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INTRODUCTION

Environmental enrichment indicates any modification in an animal's environment aiming at improving its welfare by increasing behavioural choices and encouraging species-specific behaviours¹.

AIMS

The purpose of this study was to evaluate the effects of three environmental enrichments on the behaviour of wolves in captivity.



MATERIALS AND METHODS

Subjects and study area

The study was conducted on a group of 4 adult wolves (mean age ± SE: 13.5 ± 1.09), 1 male (M) and 3 females (F1, α female, F2, F3), hosted at Pistoia Zoo in a naturalistic exhibit of 1.350 m².

Design and procedure

Behavioural data were recorded over a 3-month period using a within-subjects randomised experimental design² consisting of five conditions: baseline (BL); feeding enrichment (E1, scattered chicks); olfactory enrichment (E2, cinnamon essence); feeding/manipulative enrichment (E3, meat ice-blocks); no enrichment provided (NE). Six days of observation per condition were conducted.

Seven 30-min observation sessions per day were collected using: a) instantaneous scan sampling³ of the whole pack with 1-min interval; b) 1-min focal animal sampling³ per individual. A total of 105 hrs of data were collected.

Data were analyzed using the *Shannon diversity index*³, χ^2 test and the *paired data t-test* with significant level set at $p < 0.05$.



RESULTS AND DISCUSSION

Activity budget was analyzed using data collected via scan sampling. Behaviours were grouped into 3 categories: inactivity, moderate activity, strenuous activity⁴. Providing enrichments resulted in overall activity increase. For each wolf statistically significant variations of active behaviours (moderate + strenuous activity) were found between baseline and treatment conditions. χ^2 test results are shown in Table I.

ACTIVE BEHAVIOUR

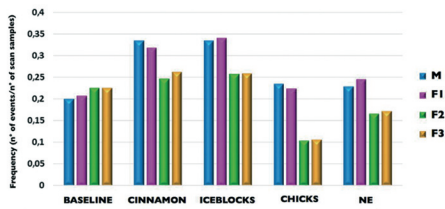
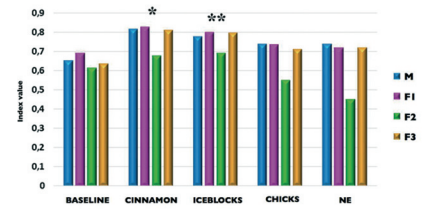


Table I

	M	F1	F2	F3
BL-E1	1.66	1.12	30.99	23.27
BL-E2	20.93	19.44	3.90	1.68
BL-E3	25.68	25.79	1.21	0.92
BL-NE	1.85	6.11	10.00	2.57

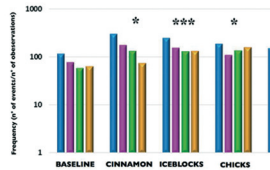
Data collected via focal animal sampling were used to calculate the *Shannon diversity index* for each wolf under the five conditions. The behavioural repertoire significantly increased in E2 ($t = -5,422$, $df = 3$, $p = 0,012$) and E3 ($t = -6,741$, $df = 3$, $p = 0,007$). Index values also rose in E1 and NE, except for the wolf F2, the oldest female.

SHANNON DIVERSITY INDEX

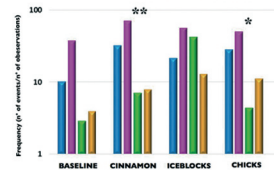


Enrichments also increased the following behaviours:
 - exploratory behaviour;
 - territorial behaviour;
 - lick self mouth + lick self nose (considered as affiliative behaviours^{5,6})

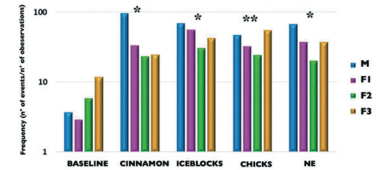
EXPLORATORY BEHAVIOUR



TERRITORIAL BEHAVIOUR



LICK SELF MOUTH + LICK SELF NOSE



Results show that simple and low-cost enrichments, operated on a random schedule, elicit positive effects on captive wolves increasing activity level and behavioural repertoire. Inter-individual variations were found^{7,8}, confirming the importance of considering individual preferences and personalities while planning an environmental enrichment programme. Findings also highlight the role played by enrichment in stimulating elderly animals. Further studies, evaluating daily and night activity and stress-hormones levels, will be carried out to monitor welfare status using different parameters.

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