



ManyOtters1 – A Pilot Study on Long-Term Memory in Otters Using Puzzle Feeders

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Introduction

- ManyX groups take the big team science approach to investigating animal cognition, for example ManyPrimates, ManyDogs, ManyFishes, and ManyBirds (e.g., Lambert et al., 2022; ManyDogs et al., 2022; ManyPrimates et al., 2019).
- The ManyOtters group seeks to promote studies with larger sample sizes and a variety of species of otters, while developing a collaborative network of scientists. We are seeking new members!
- Our pilot study focused on *long-term memory* in otters.
- The novel object recognition task, used to test memory in many species, was not an effective or engaging memory test for a river otter (Wegman & DeLong, 2023).
- Novel extractive foraging tasks (puzzle feeders) are engaging for a variety of otter species (e.g., Ladds et al., 2017; Saliveros et al., 2020) and can be used to test long-term memory.

Research Goal

Our goal was to pilot foraging puzzles modeled after Ladds et al. (2017), Saliveros et al. (2020), and foraging puzzles used in a canine cognition study (Yeater et al., 2024) to establish the protocol for the first ManyOtters project.

Subjects

- Housed at SeaWorld Texas (SWT, San Antonio, TX)
 - Asian small-clawed otters (*Aonyx cinereus*), $N = 7$, socially housed
 - Wonton (male, 15), Saki (female, 15)
 - Lucas (male, adult), Dustin (male, adult), Eleanor (female, adult)
 - James (male, 6), Juliet (female, 13)
 - African spotted-necked otters (*Hydrietz maculicollis*), $N = 2$
 - Jojo (male, 18) and Kapuki (female, 11)
- Housed at Seneca Park Zoo (SPZ, Rochester, NY)
 - North American River Otter (*Lontra canadensis*), $N = 1$, solo housed
 - Sailor (male, 17)



Figure 1. A – Jojo and Kapuki at SWT. B – Sailor at SPZ. Figure 2. Eleanor, Dustin, Lucas at SWT.

Procedure

- One puzzle per session, 10-20 min with puzzle
- Two presentations per puzzle, 2 months apart (First exposure, Re-exposure)
- Puzzles varied in "difficulty" (number of steps needed to extract food)
- Number of available puzzles = Number of otters in social grouping

Foraging Puzzles



Figure 3. The foraging puzzles used for all the otters. Puzzles outlined in blue were used at the SPZ and the other puzzles were used at SWT. The puzzles in the top row were modeled after Saliveros et al. (2020), the puzzles in the middle row were modeled after Ladds et al. (2017), and the puzzles on the bottom are commercially available dog feeding enrichment devices used in a canine cognition study (Yeater et al., in progress). Puzzles were baited with fish, squid, oysters, ground beef, or lobster. Puzzles to be used in the larger study include all puzzles, except Saliveros 4, Ladds 1, & Dog casino.

Results

Table 1
Number of Otters That Solved Each Foraging Puzzle

Subject	Species	Sex	Foraging Puzzle											
			Ladds1	Ladds2	Ladds3	Ladds4	Sal1	Sal2	Sal3	Sal4	Dog1	Dog2	Dog3	Dog4
James	Asian	M	0.0	1.1	1.1	1.1	1.1	1.1	1.1	1.1	NP	NP	NP	NP
Juliet	Asian	F	0.0	0.0	0.0	0.0	1.1	1.1	0.0	0.0	NP	NP	NP	NP
Saki	Asian	F	0.0	0.0	0.0	1.0	1.1	1.1	1.0	1.1	NP	NP	NP	NP
Wonton	Asian	M	0.0	0.0	0.0	0.0	1.1	1.1	1.0	1.0	NP	NP	NP	NP
Eleanor	Asian	F	0.1	1.0	0.0	0.1	1.1	1.0	1.0	1.0	NP	NP	NP	NP
Dustin	Asian	M	0.0	0.0	0.1	1.1	1.1	1.1	0.1	0.1	NP	NP	NP	NP
Lucas	Asian	M	0.0	1.1	1.1	1.0	1.0	1.1	1.1	1.1	NP	NP	NP	NP
Jojo	ASpotted	M	0.0	1.1	0.1	1.1	1.1	0.1	1.1	1.1	NP	NP	NP	NP
Kapuki	ASpotted	F	0.0	0.0	0.0	0.1	1.1	0.1	1.1	NP	NP	NP	NP	NP
Sailor	NARO*	M	0.0	0.1	NP,0	0.0	1.1	1.0	NP,1	NP,NP	1,NP	1.1	1.1	1.1

of otters successful - 1st
of otters successful - 2nd

Note: First exposure, Re-exposure after 2 months. 1 = Solved, 0 = Not solved, NP indicates foraging puzzle was not presented to otter. Asian = Asian small-clawed otter. ASpotted = African spotted necked otter. NARO = North American river otter. *NARO 1st & 2nd presentation used two different platform attachment methods (not used for memory interval dataset). See Figure 3 to view each foraging puzzle.



Figure 4. James solving the Saliveros 4 puzzle by reaching his paw into the opening.

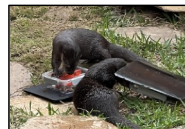


Figure 5. James and Juliet both solved the Saliveros 2 puzzle. One otter by reaching in with a paw and another by flipping the puzzle over ("other" strategy).



Figure 6. James attempting to solve the Ladds 1 puzzle by pushing the puzzle against the wall.

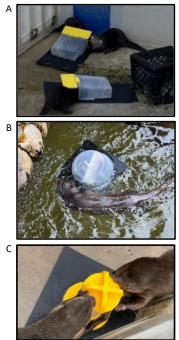
Results

Table 2
Average Solution Time and Solution Strategies Utilized

Foraging Puzzle	# Otters Solved P1&P2	Avg. Solution Time P1 (s)	Avg. Solution Time P2 (s)	Md Solution Strategies Utilized P1	Md Solution Strategies Utilized P2
Ladds1	0	NS	NS	NS	NS
Ladds2	3	245.7	137	6	4
Ladds3	2	76	60.5	5	3
Ladds4*	2	51	358	3.5	6.5
Saliveros1	8	2.1	2.4	2	2
Saliveros2	8	8.8	6	2.5	2
Saliveros3	5	18.8	9.8	2	2
Saliveros4*	7	45.9	56.6	3	4

Note: Only SeaWorld otters solving puzzles both times included. NS = not solved by any of the otters so no solution times. Periwinkle fill indicates faster/similar solution times and fewer or similar strategies at re-exposure. *Orientation of puzzle changed for Ladds4 and placement of food for Saliveros4 changed.

Figure 7. (A) Lucas, Dustin, and Eleanor with the Saliveros 3 puzzle. They are using the nose and paw strategies. (B) James solved the Saliveros 4 puzzle by bringing it into the water (an example of the "other" strategy). He solved the same puzzle using the paw strategy (he stole Juliet's puzzle). (C) Eleanor and Dustin showing two paw strategies to open Ladds 4.



Conclusions and Future Plans

- Puzzle success and solution time depended on puzzle complexity. A variety of strategies were deployed by the otters and individual differences were observed.
- Evidence for long-term memory: Decreased/similar solution times occurred for 5 of 5 puzzles (presented consistently) solved for both presentations by individual otters.
- We are seeking new members who wish to join ManyOtters to be a part of the larger study! Please contact us at manyottersproject@gmail.com. Find us on Instagram: [manyottersproject](https://www.instagram.com/manyottersproject/) or the web: <https://manyotters.github.io/>

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