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The role of synchronized swimming as affiliative and anti-predatory behavior in long-finned pilot whales

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ABSTRACT

Synchronized swimming in cetaceans has been hypothesized to play a role in affiliative processes as well as anti-predatory responses. We compared observed variation in synchronized swimming at two research sites in relation to disturbance exposure to test these two hypotheses. This study describes and quantifies pair synchronization in long-finned pilot whales at the Strait of Gibraltar, Spain and Cape Breton, Canada. Synchronization differed depending on the behavioral state and the response is different in the two sites leading to the conclusion that environment can shape the occurrence and magnitude of certain behaviors. We also analyzed intra-population variations in synchronization among 4 social units of Pilot whales in the Strait of Gibraltar and the results of this study confirmed the affiliative role of synchronization and highlighted an influence of disturbance on synchronization. We can conclude that synchronization is a common behavior in long-finned pilot whales that allow for close proximity and rapid coordinated response of individuals, with the multiple functions of showing affiliation and reacting to disturbance.

1. Introduction

Synchronization, as the behavior of several individuals related in time and space, is essential in order to maintain group cohesion in group-living species (Engel and Lamprecht, 1997; Ruckstuhl, 1999). Individuals may appear synchronized because they reacted to the same external stimuli in close proximity (Engel and Lamprecht, 1997). Alternatively, individuals may be synchronized because they modified their behavior to respond to the activity of others. This motor synchronization, defined as "kinesthetic imitation" (Kuczaj and Yeater, 2006), arises when the individual who imitate matches the movements and postures of a demonstrator. It can also emerge from "instinctive imitation" (Morgan, 1990) and "mimicry" (Tomasello, 1999). Such motor synchronization has several fitness advantages. Cooperative feeding and improved foraging, hydro and aerodynamics advantages (Cutts and Speakman, 1994; Weihs, 2004), predation reduction and social facilitation are the commonly highlighted processes responsible for synchronization (Kramer and Graham, 1976; Norris and Schilt, 1987; Gerkema and Verhulst, 1990; Webster and Hurnik, 1994; Whitehead, 1996; Engel and Lamprecht, 1997; Hastie et al., 2003; Fellner et al., 2006; Kuczaj and Yeater, 2006; Tosi and Ferreira, 2008; Patel et al., 2009).

The aim of this study is to assess the role of synchronization in long-finned pilot whales, exploring its role in affiliative and anti-predatory behavior.

Socially facilitated behaviors influence synchronization more than environmental factors (Clayton, 1978; Scott, 1967; Birke, 1974; Webster and Hurnik, 1994). Within a social context, synchronization also promotes cohesion (Birke, 1974; Clayton, 1978) and indicates affiliation (Whitehead, 2008). Cetaceans have the ability to differentiate relationships (on short term and long term basis) and establish higher order alliances as well as cooperative networks. In this context, synchronization appears to facilitate affiliative behavior and to reinforce or advertise social bonds (Connor et al., 2006; Sakai et al., 2009).

Synchronization has also been previously suggested as a response to disturbance (Hamilton, 1971; Collett et al., 1998; Hastie et al., 2003; Hoare et al., 2004; Sumpter, 2006; Carere et al., 2009). In a three dimensional environment, predation risk can be reduced by schooling behavior through an increase in vigilance, "many eyes" effect and a reduction in individual predation risk (Kramer and Graham, 1976; Norris and Schilt, 1987; Gerkema and Verhulst, 1990; Bednekoff and Lima, 1998; Fellner et al., 2006). The rapid exchange of information in a cheating-proof environment (Norris and Schilt, 1987) allows faster reaction, increases surveillance and mediates the confusion of predators. Sensory integrated system (SIS) has been detected in several taxa including fish, birds and cetaceans and permits the school to function as a

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hypersensitive organism (Fellner et al., 2006) enhancing individual vigilance. SIS requires a close spatial distribution and a high degree of synchronization, reducing inter-individual distance and a faster information transfer. Synchronous air breathing of social fishes (Kramer and Graham, 1976), synchronous feeding of common voles (Gerkema and Verhulst, 1990), synchronous behavioral state in bighorn (*Ovis canadensis*) males and ibex groups (Ruckstuhl, 1999; Ruckstuhl and Neuhaus, 2001) and synchronous foraging macaques (*Macaca fuscata yakui*) (Agetsuma, 1995) are all examples of anti-predatory synchronization.

Synchronization has been reported as an anti-predator response in cetaceans to both predators and human (boat) presence (Heimlich-Boran, 1988; Norris and Dohl, 1980; Hastie et al., 2003; Senigaglia and Whitehead, 2011). Norris and Dohl (1980) report how spinner dolphins tend to swim in tighter and more synchronized groups under predation risk. In a similar manner synchronized resting behavior in killer whales and synchronized diving in sperm whales have been linked to enhanced vigilance against predators (Heimlich-Boran, 1988; Whitehead, 1996). Synchronization for social facilitation has also been suggested for cetacean (Mann and Smuts, 1999; Connor et al., 2006; Senigaglia and Whitehead, 2011). Several studies report the importance of mother calf synchronization during the first months of the calf life (Mann and Smuts, 1999). Moreover synchronization occurs during social interactions and among male alliances in bottlenose dolphin in Shark Bay and it has been linked to affiliation behavior (Connor et al., 2006). We aim in this study to test whether synchronization can indeed be used for both affiliation and anti-predation by comparing synchronized swimming behavior in two genetically different populations of long-finned pilot whales (Verborgh et al., 2010) exposed to different socioecological conditions. The two study sites, Cape Breton (Canada) and the Strait of Gibraltar (Spain) have low and high residency pattern of Pilot whales population encountered, respectively and present low and high degree of vessel traffic and anthropogenic disturbance respectively. Hence if synchronization serves as proxy for affiliation then we expect it to vary when chances for social bonding are higher as in case of a resident population. Moreover, if synchronization is used as anti predatory strategy then its occurrence will be higher in a more stressful environment where animals are exposed to higher levels of disturbance.

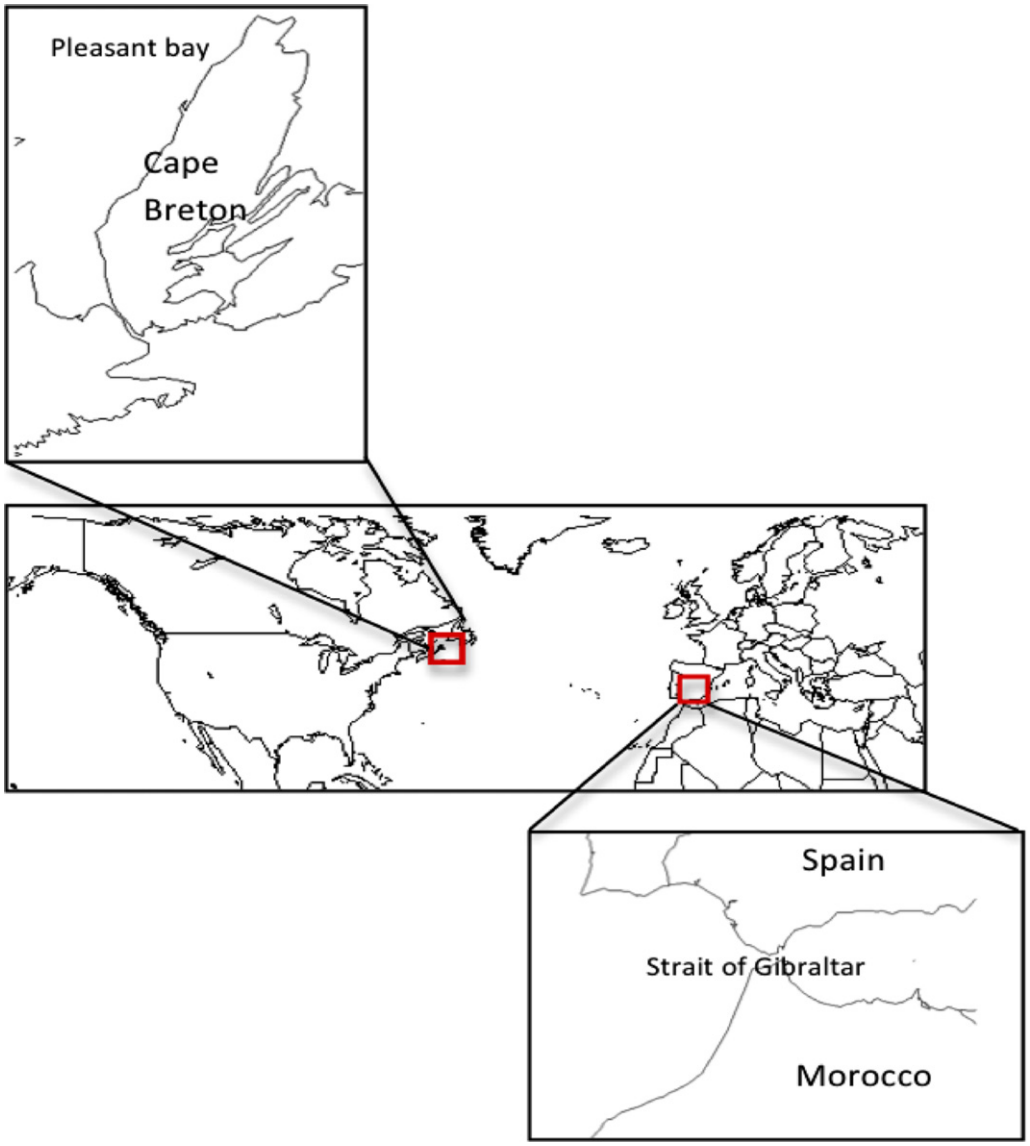

Fig. 1. Map showing the two field sites position in respect of the Northern Hemisphere. Cape Breton, Nova Scotia, Canada on the top left and the Strait of Gibraltar between Spain and Morocco on the bottom right.