Interactive rhythms in harbour and grey seal pup vocalizations

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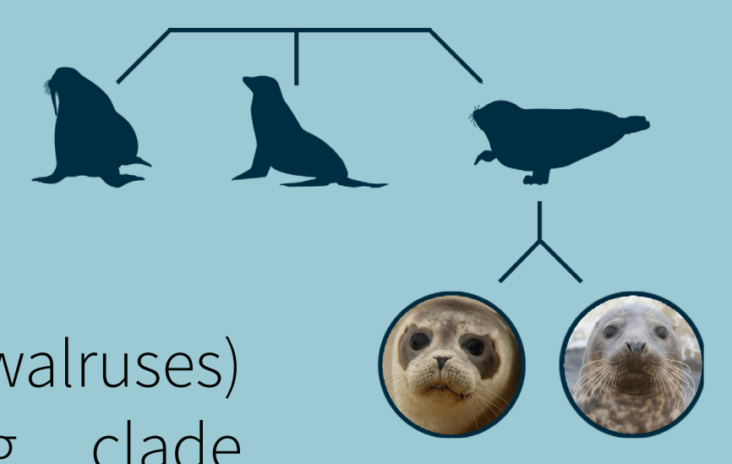
INTRODUCTION

Interactive rhythms?

- Much of human rhythmic behaviour involves temporal coordination between individuals: for example turn-taking (in language), synchrony, antiphony or canons (in music).[1]
- Rhythmic entrainment is also common across many animal species: for example fireflies synchronize their flashing[2] and tree frogs croak in alternating choruses[3].
- By studying the various types of spontaneous temporal coordination in signalling across species, we can learn more about how and why rhythmic cognition evolved[4,5].



Why seals?

- Pinnipeds (seals, sea lions & walruses) are a particularly promising clade for comparative investigations in the vocal domain[6], showing remarkable vocal flexibility[7,8] as well as rhythmic capacities[9,10], while being phylogenetically closer related to humans than birds.

Seal pup socio-ecology motivates a turn-taking strategy for temporally coordinating vocalizations: vocalizing antisynchronously allows pups to ***maintain individual conspicuousness*** in large mother-pup colonies where pups call for their mothers' attention[11].

This poster shows the methodologies and results of two different studies investigating rhythmic cognition in different species of seal pups. All pups were born in the wild and temporarily brought into rehabilitation at Sealcentre Pieterburen, where the experiment and recordings were performed.

GROUP RECORDINGS:

Grey seal pup groups vocalize in alternating turns, avoiding overlap

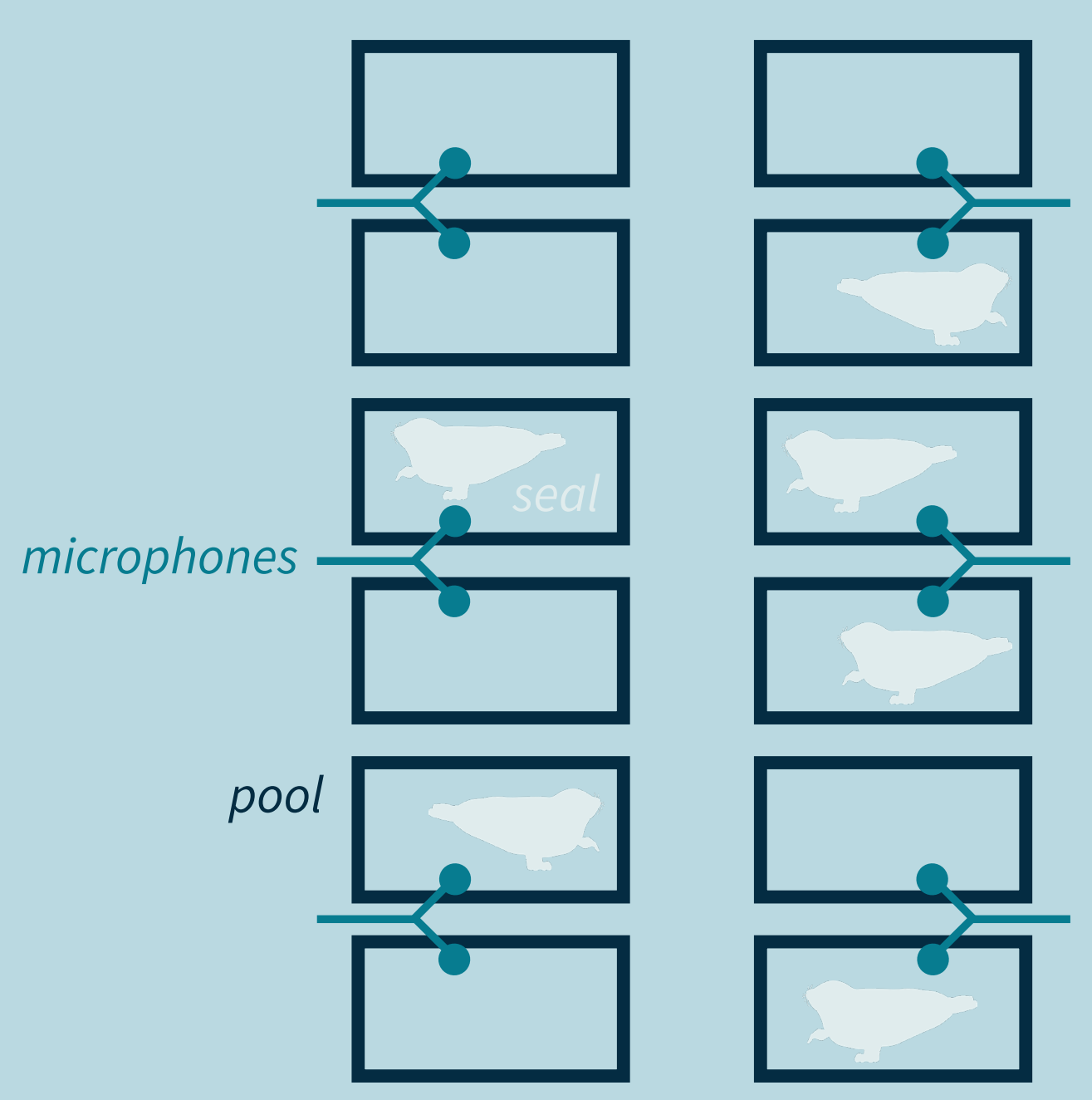
Multitrack recording set-up & data extraction

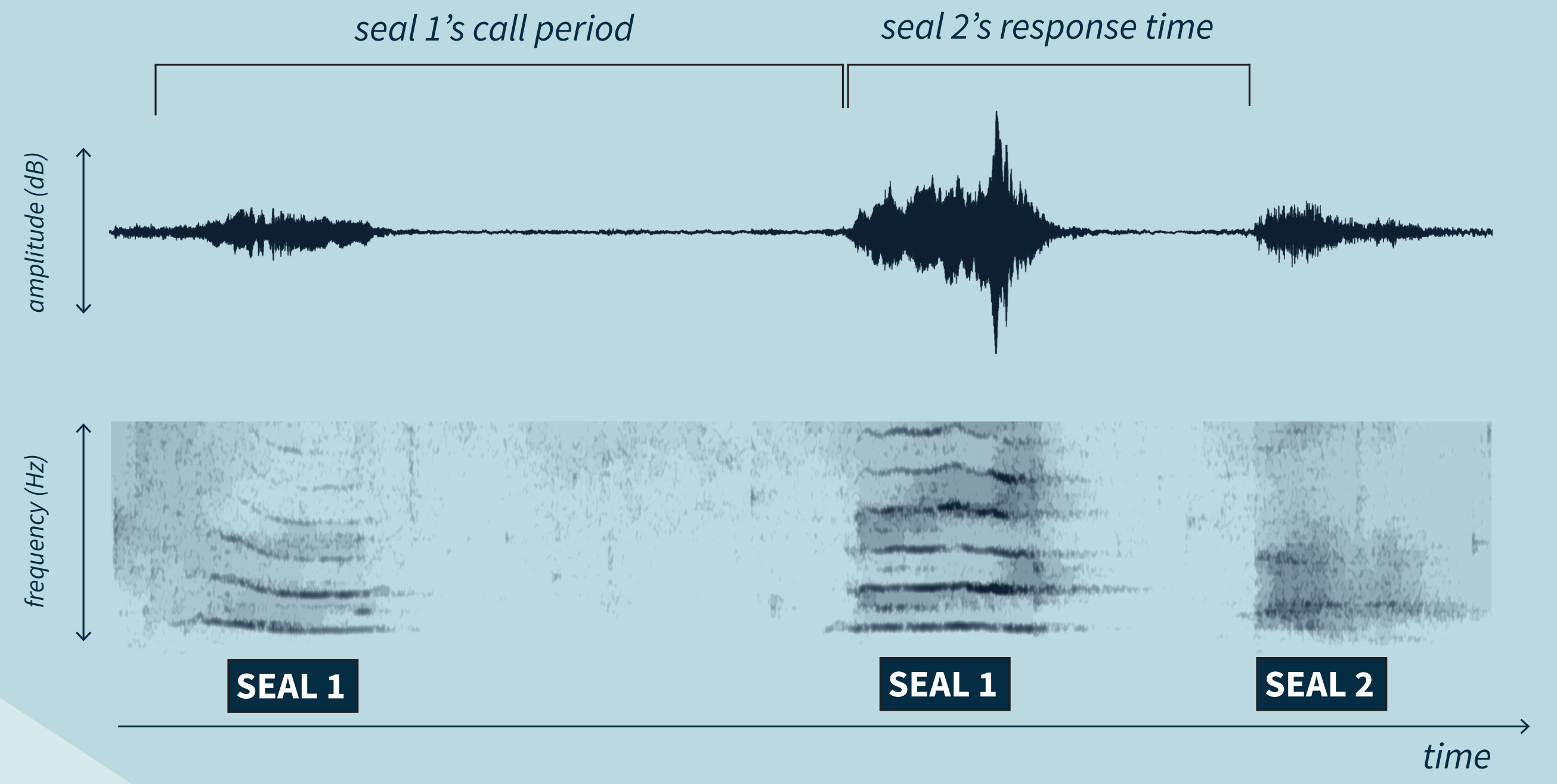
- Recordings were made in a cabin at the Sealcentre that housed up to twelve seal pups at a time in separate pools (as illustrated on the right), for approximately three hours a day over the course of two months.
- Microphones were installed above each pool. On each recording day, the microphones above pools that contained seals were turned on. The recordings would thus contain as many tracks as there were seals present on that day.
- Detecting vocalization onset/offset times and attributing them to individual seals was so far done by manual annotation, although we are working on algorithms to automate this process.

Relative response times in spontaneous interaction

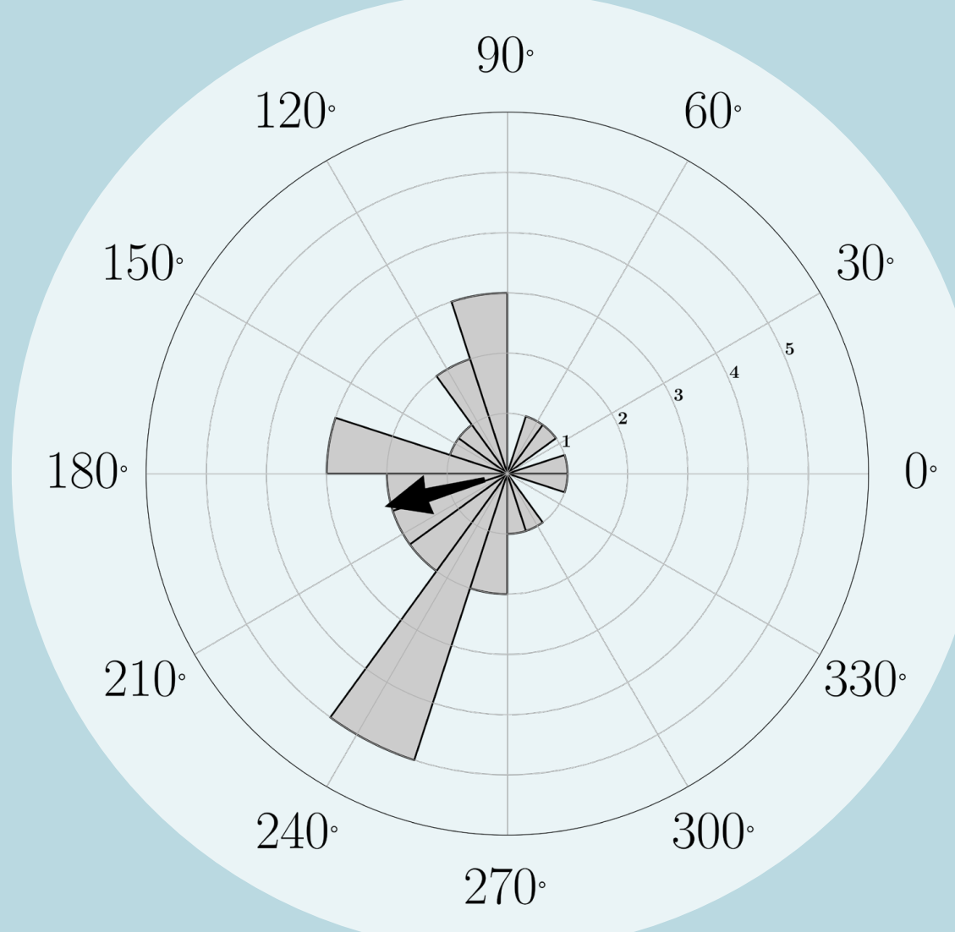
- All pups recorded were between one and five weeks old, and stayed in the cabin for varying numbers of days. In the 20 hours of recordings currently analyzed (out of 172), there were 1147 vocalizations, 427 of which occured in interaction with two or more seals.
- Response phases were calculated from interactions where one seal would vocalize twice in a row and another vocalized directly afterwards (with no more than five seconds between vocalizations).
- The response phase distribution has a significant non-uniform mean different from 0° (Rayleigh's tests, $P < 0.01$, $N = 29$), indicating that the seals were ***avoiding synchronization***.

Recording location





Response phase distribution

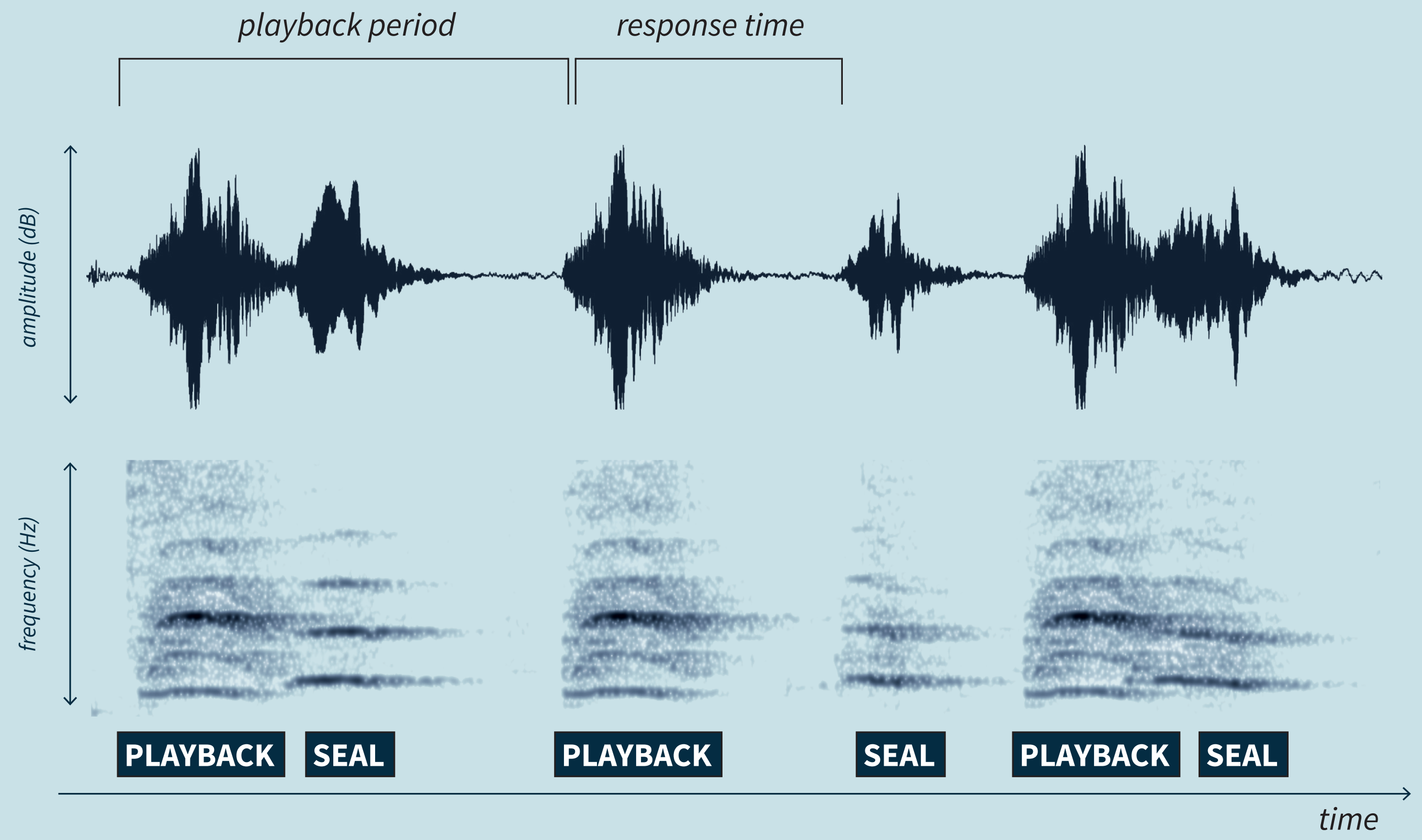


PLAYBACK EXPERIMENT:

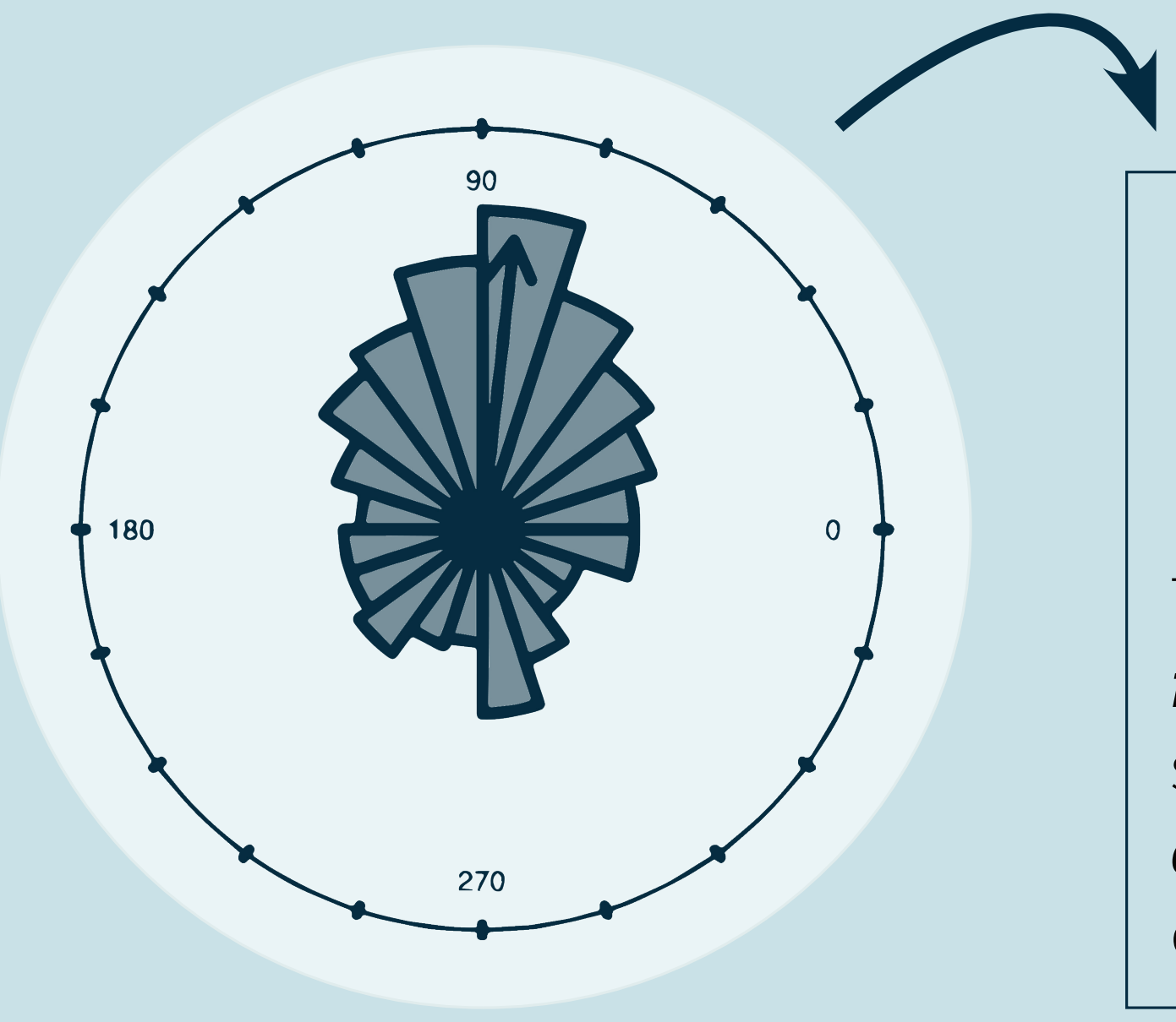
A harbour seal pup vocalized antisynchronously to a simulated conspecific

Relative response times to a simulated conspecific

- The experiment tested[11] how a single harbour seal pup would time her calls in response to several playback rhythms, constructed of earlier recorded calls of other seals.
- The rhythms varied in tempo, rhythmicity and caller identity. The pup was housed individually, and experiments were done between her 29th and 37th day of life.
- Computer simulations of a few alternative call timing strategies also showed that the response times corresponded most closely to an antisynchronous strategy.



Response phase distribution



Response phases were calculated by:

$$\left(\frac{\text{response time mod playback period}}{\text{playback period}}\right) \cdot 360^\circ$$

The ***non-uniform phase angle different from 0°*** (Rayleigh's tests, $P < 0.01$, $N = 303$) shows that the seal was timing her calls ***antisynchronously*** to the simulated conspecific.

DISCUSSION POINTS FOR LANGUAGE AND MUSIC

How can animal spontaneous rhythmic behaviour inform comparative music cognition research? Rhythmic behaviour abounds in the animal kingdom, but not every animal naturally synchronizes. This should be taken into consideration when testing animals' (spontaneous) ability to synchronize to an external beat (e.g. in human music).

Is turn-taking cooperative or competitive? Many cooperative species, like humans and other primates, take turns when vocalizing. However, seal pups show us that turn-taking behaviour can also arise from competitive pressures.

How do individual timing mechanisms map to group patterns? We see a unimodal response phase distribution in the case of the playback experiment with the individual seal, but not in the group study. How does an individual seal entrain to the group rhythm? How do humans do this?

Both language and music make use of rhythmic interactivity. Is what we see in seals closer to linguistic or musical dialogue?

What do similarities and differences between seals and humans, and between different pinniped species teach us about the evolution of rhythm? Both of these comparisons involve ontogenetic, phylogenetic, functional and mechanistic aspects.

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