Cognition, Language & Communication 2013

Assignment I

12-9-2013

Question 1 *On the back is some information about humpback whale vocalizations (songs and calls). What are the notable properties of this communication system, given the discussion of "design features" in the papers and in class? (write less than half a page).*

Question 2 *Draw a finite-state machine that can generate the language* $(ab)^n$*. What would you need to change to generate* $x(ab)^n y$*?*

Question 3 *Falsifiability is a concept from philosophy of science, and generally seen as a requirement for scientific theories; a theory is* falsifiable *if it is possible, in principle, to disprove the theory. That something is falsifiable does not mean it is false; rather, that if it is false, then this can be shown by observation or experiment. Discuss whether the theory of natural language syntax in [Chomsky(1957)] is falsifiable in this sense. Give arguments for your position (maximum 1/2 page).*

References

[Chomsky(1957)] Chomsky, N. (1957). *Syntactic Structures*. The Hague: Mouton.

Humpback Whale Vocalizations

(extracted from wikipedia.org)

Two groups of whales, the Humpback Whale and the subspecies of Blue Whale found in the Indian Ocean, are known to produce the repetitious sounds at varying frequencies known as whale song. Marine biologist Philip Clapham describes the song as "probably the most complex in the animal kingdom".

Male Humpback Whales perform these vocalizations only during the mating season, and so it is surmised the purpose of songs is to aid sexual selection. Whether the songs are a competitive behavior between males seeking the same mate, a means of defining territory or a "flirting" behavior from a male to a female is not known and the subject of on-going research. Males have been observed singing while simultaneously acting as an "escort" whale in the immediate vicinity of a female. Singing has also been recorded in competitive groups of whales that are composed of one female and multiple males.

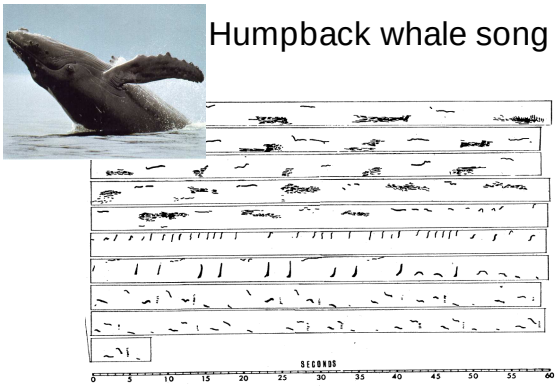
The songs follow a distinct hierarchical structure. The base units of the song (sometimes loosely called the "notes") are single uninterrupted emissions of sound that last up to a few seconds. These sounds vary in frequency from 20 Hz to 10 kHz (the typical human range of hearing is 20 Hz to 20 kHz). The units may be frequency modulated (i.e., the pitch of the sound may go up, down, or stay the same during the note) or amplitude modulated (get louder or quieter). However the adjustment of bandwidth on a spectrogram representation of the song reveals the essentially pulsed nature of the FM sounds.

A collection of four or six units is known as a sub-phrase, lasting perhaps ten seconds. A collection of two sub-phrases is a phrase. A whale will typically repeat the same phrase over and over for two to four minutes. This is known as a theme. A collection of themes is known as a song. The whale will repeat the same song, which last up to 30 or so minutes, over and over again over the course of hours or even days.

All the whales in an area sing virtually the same song at any point in time and the song is constantly and slowly evolving over time.

Whales occupying the same geographical areas (which can be as large as entire ocean basins) tend to sing similar songs, with only slight variations. Whales from non-overlapping regions sing entirely different songs. As the song evolves it appears that old patterns are not revisited. An analysis of 19 years of whale songs found that while general patterns in song could be spotted, the same combinations never recurred.

Humpback Whales may also make stand-alone sounds that do not form part of a song, particularly during courtship rituals. Finally, Humpbacks make a third class of sound called the feeding call. This is a long sound (5 to 10s duration) of near constant frequency. Humpbacks generally feed cooperatively by gathering in groups, swimming underneath shoals of fish and all lunging up vertically through the fish and out of the water together. Prior to these lunges, whales make their feeding call. The exact purpose of the call is not known, but research suggests that fish do know what it means. When the sound was played back to them, a group of herring responded to the sound by moving away from the call, even though no whale was present.



(Watlington'63; Payne & McVay'71)