Co-designing Enrichment Toys with Bottlenose Dolphins: Playfulness as a Corrective to Anthropocentrism

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ABSTRACT

This article discusses the process of co-designing enrichment toys for non-human animals under human care, offering a reflective account of this process, as it was carried out in direct and playful collaboration with a group of bottlenose dolphins at Mediterraneo Marine Park, which is located in Malta. It tells the story of an attempt to produce an active and fair context for multispecies negotiation. Leveraging thoughts and observations that emerged in moments of interspecies friction, we propose a way to critically reframe our biases and our relationships with non-human animals under human care. The paper presents the act of designing in terms of its possibility to go beyond being a passive reaction to a problem to become a conscious and deliberate process that addresses socio-cultural issues, particularly those concerning power imbalances and unfair representations. In the case presented here, a goal beyond the immediate enrichment of the lives of bottlenose dolphins in human care was the reshaping of the social practices and power relationships that determine those existences.

KEYWORDS

Participatory design, Co-design, Animal playfulness, Research through design, Research through game design, Critical game design, Dolphins

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1 INTRODUCTION

This paper discusses the experience of co-designing playful artifacts for enrichment purposes for a group of eight bottlenose dolphins (*Tursiops truncatus*) in human care at Mediterraneo Marine Park in Malta. During this design process, the researchers produced (and reflected upon) playful prototypes and interactions with the aims of enriching the everyday lives of the non-human animals involved while attempting to practice interspecies co-design. In the double pursuit of both enriching the lives of dolphins and reflecting on the potential of playing and game/toy design, multiple playful artifacts were created. Those artefacts can be used for enrichment (i.e., stimulating the dolphins both cognitively and physically) and to trigger novel behaviors (therefore improving the dolphins' welfare, see section 4). Viable routes to offer to the dolphins variety and flexibility in playful behavior in ways that even facilities with limited funds and time available can integrate into their enrichment sessions are also being proposed.

Through the course of six consecutive months of daily interactions with our non-human animal co-designers, we witnessed stories being shaped and communicated to us all while observing and being observed. There were two enclosures, each with three separate compartments. In the first enclosure at the time of the research there were:

- three adults (wild born): Sol (M 24), Mar (F 25) and Onda (F 26);
- one sub-adult: Melita (F 6) (born in the park); and
- two calves: Rohan (M 2) and Luqa (M 1) (both born at the park). In the second enclosure there were two sub-adults Cha (M 11) and Ninu (M 11) (both born at the park).

The research was conducted through the University of Malta and was guided and monitored by a team of experts in marine mammal behavior and specialized veterinarians. The project arose from the question of whether is it even possible to establish a successful and equal participation, while co-designing and co-playing in enclosures where hierarchies between human and non-human animals are established and evident. How game design and play can structure a less anthropocentric narrative? What is being expressed and communicated through play? We made an attempt to further explore and focus on how game design can be used not only as a non-invasive diagnostic tool, but also as common meeting ground for interspecies dialogue and mutual transformation. In the process of co-designing with animals, the existing literature [1–5, 7–10, 22] indicates that it is essential for designers to constantly keep several principles in mind, especially when their encounters with non-human animals do not happen in the latter's natural environment. In this paper the concepts of designing and playing overlap and merge as we treated every interspecies interaction as a crucial part of our process.

1.1 Shared game design spaces and playing with our non-human animal co-designers

As play is an ambiguous and autotelic kind of behavior—a nonfunctional behavior that seemingly has an end in itself, ethologists often have trouble categorizing it unequivocally. Our research focuses on

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exactly these ambiguous behaviors, examining them deeply. Our playful artifacts/play sessions, aimed to enrich non-human animals' everyday lives by alleviating feelings of boredom, keeping them cognitively and physically active, and further cultivating their social structure and bonds with each other, while treating them as equal individuals and enhancing their control over their own lives. In terms of research aims, as we already mentioned, we focused on how game design can be used as a common ground to allow for inter-species "becoming with" [5]. When designing for and with animals, any interaction, playful or not, should be considered a part of the design process and treated as feedback. That is why play and game design in this paper are overlapping. Wirman in *Orangutan Play on and Beyond a Touchscreen* [7], states that "cross-species play allows us to explore meta-communication as serving to establish the very rules of play, both during and throughout play. [. . .] a continuous process and an integral part of play itself" [7]. Our perspectives on this matter align with Wirman's, and similarly rely on the idea that the act of inter-species game design, in our case between bottlenose dolphins and humans, can be seen as a fluid negotiation space of exploration where monologues are slowly transformed into dialogues. As we mention in various sections of this paper, this is mere a starting point of establishing more than human ways of thinking, perceiving and becoming.

Along the same line of thought, Baker argues that the only way to truly "attend" these interspecies encounters is by "disattending [. . .] Western culture's broadly anthropocentric and inward-looking value system" [6]. One way of accomplishing this "disattending" in such encounters is through play [1, 3–5, 7, 22], where, as Wirman [7] and Cruise [8] argue, the differences among species largely collapse, and a deeper understanding of one another is reached through the semiotics of play.

In their paper *A Foray Into Not-Quite Companion Species: Design Experiments With Urban Animals as Significant Others* [2], Lenskjold and Jönsson explore co-designing with other species to "investigate the possibility of a pluralization of perspectives in design by insisting on placing human and animal actors as equally capable of action" [2]. Inspired by Haraway's *The Companion Species Manifesto* [3], their ultimate goal is not doing away with anthropocentrism in design, but rather making current creative practices fairer and more inclusive by also considering non-human animals as important stakeholders in the process [2]. According to them, taking perspectives that are not centered onto the human generate opportunities to experience new relations and points of view [2]. In our case, we not only attempted to include a dolphin-perspective but to also share with the dolphins a space for self-expression and play that would inform our project. Contra to other researchers, the authors' ultimate goal, which we followed, is not to remove the human perspective but to readjust the focus by adding to the mixture the view point of the animal co-designers as well in an equal stance. Their project is not defined by solely "designing for animals", the center of it lies to the "pluralization" of interspecies world viewings and "the ontological possibility of co-constructively sparking new relations into being" [2].

The process described, is part of a wider attempt to meet and communicate with different species through participating in shared game design practices and playful interactions [1–5, 7–10, 22]. In *Situated Knowledges through Game Design: A Transformative Exercise with Ants* [4], for example, Westerlaken and Gualeni explore alternative game design strategies and theories that could make cross-species distance manageable, creating a shared ground on which to communicate and co-create. They propose game design[1] as an active way of interpreting, addressing, and even solving problematic multispecies entanglements and an opportunity for challenging power imbalances. Westerlaken and Gualeni describe the act of engaging in playful interactions as instituting a shared, temporary semiotic context. Play can be understood as the key component of interspecies communication, often bridging part of the cognitive and perceptual distances that separate species. In another article, *Becoming With: Towards the Inclusion of Animals as Participants in Design Processes*, Westerlaken and Gualeni similarly raise the issue of the power dynamics that are at play even in attempts at multispecies co-design [5]. Boyd argues that it is essential not to treat or address non-human animals as something quantifiable, while recognizing that "things don't co-emerge in equal ways" and that the asymmetric power balance in all types of existing multispecies relationships is indisputable [6, 43].

We argue for the importance of focusing on what is needed and wanted by the non-human players (and, thus, co-designers) rather than projecting human ideals and concepts in developing innovations. We offered to our dolphin co-players and co-designers the opportunity for them to use playable artifacts as tool for expression and communication. We set up this (inevitably hierarchically) shared space by holding back and giving them an opportunity to be heard and seen without basing their experience on ambitious human-centered aspirations. A notable example would be how some of them preferred a torn rugby ball instead of the circular or fully blown ones because 1) they were easier to grab with their mouths and 2) the ball would trap air creating strings of bubbles when moved and released underwater. Usually the standard practice at the Mediterraneo Marine Park for toys that have been damaged were for them to be discarded and replaced, following human perceptions of what a toy should be or look like, or how it should function yet this very early observation and how this ball was repeatedly chosen over the others is just one moment of many that guided us through these six months and helped us grasp the concept of care in praxis.

Stepping back as a way to address unequal power situations in our case can be seen as embarking into a research without clear time frames, objectives, and even ambiguous results which can be quite intimidating. Understanding their concept of playfulness was deemed more important than a tangible revolutionary solution. When thinking about animals kept in zoological facilities, scientific and educational institutions, farming enclosures, or sanctuaries, as well as those dwelling in homes as companion animals, it is challenging to adopt a unitary framework for acting and designing. Analogously, it is difficult to draw a clear line between activities

[1]Westerlaken and Gualeni suggest the following three practical ways of gradually building anthro-de-centrifying practices through game design: 1. challenge ideologies embedded in normalized perspectives and contribute to forming a new, more ethical standpoint by culturing sensitivities in a contemporary manner, in tune with the time and place of the bodies involved; 2. adopt an interactive and mutable relationship among the parties involved by accepting the possibilities and implementing "designing as a transformative practice"; and 3. treat game design as an active way of proposing, addressing, and even solving problematic multispecies entanglements [4].

that lead to the normalization of speciesism and those that are deliberate attempts to bring hierarchical power imbalances between non-human animals and humans to the fore and, potentially, to counter them.

2 DESIGNING FOR NON- HUMAN ANIMALS

When discussing designing for animals, many of the authors already cited in this paper argue in favor of an approach that starts from a "species' specific point of view" [8]. This perspective also resonates with what Mancini describes as a "user-centered design approach" [10], where all of the participants' perspectives and feedback are to be considered through each phase in the design process. Wirman [7] and Westerlaken [1] stress the importance of sharing the non-human animal viewpoint when designing with and for animals and of closely examining the human designer's interactions with non-human co-designers, taking advantage of every opportunity to learn from interactions with them. We wholeheartedly share these perspectives. We treated the prototypes discussed below as also belonging to the non-human animals in the sense that we did not propose a univocal or "correct" way to play with them or discourage uses that a human perspective would deem "wrong". Instead, we treasured our temporary shared semiotics and unexpected playful interactions, allowing them to guide the design process.

2.1 Our approach

In line with our observations, Mancini explains that the animal–computer interaction community favors and focuses on a user-centered design approach and "regards humans and other species alike as legitimate stakeholders throughout all the phases of the development process" [10]. Mancini also proposes a "non-speciesist" [10] approach and stresses several steps [10, 23, 33–35, 45, 48] that designers/researchers should take when conducting research, which we built upon and followed in this project:

1. perform an adequate check for previous relevant projects;
2. set up the necessary collaborations (e.g., with biologists, veterinarians, and the administration of the facility where the animals are kept);
3. consider what technology is already being used in the wild or in the facilities in question;
4. gather information from human-centered interaction design practices and determine whether it can be adapted for human–animal co-design;
5.establish a "feedback loop" between theory and praxis while moving away from human-centered design and bringing non-human animals into the foreground and also focusing on "interaction"[2] and "participatory" [3] design methods;
6.take previous research into account, even if this work does not follow the same principles (e.g., pre-animal–computer interaction).

Guided by the points mentioned above [10, 23, 33, 34, 45, 48], we engaged in the co-design of playful artifacts meant to enrich the everyday lives of the bottlenose dolphins at Mediterraneo Marine Park in Malta. For the whole duration of the research, we collaborated with seven marine mammal carers as well as the veterinarian in charge. For the first month of our research we got to know the non-human animals and their caregivers by becoming a part of their everyday routine. The individual dolphins were observed daily during training, feeding and enrichment sessions with existing toys. The first part of our process consisted in learning about their individual play styles and characters. After that, the first set of prototypes was made. They were created in a manner that would function as embedded questions addressed to them. All the sessions were recorded and discussed with the caregivers and the veterinarians accordingly. We also had access to the daily spreadsheets created and archived by the park with their daily reports, describing all of their observed interactions (with each other as well as with the carers), behavioral reports and schedule (similar to a diary).

The play sessions took place on different days, groups, times of the day, weather conditions etcetera, were recorded on video and archives were kept for every individual group formation and every individual artifact along with their behavioral report and program of that specific day (a standard daily practice of the caregivers). During the sessions that were mostly observed from an underwater room, notes and observations were kept, that were then thoroughly discussed. The video recordings made the process significantly easier since it allowed us to revisit behaviors and play sessions and compare them. Crucial to keep in mind is, as we pinpoint above, is how a successful or at least more dolphin-centered feedback loop can be established. Ilyena Hirskyj-Douglas et al. in *Seven Years after the Manifesto: Literature Review and Research Directions for Technologies in Animal Computer Interaction* [46] explain how the feedback loop for ACI functions, by separating it into two distinct parts, the "gulf of execution" and "the gulf of evaluation"[48]. They suggest that the second part of the process (the gulf of evaluation) should be considered as an unreliable factor, since – despite the fact that the non-human animal interaction can be observed or recorded – the decoding process relies on speculations that cannot be verified by the non-human animals themselves [46, 48]. It is, thus, essential to take into account that no matter how familiar a researcher is with the non-human animals involved/targeted for in the design process and their behavioral psychology, the intent behind the action will always remain a speculation turning the "evaluation gulf" of the process into an open ended question [46, 48].

In line with existing research, we adopted a "play-oriented" approach [1–5, 7–10]. Wirman [7] explains, for example, that the act of playing can be considered one of "nature's most effective social lubricants," and argues, citing Bekoff [9] and Pierce [11], that "play is a unique category of behavior that tolerates asymmetries more than other categories of social behaviour" [7]. Indeed, it is not infrequent for animals that are dominant in their social group to adopt a subordinate role when playfully interacting with young animals in the group, and structural hierarchies often become momentarily more fluid in play. This "role playing" and elasticity in the power

[2]Interactive design, which is often associated with interaction design, is a practice that respects the users' "needs and desires from an external-observer's perspective" [23]. Interactive design incorporates a cyclical loop of feedback collected from real-time interactions in a playful, user-friendly way, valuing responsiveness and personalization.
[3]Participatory design is usually used and encountered in human–computer interaction and child–computer interaction. The main goal in this type of design is to shift the primary focus to a user-centered way of thinking. By following users' direct and indirect choices, designers attempt to better comprehend their target audience and to be more inclusive and respectful [31–34]. The aim is to systematically include the target audience from the early stages of the process, either systematically until the end product/artifact is ready or periodically, placing the user at the center of the act of designing [33–35].

balance are limited, lasting only as long as all parties are actively participating in the playful interaction.

With the goal of stimulating playful improvisation and engaging the bottlenose dolphins in participatory game design, we explored the social bonds between them, their interactions with each other, and their relations with their caregivers. We used these observations to provide a variety of different stimuli to trigger creative improvisation sessions and encourage physical exercise. In this process, following Mancini [10], we considered it crucial to show equal respect to everyone involved and to ensure that they were all treated equally, with consideration, respect, and care, while remaining aware that we had become part of a network that did not include only a group of bottlenose dolphins, but also humans who interact with them and an institution that is responsible for them. We ensured that all parties were treated in ways that were non-invasive, non-oppressive, and non-depriving and that they could opt out whenever they wanted. To accomplish this, we made use of the sides of the main pools and the various pool compartments, allowing the dolphins to choose whether to interact with the prototypes presented. They were also given the choice of deciding whether they wanted to interact with the new toys provided or with their existing enrichment (balls, buoys, pulling toys, hoops).

We included the caretakers in play and in our improvisation sessions, as these people are in fact more than the dolphins' caregivers; they are the people with whom the dolphins are familiar with and the ones they trust. The dolphins at the Mediterraneo Marine Park rely on their caretakers and seek their approval regarding any newly introduced scenario, and they trust them concerning whether something should be considered safe.

Following the phase where a new playful artifact was introduced and a phase where the presence of the caretakers was desirable, we experimented with play sessions of varying proximities between the caretakers and the dolphins. This was due to the fact that the dolphins' interactions with the artifacts were affected by the human presence in a number of ways (i.e. attempting to incorporate them in the play session or demanding primary reinforcements from them, such as fish). We ensured that the play sessions took place right after the feeding sessions and that there were no fish buckets present anywhere in the enclosure, therefore communicating to them the nature of the session.

3 DESIGNING FOR (AND WITH) DOLPHINS

Observing groups of dolphins in the wild or in human care, several researchers have categorized behaviors that seem idiosyncratic, lack an evident scope, or appear to have an end in themselves as "unidentified" or simply "playing". For example, Allen et al. describe sightings of individual dolphins lifting "sizeable conch shells" above the surface of the water, concluding that "Determining the function of this unusual behavior has been difficult, largely due to its infrequent occurrence and the relatively fleeting glimpses obtained when it has occurred. Functional hypotheses include feeding on the flesh of the living conch mollusk, play behavior, and use of the conch as a socio-sexual display item" [16] [17].

The first partners in play in a young dolphin calf's life are the mother and other young calves. They also engage in solitary play. Some hypotheses on why younger dolphins spend more time playing than their mature counterparts relate to aspects of social learning linked to play. Through play activities, dolphins learn to comprehend social structures and explore their own social skills while learning to interpret others' emotional states [17, 37–42]. Gibson and Mann [18] argue that mothers are determinant figures, through play and other activities, in introducing young dolphins to social dynamics. In *Why Do Dolphins Play?* Kuczaj and Eskelinen explain that dolphins exhibit playful behaviors throughout their lives [16–20, 26], with the amount of playful behavior decreasing with age [19, 26]. Dolphin calves seek to constantly challenge themselves, and consequently their playful activities become increasingly difficult and elaborate as they grow older [19, 20, 26, 36]. An indicative example is that of a calf creating bubbles and then rushing to bite them before they reach the surface of the water [19, 20, 36]. As the calf became more proficient, the process became increasingly complicated, with the calf starting to experiment with various parameters, like variations in the depth and quantity of the released bubbles. When other young dolphins are present in the group, the youngest dolphins tend to engage in ways of playing that are more "advanced" for their age and to develop cognitive and motor skills earlier, compared with dolphins who do not engage in such behaviors [18–20]. Bottlenose dolphins are also one of the species that have been observed in their natural environment to initiate a variety of interactions with other species, and have even developed complex foraging techniques that involve humans (i.e. collaborative fishing) [45].

In *Interfaces and Keyboards for Human-Dolphin Communication: What Have We Learned?* Herzing offers a retrospective on some of the most important scientific projects related to human–dolphin communication and describes many of the prototypes that have been used for this purpose [21]. Many of these prototypes are tangible, interactive artifacts, but she stresses that most of these technologies were built for "one-way communication", generally trying to teach cetaceans to express themselves in human language. These devices, in other words, functioned as teaching tools or as ways to test dolphins' cognitive abilities rather than working to build spaces of mutual connection and understanding. However, Herzing also suggests that many of the artifacts she examined could be used as blueprints to adjust and transform anthropocentric dolphin communication interfaces to become interfaces favoring connection rather than having an ulterior motive [21].

Bottlenose dolphins are marine mammals. Their habitat and their biological setup present certain limitations to how prototypes should be built to allow for optimal manipulation because dolphins' bodies are adapted for aquatic life, resulting in significant biological differences from terrestrial beings. For dolphin enrichment, most institutions use tangible readymade items and human toys such as balls, pool noodles, empty bottles, and buoys of various sizes, as well as hoops, ice, and gelatin:

Dolphins maintained in captivity play with objects they are given (e.g., balls, buoys, and ropes), objects they find (e.g., feathers, hats, and wallets), objects they create (bubbles and bubble rings), animals they capture to use as toys (e.g., birds, fish, eels), prey items that are played with prior to being consumed (fish and eels), and animals that are unwittingly and unwillingly treated as play objects (e.g., sea stars, sea turtles, sharks) [19].

These details, along with the research of Clegg and Minikin in their ongoing project *Animal Welfare Expertise's IdeaBox*, an online open-access Cetacean-enrichment catalogue that categorizes the types of enrichment available for Cetaceans in human care and provides suggestions and guidelines for innovative artifacts [25], as well as Delfour et al.'s research about object manipulation [26] among bottlenose dolphins in human care, which presents multiple dolphin interactions with do-it-yourself designs often used for enrichment in dolphinariums [16–20, 25, 26], were essential when deciding the direction of our designs and contributed to our initial observations.

Herzing's research shows that the waterproof underwater equipment needed to pick up dolphin vocalization is expensive and hard to acquire for experimental research projects and that communicating with visual cues is therefore a preferable method for trying to understand dolphins [21] something which we also confirmed through our observations. Among other useful practical guidelines that were valuable to our process, Herzing also recommends paying close attention to the amount of human involvement and participation during interactions with dolphins [21]. Accordingly, in our research project, we experimented with the following factors across multiple play sessions:

- altering our physical proximity to the dolphins during play;
- playtesting the artifacts with and without the dolphins' caretakers present;
- observing how the dolphins interacted with our prototypes when they were alone and when they were being observed by humans (standing in the vicinity of the pools).

Monitoring the play sessions with video recordings either from above the water or through the underwater room clearly facilitated the experimental process, allowing us to go back and re-examine sessions as well as individual interactions that we considered particularly salient. This, together with the record of the activities kept by the caretakers, gave us the opportunity to frame some of our findings in the wider context of the dolphins' everyday lives. The dolphins followed a very specific daily schedule which included routine physical checks, training for facilitating medical exams, multiple feeding sessions, an educational program and swimming sessions with the visitors of the park. Our play sessions took place during the allocated times for enrichment.

4 BEHAVIORAL DIVERSITY AND TECHNOLOGY

The concept of enhancing the environment of animals in human care in various ways is not new. In their 2010 paper *The Use of Technology to Enhance Zoological Parks*, Clay et al. discuss how "technology has been used to improve animal welfare by promoting behavioral diversity, increasing control and choice, and creating more cognitively complex environments," while also giving researchers the opportunity for "noninvasive testing of nonhuman animals' cognition, behavior, and perceptual abilities" [12]. Baker suggests that, in the context of enrichment, "low tech" and inexpensive projects tend to be highly effective [13]. Clay et al. agree with this idea but also stress that technology enables new ways of enrichment that previously were not possible and creates a larger variety of enrichment tools, further enhancing the welfare of animals in human care [12].

The key points for a successful enrichment project, they argue, are the accuracy of the approximation of the animals' natural habitats in enclosures and the provision of stimulation while maintaining "behavioral diversity" [12–15, 26]. This is often pursued with technologically mediated activities that mimic and stimulate hunting and foraging techniques that the non-human animals in question would commonly use in the wild. [12, 13, 25].

The concept of "behavioral diversity" [12–16] is a key factor which shaped our process and a recurring theme in marine mammal studies. In their *Behavioural Diversity Study in Bottlenose Dolphin (Tursiops truncatus) Groups and its Implications for Welfare Assessments*, Delfour et al. conclude that the diversity of the behaviors exhibited corresponds to bottlenose dolphins' welfare status [15, 26]. This means that, when the behavioral repertoire of the dolphins is stunted, their quality of life should be considered less than optimal. The two parameters we chose for determining and evaluating the "success" of the newly designed play objects (and for determining ways to trigger more novel behaviors) were the dolphins' novel behaviors and the variety of behaviors exhibited in relation to each prototype. The process would significantly benefit and progress with the use of a tailor-made ethogram, we further explore how our research could potentially be shaped from the use of one in section 6. An ethogram is a detailed list of behaviors and their descriptions, usually accompanied by the necessary sequence of photographs or drawings of the referenced movements, is a fundamental tool not only when attempting to research a specific animal population, but also become a way that the exhibited behaviors of a certain species can be successfully "described, quantified, and compared across populations" [47]. During the last months of our research, we started developing one as a way to measure more objectively the success of the prototypes, but to also address the problematic feedback loop. We kept track of all the behaviors that were triggered from our prototypes from the early sessions as well, with a special focus on novel behaviors and alterations of previously exhibited behavioral sequences. An example of that is explained in section 5.3.

The feedback collected from our project and research could potentially be linked with future technological advancements and provide valuable information for Animal Computer Interaction researchers and even serve as a guideline on how to approach and build dolphin computer interfaces that tackle Herzing's concerns previously mentioned. Our final prototype along with our more fluid process could also be used as a gradual way to introduce interfaces and electronical devices to groups of bottlenose dolphins in human care, who are more reluctant to such interactions. More data and data of better quality could also be collected by repeating the cycle of play sessions and improvisation sessions while incorporating more advanced technological equipment such as hydrophones and underwater cameras covering multiple angles, as well as updating and applying artificial-intelligence algorithms to facilitate the observation and categorization progress of the behavioral repertoires exhibited.

5 THE DESIGN PROCESS

Here, we present an in-depth examination of key moments that stood out during our observations of and encounters with our co-designers. We explain how these dolphins guided our observations and shaped the design process. The prototypes functioned as material questions, progressing from simple to more articulated, that we posed to the dolphins in the context of play. For ease of reading, we have grouped the interactions by the type of play session where they originally emerged. Consequently, the following section is divided into the following five subsections, each of which introduces a different type of interaction (or a particular preference expressed by the dolphins in the context of play):

- improvisation sessions (with pool noodles and pool noodle prototypes, ice prototypes, and sound prototypes);
- seaweed prototypes;
- pufferfish prototypes;
- multisensory prototypes;

the final prototype.

5.1 Improvisation sessions

On the basis of initial exploratory play sessions with the dolphins, we decided that an efficient way of asking questions through design (in addition to the questions embedded in each artifact's form) [22, 23] was through improvised play. The questions addressed and explored during the improvisation sessions were not the same as the ones asked during the scheduled encounters with the playful artifacts created. The playful artifacts were introduced within specific time frames (15min-60min) and our role was not active but limited in observing, keeping notes, recording and ensuring their safety at all times.

The design choices of the artifacts (i.e. the number of handles used, the sizes of the toys etcetera) posed certain questions (i.e. how are the handles used? Which dolphin body parts are used for the interactions? Does the size of the toys affects the playful behaviors exhibited?), and we, with the help of experts did our best to decode not only their answers, but whatever was communicated with these interactions. Hook's article titled *Exploring Speculative Methods: Building Artifacts to Investigate Interspecies Intersubjective Subjectivity* [22] argues that the produced knowledge is mostly "embodied in an artifact" therefore allowing both human and non-human users to comprehend, experiment and connect with it through experiencing it. The improvisation sessions on the other hand, were more direct and brief, including active human-dolphin interaction to mostly test materials, concepts and the boundaries of playing. Some of the questions addressed in these sessions were: What type of dolphin-human contact is ideal? Should humans (caretakers not the public) actively participate in playing sessions? How long should these interactions be? How animated should we be? We also experimented with new objects (a few examples can be found in sections 5.1.1, 5.1.2 and 5.1.3), asking questions involving the new objects and their first impressions of them, like "What is more exciting, a new sound or trying to find out what is inside?" or "Is this new material (i.e. pool noodles) interesting to them?"

The act of Improvising and playing according to Stephen Nachmanovitch is a praxis bound to the real time observations and reactions of the participants, which shaped our interspecies sessions. Tucker *in Meaningful play: Applying Zoosemiotics to game development* [44] explains that it is through examining improvisations and playing of species in relation with their social and spatial conditions that can indicate "how play moves, travels, and be more easily initiated" an opportunity to "predict potential in abilities and communication" [44]. Therefore, during our research we held improvisation sessions outside of the strict limits of time frames and socio-spatial restrictions. These play sessions were more fluid, often initiated by our dolphin co-designers, triggered by an item or simply our physical proximity (i.e. if they were looking at an item that was not destined as a prototype we would treat it as such, like a slipper, or a plastic tray, the game rules were invented on the spot and shaped by each other's' reactions).

Our attempts to co-design were in line with the work done and described by French et al., who have discussed how they moved from theoretical frameworks and brainstorming sessions to more tangible experimentation with their non-human collaborator, Valli the elephant, stating that "the physicality of the experience can lead to useful insights, as constructing objects can aid reflection on how the target species might interact with the design" [24]. The authors focus on how by carefully observing Valli's interactions with the prototype she was suggesting through her body alternative adaptations of it. The way she manipulated the artifacts, how she held them, for how long, how she used them, dictated the shape, size, materials and that the optimal physical combinations would eventually come to be. [24] Our approach, on how we incorporated every single dolphin indexical sign/movement/vocalization in the design process was quite similar. We also came to the realization that, instead of presenting a finished toy prototype to the dolphins in Mediterraneo Marine Park, it would be more effective to playfully involve them, like in Valli's case [24], from the earliest stages of the design process (i.e., presenting them only parts of a toy or testing an interesting idea with a rough prototype).

Similarities of our process can also be found in the work done by Westerlaken and Gualeni, who borrow the notion of "bodystorming" from the field of interactive design [4, 5]. Applying it in their design with animals, they explain how this concept "enables the expression and exchange of tacit knowledge at a physical level of experience" and how, through early prototypes, "new ideas are acted or played out within their specific use-contexts," using learning and exploring through the body as ways to communicate and to do research [25].

To adopt a more respectful and inclusive approach and accomplish a gradual transition to new designs, we opted to use for the most part materials that were already familiar to the dolphins, mainly repurposing parts of older toys, giving them new forms; this decision was quite restrictive and challenging, postponing our initial plans for more elaborate and complex designs, which would include components, that would potentially be perceived as more intrusive from our co-designers (i.e. vibrating or automated parts) therefore we decided to use tangible designs as a starting point before introducing and even transitioning to low-tech designs. The feedback collected though along with our process could be proven beneficial for researchers attempting to design less anthropocentric computer interfaces for cetaceans in human care.

Figure 1: Melita interacting with a pool noodle during an improvisation session.

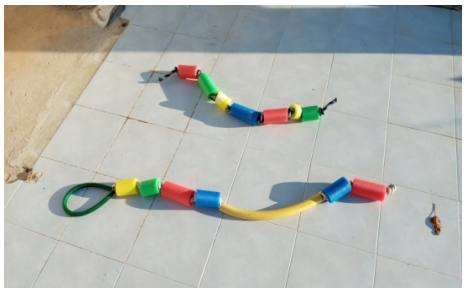

Figure 2: Pool noodle toy prototypes.

5.1.1 Pool noodles and pool noodle-alikes. One of the materials we tested was plastic foam floating "pool noodles"; we had sessions using whole pool noodles, and we also included them as parts of some of our seaweed prototypes (see figures 1 and 2). The younger dolphins were keen to interact with the pool noodles in various ways, whereas the older dolphins were more reluctant. Melita and Rohan, two of the most inquisitive dolphins, chewed on the pool noodles. We concluded that we should not use pool noodles for any detachable parts in the final design, instead suggesting separate supervised sessions with them because this type of material was successful in the sense that it triggered new playful behaviors and creative interactions.

5.1.2 Toy prototypes that emitted sound. We created multiple small do-it-yourself musical instruments with which the dolphins could experiment by producing and manipulating sounds. Our initial impression was that the dolphins were more interested in the visual cues of the internal movement of the object in question (for example a stone in a plastic bottle) and how the caregivers handled it than in having the ability to create sounds themselves with them (see figures 3 and 4). More research is needed, but -following these sessions - we concluded that, if we were to include a detachable sound-making part in our final design, it should ideally be see-through.

5.1.3 Toy prototypes featuring colored ice. Another session that helped us to extract important information involved several alterations to the dolphins' ice toys, which were already a part of their weekly enrichment sessions. We introduced more variation in color and size (see figure 5). The newly colored ice toys, although they were intended to be something familiar to the dolphins, were often

Figure 3: Ninu (left) and Cha (right) interacting with two do-it-yourself sound-producing prototypes during an improvisation session.

Figure 4: Rohan closely observing the contents inside a do-it-yourself sound-producing prototype presented to him in the underwater observation room during an improvisation session.

Figure 5: Melita bringing multiple ice toys of various sizes and colors into the pool at once and interacting with them while observed by Onda who is keeping her distance, during an improvisation session.

treated with reluctance, demonstrating that the dolphins noticed even the smallest changes, even when the materials were the same, which indicated that the use of unfamiliar color hues is something that should be considered carefully.

In the following sections, we will now move from the fluid improvisation sessions to introduce and briefly discuss the prototypes that were predominantly tested during more structured play sessions.

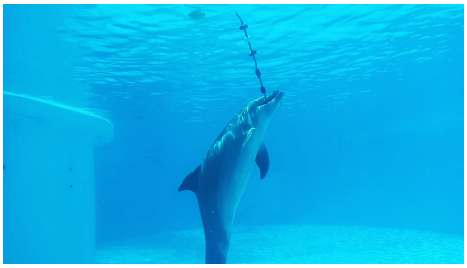

Figure 6: Rohan creating different movement patterns with the seaweed (floating type) prototype with his mouth during a play session

Figure 7: Ninu interacting with the seaweed (floating type) prototype with his mouth during a play session.

5.2 Seaweed prototypes

The design of our first seaweed prototypes was inspired by the movement of seaweed in the water. The seaweed (floating type) prototype's form was heavily based on previous toys and can be seen as a relatively small deviation, introducing new ways of movement. We placed five small floating buoys along the toy's length instead of using a single large buoy. When the prototype is pulled underwater, it resurfaces in a slower and more organic way, compared with previous toys. The design was kept relatively simple, and there is a knot in the middle to add flexibility to its movement (see figures 6 and 7). When the dolphins had not interacted with this seaweed (floating type) prototype for a few days, they were keener to interact with it when it was again placed in the pool, and they remained interested in the prototype for longer periods of time. Through this design, we therefore realized that the toys need to be swapped regularly and that the same enrichment activities should not be provided in every play session—something that the caregivers and previous literature [25, 26] had already mentioned and is well known in several species.

The second seaweed (sinking type) prototype takes significantly longer than the other prototype to reach the surface when fully submerged. There are only two very small floating buoys on each side of the toy, resulting in slower, smoother underwater movements (see figure 8). Paradoxically this is also the prototype that "moves" the fastest when a dolphin interacts with it because it is composed of multiple small pieces of hose and has a number of knots that function as knuckles. The first time this prototype was introduced

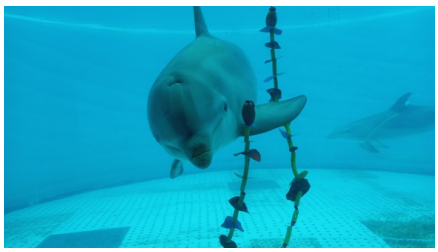

Figure 8: Luqa holding a seaweed (sinking type) prototype and interacting with it using his pectoral fin during a play session while observed by his mother, Onda.

to the dolphins, their reactions were polarized, even though all the materials used for the design were familiar to them. It was the prototype that took the longest to be "accepted" (i.e. while Ninu, Melita and Luqa interacted with it from the first session, Cha was very reluctant at first, and Mar would not initially allow her son Rohan to touch it) by the group. Melita also used it more compared to other toys to simulate herself sexually since we hypothesize offered greater friction and grasp.

Overall, it was evident that more "organic" prototype forms (resembling real sea weeds, having a more fluent movement) were associated with more reluctance on the part of the dolphins. Some of the dolphins were particularly interested in the variability of movements produced by the prototypes and in the different ways that they could affect these movements; therefore, we decided to incorporate detachable parts of various lengths and similarity to their natural counterparts (sea weed) in the final prototype (this decision is further explained in section 5.5)

5.3 Pufferfish prototypes

The design of the pufferfish prototypes was based on dolphins' interactions with pufferfish in the wild. Our idea was to create something that would mimic a real pufferfish: a chewy, ball-like artifact that would emit substances that are pleasant to dolphins, or would be used to hide edible treats (fishes and/or gelatin) inside of it. These artifacts were also inspired by the various foraging techniques [15–20, 25, 26] that dolphins use when searching for food as a group, collaboratively; along with another behavior described by Allen et al. [17] , which we mentioned above, known as "conching" (interacting with conch shells). We decided to cut a buoy in half to resemble a pufferfish. It was essential to choose something soft but resilient so the dolphins would not harm their mouths or teeth when interacting with it (see figures 9, 10 and 11). The two prototypes were not identical; there were some alterations to make the questions more specific (for example the number of handles) asking questions about the length of the handle, the material, the placement of the handles and the level of buoyancy among others.

These cone-shaped, hollow pufferfish prototypes are the only prototypes that sink and rather than staying afloat on the surface of the pool. This difference resulted in the alteration of two behaviors that the dolphins had exhibited with the other objects: the former behavior of bringing the object(s) to different levels toward the bottom of the pool followed by letting the object(s) rise was adjusted to the sinkable nature of the new prototypes, becoming bringing

Figure 9: Pufferfish prototype (version 1 with two handles).

Figure 10: Pufferfish prototype (version 2 with one handle and flexible plastic parts attached resembling fins and a tail).

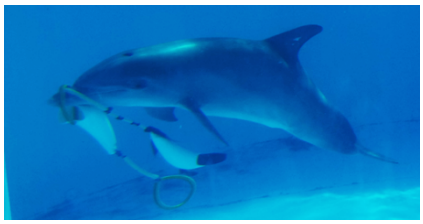

Figure 11: Rohan holding pufferfish prototypes (versions 1 and 2) and interacting with them with his rostrum during a play session.

the object(s) to the surface or to different heights from the bottom followed by letting the object(s) sink. This observation was essential in our research since it indicated a number of novel behaviors exhibited during their play sessions with these prototypes.

After observing how introducing different degrees of buoyancy affected the dolphins' repertoire of behaviors with the prototypes, we aimed to incorporate numerous variations in our final design. Contrary to our initial speculation, the dolphins were more interested in the objects' buoyancy than in the fish placed inside; we nevertheless decided to incorporate multiple hollow containers in our latest version to allow for further exploration of including dolphins' foraging techniques since in other occasions the dolphins only cared for the fish inside the containers at first and they later interacted with them. The decision was made for optimal variability and versatility.

5.4 Multisensory prototypes

The multisensory prototypes were designed to test different stimuli and combine stimulation of different senses while monitoring the dolphins' reactions and preferences (to and for, e.g., fish, tonality, vibration patterns, and light sources).

Figure 12: Ninu pushing the multisensory prototype (version 1) with his rostrum during a play session.

Figure 13: Melita pulling the multisensory prototype (version 2) by its loop during a play session.

Our first approach was to equip the multisensory prototype (while empty) with two loops, which served as handles. The need for this element was evident from our initial observations, and loops proved to be a key design feature. The dolphins used the loops to "grab" the toys because they have been encouraged by their caretakers not to use their teeth as much, for safety reasons. We also noticed another feature associated with these loops: even when our prototypes were novel, if we incorporated a loop/handle, the amount of time needed for the dolphins to approach the object was minimized. However, although the toys that had a specific type of handle gained an immediate "recognition", neither the production of new behaviors, nor a standard level of engagement (see figures 12, 13 and 14) was ensured because of it.

A key realization here was how the presence of these loops/handles communicates "ownership" and is a direct way to convey purpose. In the article *Designing for Intuitive Use for Non-Human Users*, Wirman and Jørgensen argue that designs should be intuitive [27]. Luqa's attempts to pass his rostrum through both handles of the pufferfish prototype (version 2) at the same time illustrates how intuitive design can be used to upgrade a concept; we added additional handles to our final prototype.

5.5 The final prototype

Our final prototype was designed as a synthesis of updated versions of the previous prototypes. It consists of multiple detachable parts that can be combined in multiple ways to produce several distinct variants in different play sessions. A key element of this design is that carabiner clips can be connected to various parts of the toy. Because multiple parts can then be attached to each carabiner clip, this prototype offers great combinational variety in terms of alternative forms/designs (see figure 15). Our approach with this

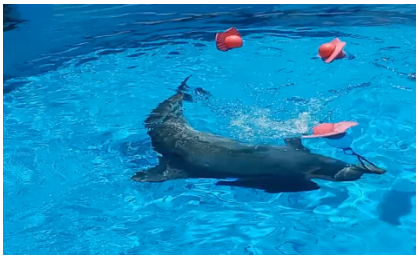

Figure 14: Melita choosing to interact with the multisensory prototype (version 2) by its loop during a play session.

Figure 15: Digital collage of several combinatorial possibilities for our final prototype afforded by the various detachable parts.

final prototype ensures that the caretakers can experiment with different shapes and types of movement. Most of the forms that can be realized with this toy are based on the current research. To better articulate and explain how we incorporated the information collected from all the previous sessions we will briefly revisit the Seaweed Prototypes (see section 5.2) and offer an example of our co-designing process and how it was not the result of just combining everything together but a mindful act of care. How organically the prototype moves (in relation to its natural counterpart) and how this affects differently each dolphin is an aspect of our design process that could have been overlooked or not deemed as important from other human enrichment designs that are not targeted to specific individuals. The decision to incorporate various degrees of organicity in the final prototype was taken for three reasons:

1. there are different preferences and play styles for each dolphin;
2. the emergence of habituation (most of the dolphins valued variability, and would interact more enthusiastically, for more prolonged periods of time with a "successful" design when it was not presented daily);
3. for safety reasons (what is safe for one dolphin might not be safe for another, the main reason why pool noodles where only given to them when closely supervised).

Our main goals with the final prototype were to communicate the preferences for and perceptions of play of this particular group of individual dolphins and to upgrade their daily enrichment by offering variability, thus leading to a richer behavioral repertoire. A unique characteristic of this final design is its adaptability and flexibility, which allow spontaneity by creating a safe space for the gradual introduction of new objects, while limiting the risk of assembling a toy that would trigger neophobic behaviors. This could also potentially be perceived as an alternative approach to enrichment overall rather than a single prototype. Further, it could serve as a solution for many zoological institutions with limited budgets and time to provide and test new playful artifacts. Clegg and Minikin suggest that a successful enrichment program will have to be frequent, offer variability, and positively impact the lives of the non-human animals [25]. The detachable parts of our final prototype were modeled after the information we gathered through observing the dolphins' interactions with our previous prototypes. We would not have reached these realizations and could have missed multiple indicators if we had focused solely on expected behaviors and concepts or adopted a less fluid approach.

When conducting research on the behavioral repertoires of non-human animals, it is essential to consider that every animal is an individual with their own distinct personality, likes and dislikes, "age, social rank, reproductive activity and gender" [26], as well as taking into account group and environmental factors. Every single one of the dolphins that we worked with contributed to the project in their unique ways. Delfour et al. [26] conclude their research by stating that their results support the idea that complex designs are not as successful as simpler ones and do not offer "greater stimulation" for bottlenose dolphins [26]. They also note, citing Delfour and Beyer [28] and Goldblatt [29], that "supposed novel complex objects may also quickly lose interest, as habituation to objects is frequent, especially when dolphins do not interact regularly with them"[26]. Delfour et al. continue with mentioning that more monitoring is needed concerning the dis-interest towards objects and their habituation patterns especially during play sessions.

We partially agree with this statement, but – following our observations of this specific group which our prototypes were introduced – we would rephrase to avoid characterizing the items discussed as "simple," instead describing them as "versatile," allowing the non-human user/player to project their own concepts of playfulness and to engage in complex actions created by their own creativity rather than by the anthropocentric concepts of "what animals with developed cognitive abilities might need" [26]. Meaning that when new, complex playful artefacts are designed they do not guarantee the emergence of complex or novel behaviors in the dolphins, and they might not even be cognitively simulating for them.

6 FURTHER RESEARCH

Because of multiple unforeseen circumstances, parts of our research had to be reduced or even changed, limiting our area of focus to specific interactions and mainly to the design process. We have pinpointed though, potentially fruitful areas of research, and observed behaviors and patterns that, with more time and more playful contact with dolphins, could take this project further. By following our process again, adjusting the main focus from design to a more thorough mapping of the behavioral repertoires exhibited, we could further explore how character traits affect each individual's play style.

Another area of interest would be to compare the behaviors seen when alone (in "solitary play") versus those observed in group play and to analyze how the social structure and roles in the group shape playful interactions. Given that dolphin welfare is associated with the number of unique behaviors exhibited [15, 26], it would be useful to examine how (and if) the level of creativity shown can function as a finer indicator of cognitive welfare. A way to expand our project could also be to further explore how mothers use and manipulate objects and playful artifacts with their calves. We witnessed both Mar and Onda (who were still whining at the time) to playfully interact with their calves, Rohan and Luqa respectively. It would be interesting to compare the behaviors produced to when other adult dolphins interacted with them, like Sol (their father) or Melita (Rohan's older sister).

Other possible future developments for research in this area might involve a more specific focus on dolphins' socio-sexual behaviors. These typically occur in close temporal proximity to play sessions (before, during, and after). A natural next step of our project would be to use the feedback collected (since both Rohan and Melita used the prototypes for sexual relief), and create toys whose objective is the sexual relief of both male and female dolphins, while addressing how the sexual nature of non-human animals under human care is being perceived and treated. It would be interesting to put side by side the topic of husbandry versus how playful artifacts can be used as socio-sexual display objects but also as sex toys themselves. With more experiments and observation, researchers could examine the possible correlation of the reproductive cycle and hormonal levels with playful object manipulation.

7 CONCLUSION

This paper reflects on the process of co-designing enrichment toys for non-human animals in human care. More specifically, it offers a reflective account of this process as experienced in direct and playful collaboration with a group of bottlenose dolphins at Mediterraneo Marine Park in Malta. In recounting this story, we also attempt to create an active and fair context for multispecies negotiation. In other words, leveraging thoughts and observations that emerged in moments of interspecies friction, we have proposed a way to critically reframe our biases and our relationships with non-human animals in human care. In sum, this paper has presented the act of designing in terms of its possibility to go beyond being a passive reaction to a problem, becoming a conscious and deliberate process that addresses sociocultural issues, particularly those concerning power imbalances and unfair representations.

In *Imagining Multispecies Worlds* [1], Westerlaken argues that it is paramount to recognize and address the embedded inequalities between humans and animals in artificial contexts such as zoos, marine parks, and rehabilitation facilities. She considers it crucial to maintain focus on how these relationships of power and oppression are inextricably woven into and normalized in our societies. These are intricate and ramified relationships of responsibility, power, and care, and they are also inevitably imbricated with economic, legal, and ethical factors (which, in our case, includes interfacing a publicly funded research institute with a privately run center for amusement and education). It is therefore reasonable to ask whether and how changes in such contexts can be accomplished—or even just initiated—by a single person or a small team of people. The frequently advocated "welfarist standpoint", which aims to make the lives of animals in human care as pleasant and rich as possible, "benefit[ting] the lives of other animals directly, but not necessarily in a more systematic multispecies manner" [1], should be understood as a temporary solution. In line with Westerlaken, [1] we argue that co-design has the potential to be something more than a provisional "patch" for a deep-seated anthropocentric perspective.

We acknowledge that we cannot demand the non-human animals in zoological institutions, animal centers, and sanctuaries to become the ambassadors for every individual of the same species. However, it is also unacceptable to completely ignore their voices and everyday lives, and we should not let their entanglement with humans be a reason to silence them. We therefore decided to treat human–non-human animal shared spaces as opportunities for interaction and negotiation and a resource to produce change and transformation for all the parties involved, seeking to allow the non-human animals as much autonomy as they can enjoy while being fully dependent on humans.

In their paper on *Research Through Design as a Method for Interaction Design Research in HCI*, Zimmerman et al. [30] argue that the goal of the subfield of critical interaction design is not to produce what would be considered a "successful" product from a capitalistic orientation (i.e., an efficient marketable good), but rather to confront problematic social conventions and perceptions. Their idea is to design a provocation in the form of tangible/tactile questions that forces the viewer, the user/participant, and the designer, to adopt a critical state of mind.

Our playful artifacts can be seen as vehicles of identifying and adopting less anthropocentric ways of thinking, designing and doing research. Our process provides an ethical, inclusive, and safe way to address inequalities in the spaces shared by human and non-human animals. The final prototype, which is more of a flexible concept rather than just one group of specific items, was designed by combining the feedback collected during the improvisations and the play sessions. It is not to be seen as a final product but more as a tool, an approach and solution to welfare and enrichment programs on how to accumulate different wants/interests while simultaneously producing new experiences/forms in a safe and more respectable way for dolphins in human care.

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