Olfactory discrimination ability of South African fur seals (*Arctocephalus pusillus*) for enantiomers

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Introduction

Marine mammals are traditionally considered to have a poorly developed sense of smell. However, increasing evidence suggests that pinnipeds (seals) may use their sense of smell in a variety of behavioral contexts including social communication, foraging, food selection, and reproduction.

In the present study we continued to explore the sense of smell in South African fur seals and assessed their ability to discriminate between the 12 odor pairs of enantiomers*.

*Why enantiomers?
Enantiomers are mirror-imaged molecules, that is, the (+)-form and the (-)-form of a given enantiomer are identical in most of their physical properties such as size, shape, and electrical charge distribution but only differ from each other in chirality. Thus, enantiomers are particularly useful for assessing olfactory discrimination abilities.

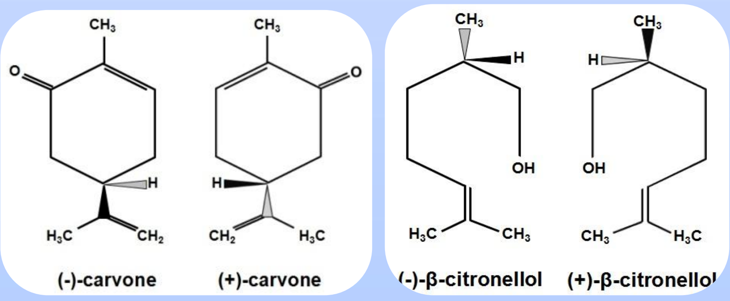

Figure 1. Examples of molecular structures of enantiomers

➢ Aims of the present study

- to assess the olfactory discrimination ability of South African fur seals for 12 pairs of enantiomers
- to compare their performance to those of other species tested previously on the same set of odor pairs.

Materials & Methods

➢ Animals

Four female South African fur seals (*Arctocephalus pusillus*) were tested at Kolmården Wild Animal park, Sweden.

➢ Odorants

A set of 12 enantiomeric odor pairs was used.

➢ Behavioral test

The test was based on an operant conditioning. The animals were trained to sniff both odor sampling ports and to chose one of those which presents the rewarded stimuli. The animals recieved 5-8 training sessions (one form of enantiomer vs. pepper oil), and then 4 critical sessions (the (+)-form of enantiomer vs. the (-)-form of enantiomer).

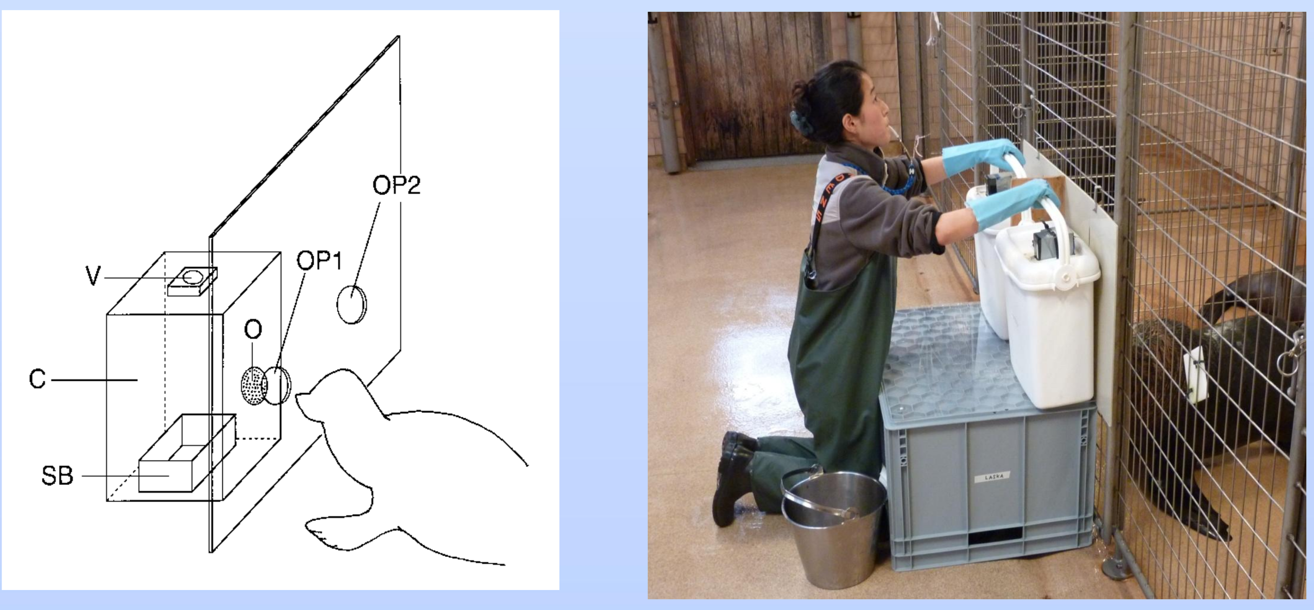

Figure 2. Left: C (container), SB (stimulus box), V (ventilator), O (outlet for airflow), OP1 and OP2 (odor sampling ports 1 and 2). Right: A photo of the experimental set-up. The behavior was observed through a mirror attached on the top of the cage (not shown in this photo) in order to avoid any inadvertent interaction between the experimenter and the animal.

➢Data analysis

- The percentage of correct choices out of 40 trials (the best two consecutive critical sessions) for each animal was measured by two-tailed binomial test.
- As for the performance at the group level, at least 3 animals had to reach the criterion (72.5%, p<0.01; 67.5%, p<0.05).
- Comparisons of performance across individuals were made using the Mann-Whitney U-test for independent samples.

A lot of thanks to my supervisor Matthias Laska, the trainers in Dolphinarium at Kolmården Wild Animal park, and professor Mats Amundin. Furthermore, in memory of Flisa, one of the four animals tested in the present study.

Conclusions

➢South African fur seals display a well-developed olfactory discrimination ability with enantiomeric odor pairs.

➢ Comparisons with other species show that the fur seals at least performed better than human subjects and squirrel monkeys.

➢The sense of smell may play an important role in regulating the behavior of fur seals and has been hitherto underestimated.

Results

➢ Discrimination performance

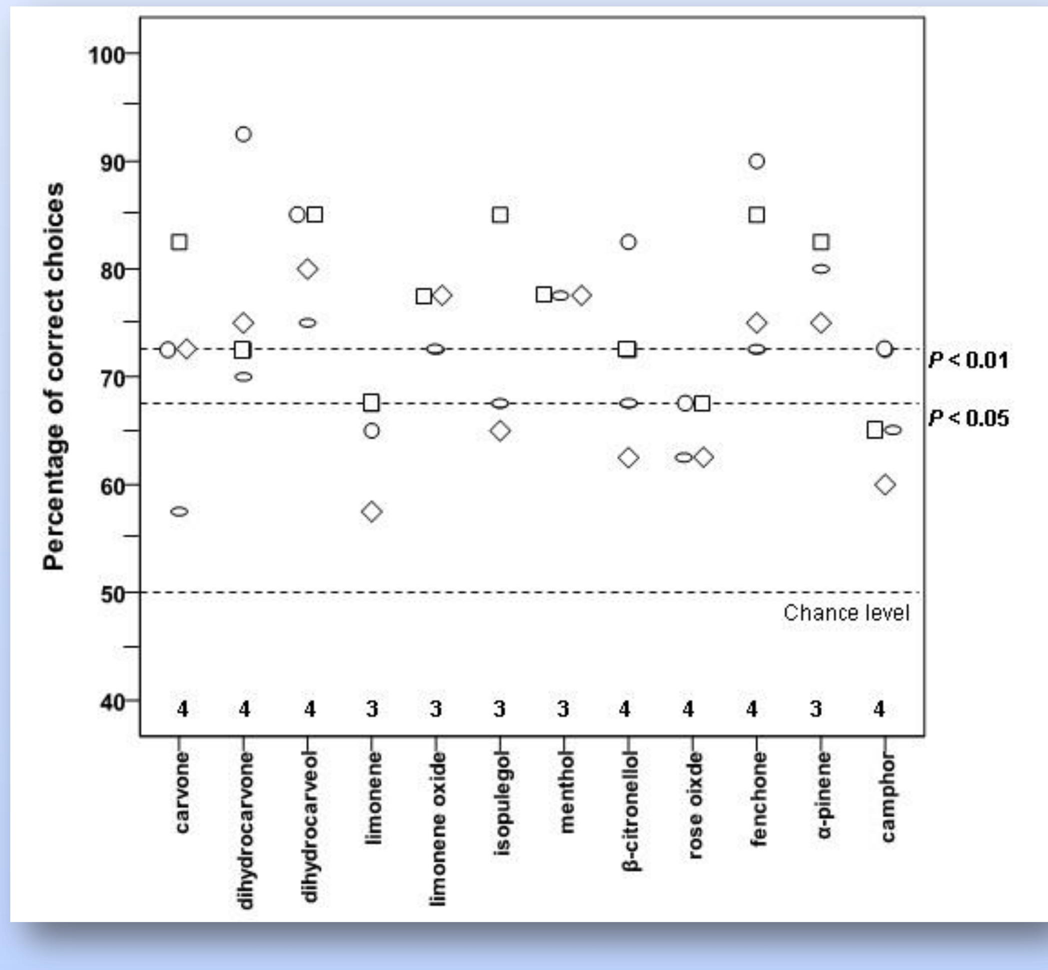

Figure 3. Discrimination performance of four South African fur seals with 12 enantiomeric odor pairs. Each shape of figure represents each animal. Numbers above abscissa indicate the number of animals tested on each task.

- The fur seals succeeded in discriminating between 7 out of 12 odor pairs (corresponding to p<0.01), and 8 out of 12 odor pairs (corresponding to p<0.05).
- No significant differences in performance between the animals were found across all tasks (average difference between the best and the poorest performer was only 12.9%).

Discussions

➢ Comparisons with other species

	Fur seals	CD-1 mice	Human subjects	Squirrel monkeys	Pigtail macaques	Honey bees	SD/LE rats	Asian elephants
carvone	+	+	+	+	+	+	+	+
dihydrocarvone	+	+	+	+	+			+
dihydrocarveol	+	+	+	+	+			+
limonene	-	+	+	+	+	+	+	+
limonene oxide	+	+	-	-	-			+
isopulegol	-	+	-	-	+			+
menthol	+	+	-	-		+		+
beta-citronellol	+	+	-	-		+		+
rose oxide	-	+	-	-		-		+
fenchone	+	+	-	+		-	+	+
alpha-pinene	+		+	+		+		+
camphor	-	+	-	-		-		+
Success rate	8/12	11/11	5/12	6/12	5/6	5/8	3/3	12/12

- In general, the fur seals' performance is not poorer than that of the other species; rather, better than that of human subjects and squirrel monkeys.
- All species tested so far succeeded in discriminating between enantiomers of carvone, dihydrocarvone, dihydrocarveol, alpha-pinene.
- Only fur seals failed with enantiomers of limonene.