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# STUDY OF BEHAVIOURS AND EMITTED CODAS DURING SPERM WHALE SOCIAL INTERACTIONS

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## ABSTRACT

Sperm whales live in the matrilineal population structure based on complex social interactions. Groups of 10-20 adult females stay together and raise their offspring. During social activities, they emit specific patterned time sequences of clicks, called codas. These codas are also the social unit acoustic signature. However, no associations were already done between these emitted sounds and behaviours. To answer this question, we used a dataset including simultaneous video and acoustic recordings during sperm whale activities close to the sea surface. In 2017 and 2018, 114 days of observations for 25h33min was done. A total of 1,810 behaviours and of 1,324 codas were extracted. We analyzed their internal structures, based of number of clicks and also the variation of inter-click intervals. Results showed firstly that the 8-clicks codas were the most frequent sequences for this social unit, and secondly that codas seems to be call and contact signals for this haptic species.

## 1. INTRODUCTION

Adult sperm whales (SW) females and juveniles live in groups with about 10-20 individuals in matrilineal societies (Whitehead, 2003). For our study, visual and acoustic observations were collected from a social unit off Mauritius Island, by the two NGO MMCO and Longitude 181 and the film production company Label Bleu (Fig. 1). The 2017-2018 dataset consisted of 25h33 of audio-video recordings of 17 adult females, 1 adult male and 10 juveniles (Sarano et al., submitted). We focused on 3 types

of pairs, adult-adult (A-A), adult-juvenile (A-J) and juvenile-juvenile (J-J), and we investigated their inter-individual relationships based on complex interactions close to the sea surface (Fig. 2).

Sperm whales are vocally active. They emit transient broadband sounds, called clicks (Mohl et al., 2000). The inter-click interval (ICI) is used to describe 3 different types of clicks: regular clicks, buzzes and codas (see review in Jaquet et al., 2001). The codas are patterned sequences of a limited number of clicks with variant ICI. They are emitted mainly by adult females and juveniles during social activities (Cantor et al., 2015). Individuals from the same social unit share codas with the same time structure (Rendell and Whitehead, 2004).

## 2. METHOD

Firstly, from the videos, we created, using the Boris software (Friard and Gamba, 2016), the behavioural catalogue, including 6 main categories: Haptic, Approach, Moving away, Active swimming, Rest and Others. Secondly, during these behaviours, we extracted the emitted codas and we annotated their time structure following the Weilgart and Whitehead's notation (Weilgart and Whitehead, 1993). We divided the codas into 3 different parts: the sustain part made by the highest number of long ICI clicks, the attack part with the previous clicks and the release part with the last clicks. Then we were able to study potential associations between behaviours and emitted codas.

### 3. RESULTS

From interactions of 384 A-A pairs, 832 A-J pairs and 147 J-J pairs, a total of 1,810 behaviours and 1,324 codas were extracted from the dataset (Fig. 3). The majority of the emitted codas was based on 8 successive clicks (51%), and if we combined the 7-clicks codas, 8-clicks codas, and 9-clicks codas, the number increased to 1124 codas (85%). The diversity of the codas was important, with 113 different time structures. We noticed that 58% of the codas started with 2 clicks. However, the attack parts were very different and could be complex with different combinations of clicks. Moreover, only very few of them had no attack part (4%). Same for the sustain part: 40% of the codas had 6 clicks in their sustain part and if we considered sustain parts composed by 3 to 7 clicks, this number increased to 95%. The large majority of codas (91%) had no release part. These results suggest that the attack and sustain parts could have a higher role in the social communication of sperm whales and no or less information is coded at the end of codas.

The time structures are more diverse for the J-J pairs than for the other types of pairs. J-J pairs are more diverse with male-female pairs, male-male pairs, and female-female pairs, and also with combinations of different age groups between calves of the year and older juveniles. They also were doing more different activities than A-A pairs, including playing, nursing, peduncle dives. They probably were still on an ongoing process of vocal learning.

Haptic interactions were the main behaviours done by the individuals from this social unit, whether for A-A pairs, A-J pairs or J-J pairs (Fig. 4). This result is consistent with previous studies showing sperm whales as a very haptic cetacean species (for example, Whitehead, 2003). We investigated sequences of behaviours in order to better understand the potential roles of the emitted codas. From state diagrams, we described the contact interactions by the following steps : firstly, 2 individuals approached each other; secondly, one or several different types of contact were performed. And finally, in a third step, they swam together or moved away from each other. Interestingly, A-A pairs performed successive Haptic behaviours, including more often Back-belly, Side-side and Side-back contacts. Codas were mainly emitted during haptic behaviours and also during the approach, suggesting that these vocal productions could have a significant role during social interactions, as call and contact sounds.

### 4. CONCLUSION

For this study, we analyzed behaviours and codas emitted by sperm whales during social interactions. Results showed that codas have mainly the same number of clicks, but with different time structures. We introduced a decomposition of each coda in different parts and noticed that the end of codas was less important in communication, compared to the first and sustain clicks. One of the other

results was to fully describe contact interactions, confirming the importance of these contacts for this haptic species.



Figure 1. Mauritius Island, Indian Ocean



Figure 2. Sperm whale social interaction (Photo credit F. Sarano)

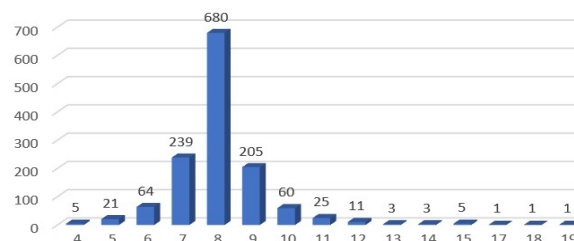


Figure 3. Number of clicks per coda

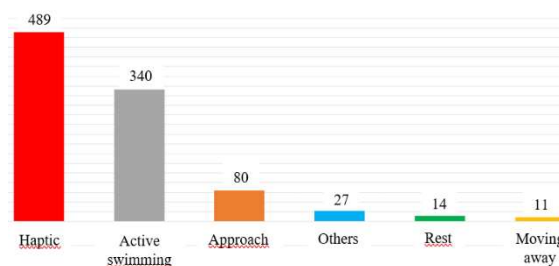


Figure 4. Number of codas per behaviour category

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