very complex.

The typical community dynamic in killer whales is based in matrilineal groups - descendants from a matriarchal head that stay in close proximity and function as a unified group (Ford 1991). matrilineal lines usually only contain one or two generations and separation occurs frequently. These small matrilineal groups are sometimes associated with other close lines and form bigger subpods, which can also be in association with other subpods to make a pod. Collections of pods together is considered a clan, and usually exist with one type of killer whale (either transient, or resident) (Ford 1991). Language is taught down these matrilineal lines, and highly conserved down generations, however we see variations between groups that do not interact with one

another regularly. Because of the strong matriarch presence, males often split, spererate, or merge into other pods - bachelor subgroups not being rare in orca clans. The transfer of males between groups allows for auditory interactions and merging of different discrete calls, allowing for exchange of information to wider populations of orcas. This can account for the range of specializations and similarities between calls that are performed in the same context (Riesch et al 2006). The growth of both an orca's repertoire of sound, as well the specialty and modification of a baseline call is also very important to how kinship shapes an orca's innate temperament and ability to function as a cohesive part of a pod or other association (Reisinger et al 2017). The more social and interactive an individual, the more exposure to other specialized discrete calls, and the richness of the individual's repertoire increases (Riesch & Deecke 2017).

So what are vocalizations used for then? A range of things, really. Hunting and predation; mating and parental care; migration; identification of self and other; vocal learning; and lots more that is still being studied. Context based vocalizations can give input on what, why, and how signals are being used by individuals. Compiling lots of data can then show us trends that give overall pictures of animal behaviour regarding the species.

In hunting and predation settings, burst-pulse calls were studied and compared on sonography and other measures to identify what corresponding behaviors follow a call. Samarra 2015 found that a herding call was performed when exposed to a food source - frequency of the herding call increased as food supply increased - which would bring other orcas to the food source. Following the increase of orcas around prey, hunting tactics such as tail slaps and cornering would commence as the hunt proceeded (Samarra 2015). This association of call to action shares lots of information about the form of learning and the efficiency of auditory signalling within an orca's vocal repertoire.

Furthermore, future study on these context based call interactions over long periods of time gives insight on both specific and general animal behaviour. Connecting back to predation, the presence of more specialized calls within groups can tell more than just social interactions (Samarra 2015). Samarra 2015 related call specialization with food specialization, generalists had more generalized call patterns, and shared more similarities with each other. Dietary specialists however, saw distinct, more individualized calls. The types of niches that orcas exist in actively show up in their vocalization or their 'language'.

The many connections that were discovered and related through all sorts of studies are able to give a cohesive effect of how orcas behave in relation to how they vocalize, and where things like temperament, sociality, and methods of predation and translocation occur fit into how we observe and study orcas in the future.

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