

# Sperm whale (*Physeter macrocephalus*) communication evolution: A cultural linguistics perspective

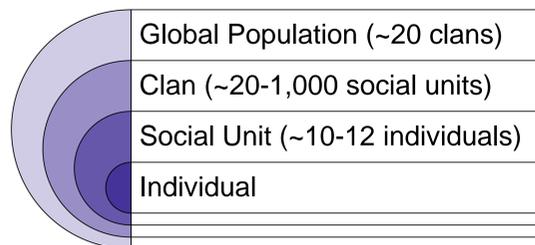
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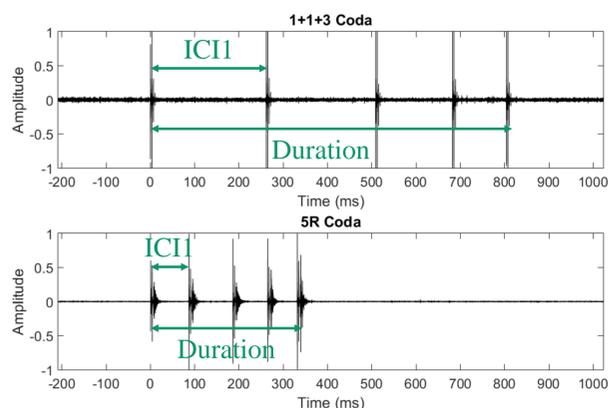
**Overarching Question:** What linguistic processes allow sperm whales to evolve and maintain distinct dialects in both sympatric and non-sympatric waters?

## Background

- Sperm whale social structure is hierarchical and complemented by an intricate vocal culture.<sup>1,2</sup>



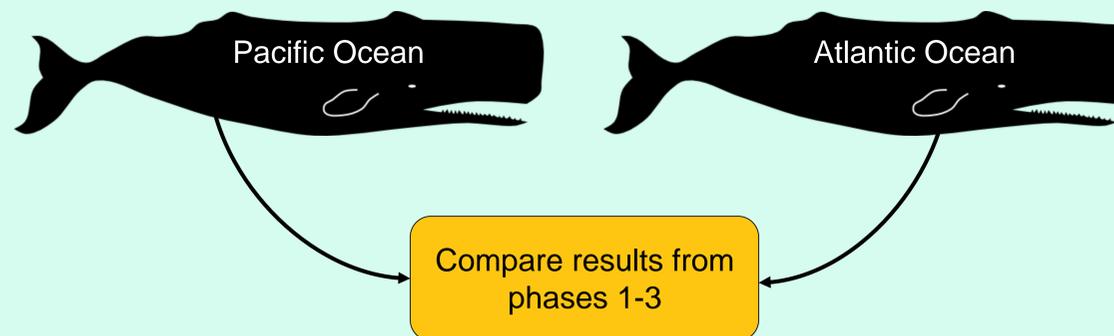
- In social situations, sperm whales communicate using **codas** (stereotyped combinations of 3–12 clicks).<sup>3</sup>
- Variation in the number of clicks, overall duration, and interclick interval (ICI) pattern results in ~60 coda types.



- These coda types are assembled into socially-learned **dialects** that vary by unit and clan.<sup>3</sup>
- We know little of how codas change over time, and even less regarding the processes that facilitate dialect evolution and maintenance in sperm whales.<sup>4</sup>

## Acknowledgements

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## Methodology

### Phase 1: Characterize

- Examine coda usage rules at different acoustic levels (clicks, codas) and social scales (unit, clan).
- Metrics: Number of clicks, duration, ICI patterns.

### Phase 2: Quantify

- Investigate how codas/repertoires change over time.
- Are clicks/codas added or deleted?
- Does duration increase or decrease?
- Does the ICI pattern change?

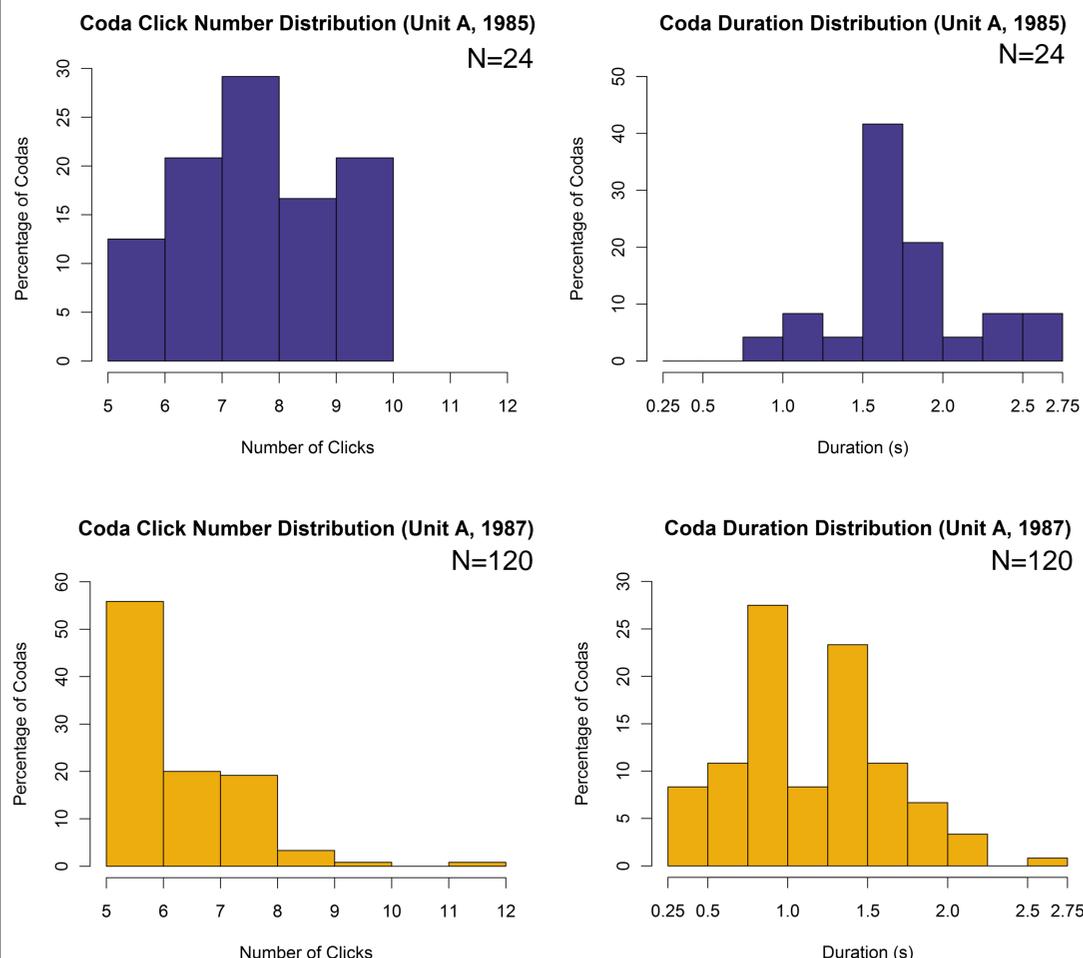
### Phase 3: Model

- Determine what evolutionary linguistics account(s) best explains the empirical trends.
- Agent-based models.

### Phase 4: Compare

- Compare coda evolution patterns and rates in units and clans from both the Pacific Ocean (Ecuador, Peru, and Chile) and the Atlantic Ocean (Dominica).

## Preliminary Results: Phase 1, Pacific Ocean



- 1985 Mean: 8.08 clicks (SD=1.41)
- 1987 Mean: 6.34 clicks (SD=1.42)
- 1985 Mean: 1.74 seconds (SD=0.42)
- 1987 Mean: 1.31 seconds (SD=0.46)

## Significance

- Language can strongly affect both biological and cultural fitness.
- Understanding how sperm whale cultural dialects evolve on multiple social scales will allow us to investigate how population structure changes, which will facilitate improved conservation and management for this deep sea keystone species.
- This work also probes deeper into several fundamental scientific questions, including how vocal learning is influenced by cultural rules and how dialects evolve in non-human systems.

## References

[1] Whitehead & Rendell (2014). [2] Weilgart & Whitehead (1997). [3] Cantor et al. (2015). [4] Whitehead (2010).