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Behavioural flexibility in two common octopuses: context of a recurrent arm movement and a planned delay-choice test

The present project investigated two aspects of behavioural flexibility in the common octopus (*n*=2, juvenile *O. vulgaris*). Recurrent arm-raising was more frequent in some recorded social and lighting contexts than in others. Human presence and recent departure gave the clearest social pattern, with overlap between light changes, departures, and interrupted activity: Arm-raising was most frequent soon after a person left (16 of 22 events) and least frequent when nobody was present (17 of 52). A planned follow-up experiment builds on recorded menu-card choices to test whether the octopus waits for the prey it selected when an alternative is available sooner.

Observational study – Towards interspecies communication

Research question and study design

Could event-level coding distinguish among alternative explanations for a recurrent arm movement? The outcome was a binary record of the target arm movement, described as arm-raising, waving, or reaching. The analysis coded the movement and its context separately from any proposed function. In the showcase clip, Nity (*O. vulgaris*) waves an arm towards the light source after the aquarium light is switched off and stops when it comes back on (Figure 1).



Figure 1: Image representing the "lights-off" behaviour performed by Nity (O. vulgaris).

In this study, 293 events were recorded over 204 days, from 18 September 2025 to 10 April 2026. The primary quality check retained 241 events. The unit of analysis used in this case study was the recorded event. Antecedent conditions, movement occurrence, subsequent consequences, and prior behavioural history were considered.

Hypotheses and analysis

Hypothesis	Relationship examined
H1 Illumination	Occurrence following a classified light change.
H2 Social context	Occurrence with a person present, absent or recently departed.
H3 Interruption	Occurrence when an interaction or ongoing activity was interrupted.
H4 Behavioural history	Variation over time and associations with outcomes of earlier events.

The analysis used event proportions with 95% Wilson intervals, reported as descriptive summaries, since events occurring within the same day may not be fully independent. Event-level logistic regression with Newey–West heteroskedasticity- and autocorrelation-consistent standard errors, interactions between study time and H1 and H2 predictors, and cumulative-history and lagged-event analyses.

Main findings

Nity performed the target movement in 124 of 241 eligible events (51.5%). The two classifications below use the same events. Each percentage is conditional on its recorded context within the eligible dataset.

Context	Occurrence	95% Wilson CI
H1 Clear light change	75.0%	46.8–91.1%
H1 Uncertain light change	25.0%	10.2–49.5%
H1 Light-off transition unspecified	52.1%	45.4–58.7%
H2 Human absent	32.7%	21.5–46.2%
H2 Human present	54.5%	46.9–61.9%
H2 Recent human departure	72.7%	51.8–86.8%

Table 1. Target movement by light and human context

Light and social context

Arm-raising was most frequent after a recent human departure in the social classification. The final submission identified social context as the leading interpretation to follow up. The light classification showed a high proportion after a clear transition, based on 12 events, while transition details were unspecified for 213 events. Remote light switching provided examples of lighting changes without a person beside the tank. The amount of overlap across categories limits attribution to a particular antecedent.

Interruption and behavioural history

Interruption-related events also showed an association with occurrence. Departure, light switching and interruption of an interaction can belong to the same sequence. Longitudinal models suggested that some context associations varied over time, with no clear progressive increase in the movement or increasing specificity to social contexts. Lagged and cumulative-history analyses suggested that earlier interaction outcomes may help describe subsequent occurrences. These patterns are exploratory and may reflect changes in

routines or exposure over time. However, future studies performed on different individuals may help to infer about the whole species.

Planned experiment – Self-control

Hanni, a young octopus (*O. vulgaris*, weighing around 700g in November 2026, 6 months of age), chooses between two prey items presented on picture cards during routine feeding (Figure 2).



Figure 2: Representative picture showing the "menu-card" meal selection with Hanni (O. vulgaris).

In the proposed test, her menu choice identifies the selected prey for that session. The team will first check that the octopus takes the prey indicated on the card when both options are equally accessible, and that the countdown cues signal when the boxes will open (Figure 3).

The two prey items will then be offered in separate boxes. The alternative will become available first, while the menu-selected prey will be accessible after a longer delay. Black bars indicate the remaining countdown steps, and each door opens when its countdown reaches zero. As soon as the octopus takes one food, the box with the other food is removed, so choosing the food that is available earlier makes the other food become unavailable. In the showcase example, the shrimp becomes available before the langoustine that was selected via the menu cards (Figure 3).

A control condition will be added: A bold yellow "X" on a black background has been introduced as "no" on menu cards, and will be used only in the control condition, meaning the door stays closed indefinitely. This shows that waiting cost depends on expecting the preferred prey, and is inspired by the work performed by Schnell and colleagues in 2021, as a control condition (their work used visual signals with cuttlefish). Additionally, a delay schedule will be introduced with increasing waiting times.

The test asks whether Hanni takes the available alternative or waits for the prey she selected, and how long she will wait as the delay increases. The main observations will be which prey she takes and how long she waits. This food-choice task examines a trade-off between reward preference and waiting cos, contributing to shed

lights on sentience criteria in octopuses (Schnell et al., 2026). We proposed a self-control task, replacing noxious or threatening stimuli with a variable waiting time, measuring decision making under conflicting circumstances, while preserving octopus welfare. Additionally, the preceding selection of the prey via menu cards allows one to take into account the food preference on the experiment's day, as we have informally observed that octopuses prefer variety over time instead of always choosing a single preferred prey. The future steps are illustrated in Figure 3.

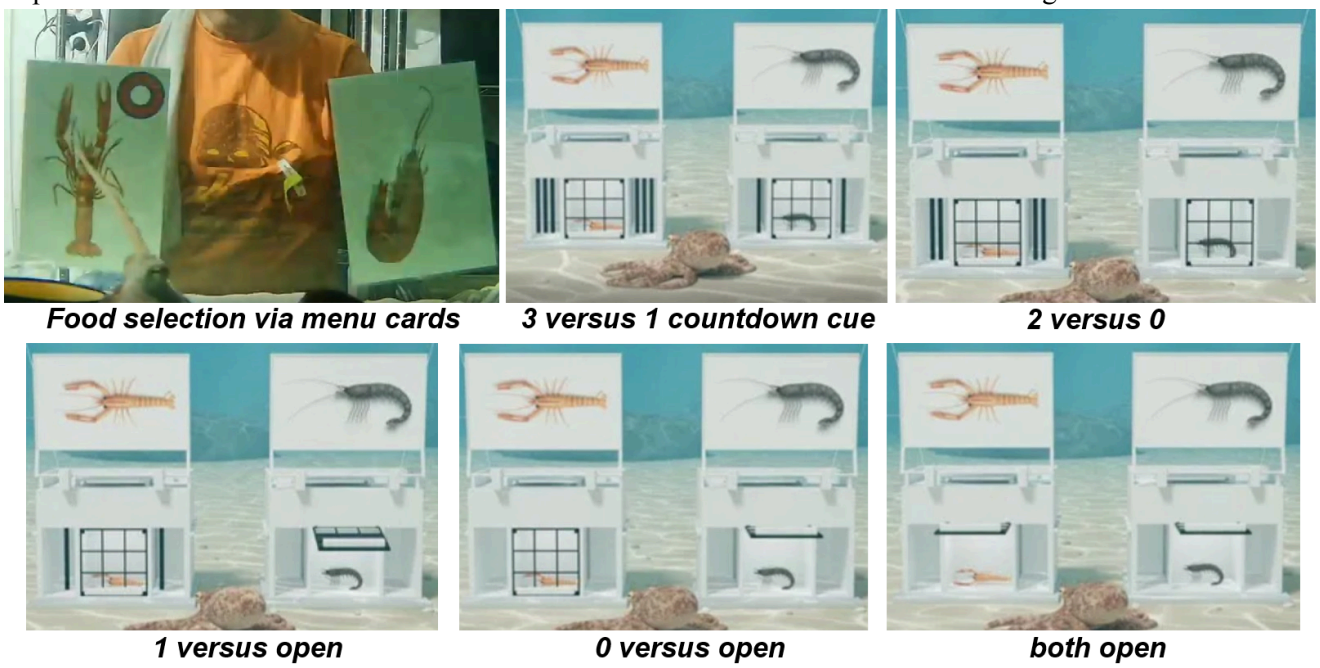


Figure 3. Proposed feeding boxes. The cues disappear in succession until the doors open. The panels illustrate the test condition in which the alternative that was not chosen by the octopus becomes available first. The box panels are renders of the proposed setup.

Conclusion

Event-level coding narrowed the candidate explanations for Nity's recurrent arm movement without settling them. The movement followed about half of all eligible events (124 of 241). It was most frequent soon after a person left (16 of 22 events, 72.7%) and least frequent when nobody was present (17 of 52, 32.7%). It was also frequent after a clear light change (9 of 12), although that estimate rests on few events. Departures, light changes and interrupted interactions often occurred in the same sequence, so the data cannot attribute the movement to a single antecedent. The longitudinal analyses showed no clear progressive increase in the movement and no growing specificity to social contexts. These results come from one animal and are exploratory, but they show what a confirmatory study needs: a predefined departure window, independent manipulation of light and human presence, and replication across individuals.

The planned experiment asks a different question with a design that keeps welfare costs low. Menu cards let Hanni's own choice define the preferred prey for each session, and the countdown boxes set that choice against a waiting cost. Whether she waits, and for how long as the delay grows, will show whether an octopus trades reward against delay in a way relevant to sentience criteria, without exposure to a noxious stimulus. The next step is a training phase confirming that she takes the prey shown on her chosen card and learns what the countdown cues predict. Test sessions with increasing delays follow.

Future perspectives

The present findings, obtained from the Nity case-study, suggest that arm-raising may be influenced by social context, particularly following human departure, but its communicative function remains mainly unresolved. However, in the next future we plan to expand this method to other individuals, to evaluate its robustness of the observed patterns and determine if they are consistent across the species. Future research could also investigate whether interspecies communication and self-control reflect different manifestations of a common capacity for flexible, goal-directed behaviour in *O. vulgaris*. Evidence that *O. vulgaris* can distinguish among individual conspecifics (Tricarico et al., 2011) suggests that social information may play a more important role in octopus behaviour than traditionally assumed. Future studies could therefore examine whether octopuses are able to discriminate among different human interaction partners and whether such differences influence the occurrence, frequency, or context of arm-raising.

At the same time, the planned delay-choice experiment will explore whether octopuses can maintain a previously selected preference despite the availability of an immediate alternative, extending findings of future-dependent decision-making in cephalopods (Billard et al., 2020). Integrating these approaches may help determine whether communicative behaviours and delayed-reward choices rely on shared cognitive processes involving expectation, behavioural inhibition, and the evaluation of future outcomes. Such a framework would move beyond the study of isolated behaviours and contribute to a broader understanding of cephalopod cognition, agency, and welfare-sensitive assessments of sentience.

Ethics and welfare

Both animals in this report were housed individually in a 2,000-litre single-occupancy tank built specifically for *O. vulgaris*. Housing and care follow the guidelines of Fiorito et al. (2015). The observational study involved no intervention for research purposes. It recorded Nity's spontaneous behaviour during routine husbandry, including the normal switching of the aquarium lights.

The planned experiment takes place during routine feeding and adds no food restriction: Hanni receives food in every session, whichever prey she takes. It involves no handling, no invasive procedure and no aversive stimulus. The only cost of choosing the preferred prey is a short wait, which is why a delay replaces the threatening stimulus of a standard Criterion 5 test. Participation is voluntary, since she can ignore the boxes. Before testing, the boxes will be checked to ensure that no moving part can trap an arm. Sessions will stop if she shows signs of stress such as inking, jetting or persistent avoidance of the apparatus. All prey items are fresh dead or thawed, so no live crustaceans are used, which matters because there is also strong evidence of sentience in decapod crustaceans (Birch et al., 2021). Directive 2010/63/EU applies to live cephalopods (Article 1(3)(b)). It does not apply to practices not likely to cause pain, suffering, distress or lasting harm equivalent to, or higher than, that caused by the introduction of a needle in accordance with good veterinary practice (Article 1(5)(f)). We regard both studies as enrichment-equivalent and below this threshold.

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