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Whistles and bray-call variability in a Mediterranean bottlenose dolphin population: the effect of the context variables

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AIMS

The aim of this work is to address the **acoustic variability** of two **common bottlenose dolphin's** (*Tursiops truncatus*, BD) sound types: **whistles** (frequency-modulated, narrowband sounds; Figure 1) and **bray-calls** (sequences of multi-unit rhythmic signals; Figure 2), in relation to different **context factors,** in a BD population in the central Tyrrhenian Sea (Rome, Italy).

MATERIAL & METHODS

1299 whistles and **2273 bray-call elements** (Gulp) were extracted from **1453 recordings** collected between 2019 and 2021 during **103 BD sightings** (Figure 3). Three potential **influencing factors** were considered:

(1) Environmental: seabed type, depth;
(2) Social: group size, calves' presence/absence;
(3) Behavioral: observed activity.

Two MANOVAs and linear models (LM) were performed in R 4.0.3 considering whistles (LM1) and bray-call elements (LM2) acoustic parameters and using context factors as independent variables.

Figure 1. Spectrogram of a **Whistle**

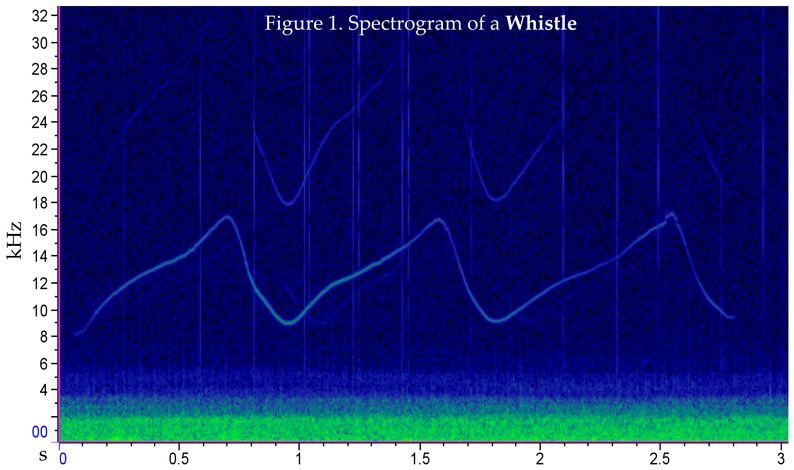
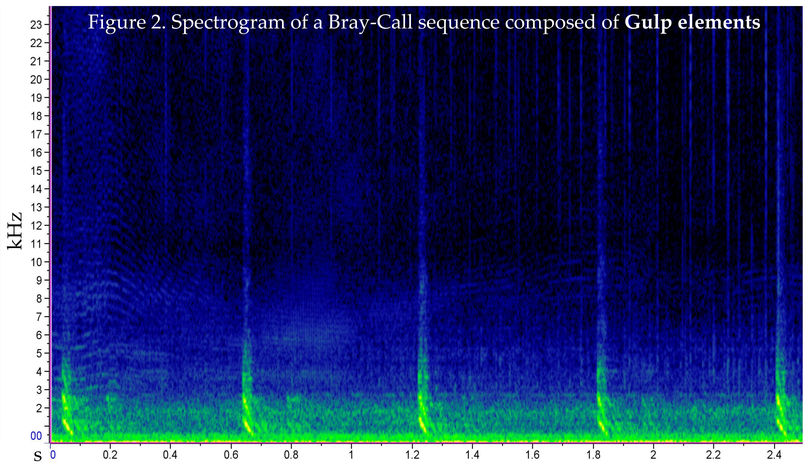


Figure 2. Spectrogram of a Bray-Call sequence composed of **Gulp elements**



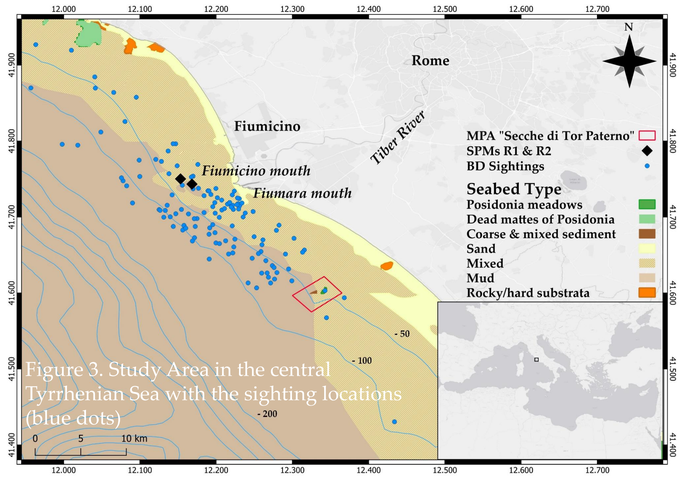


Figure 3. Study Area in the central Tyrrhenian Sea with the sighting locations (blue dots)

MANOVA	Environmental		Social		Behavioral
	Seabed Type	Depth	Group Size	Calves' Presence	Behavior
Whistles	0.05 < 0.05	0.01 < 0.05	0.05 < 0.05	0.03 < 0.05	**0.17** < 0.05
Gulps	0.01 < 0.05	0.01 < 0.05	0.07 < 0.05	0.03 < 0.05	**0.08** < 0.05

Table 1. Output of the MANOVA models. Pillai's trace (upper) and p-value (lower) are reported.

LM		Environmental Variables				Social Variables				Behavioral Variables		
		Seabed		Depth		Group size			Calves	Behavior		
		Mixed	Mud	>50m	<50m				Yes No			
Whistles	Minimum Frequency (LF)	-	-	↑	↓	-	-	-	- -	↑	↓	↓↑
	Maximum Frequency (HF)	-	-	-	-	-	-	↓	- -	-	-	-
	Start Frequency (SF)	↑	↓	↑	↓	-	-	-	↓ ↑	↑	↓	↓↑
	End Frequency (EF)	-	-	↑	↓	-	-	-	↑ ↓	-	-	-
	Duration (DT)	↑	↓	-	-	-	↓	-	- -	-	↓	-
	Inflection Points (IP)	-	-	-	-	↑	↓↑	↓	- -	↓↑	↓	↑
Gulps	Minimum Frequency (LF)	↓	↑	NA	NA	↑	↓	↓↑	↑ ↓	-	-	↑
	Maximum Frequency (HF)	↓	↑	NA	NA	↑	↓↑	↓	- -	-	-	↑
	Duration (DT)	-	-	NA	NA	-	-	-	↑ ↓	↓	↓↑	↑

Figure 4. Output overview of the two LM models. Green, yellow, and red arrows are associated with factors for which the model estimates a positive, weak, or negative effect on the response variable, respectively. The dash indicates a non-significant variation of the acoustic variable among different context categories.

RESULTS

- **All context factors** have **a significant effect** on the **acoustic structure** of both vocalizations (Table 1);
- **Behavior** appears to have the **largest influence** on the **overall structure** of both whistles and bray-call elements;
- **Each context variable influences differently the acoustic parameters of each vocalization type** (Figure 4), with the only exception of maximum frequency that seems to be negatively affected by higher group sizes in both vocalizations (LM1, est=-0.04, p<0.05; LM2, est=-0.08, p<0.05).

CONCLUSIONS

The study shows that **several factors** likely **influence the expression of sounds** in different ways. Although both vocalizations appear not context-specific, being expressed in all analyzed situations, their **acoustic structure** seems to **change** in relation to the **specific combination of influencing factors**.