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Evidence-based practice

Pinniped training for research in zoos: a case study using sensory discrimination tasks

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Abstract

Zoo research is mainly behavioural in focus. Developing training interventions to enable more controlled behavioural experiments may increase the impact and rigor of animal behaviour research in zoos. This study investigated the impact of setting up a new, complex object identification task, with multiple training stages. The task was carried out in two pinniped species, including South African fur seals *Arctocephalus pusillus pusillus* and harbour seals *Phoca vitulina*. The training intervention took place alongside their normal routine, including husbandry training, educational demonstrations, animal experiences and animal relocations. There were significant individual and species differences with the training stages. Individuals encountered challenges, particularly while blindfolded and undertaking the tactile discrimination tasks. Two out of four South African fur seals successfully completed all three discrimination tasks. Although the two harbour seals successfully learned to be blindfolded, they were unable to perform any tactile tasks while blindfolded, despite having completed the tasks without the blindfold. While we show that it is possible to use existing training behaviours to train new tasks for research, developing a new or extensive program of research with trained animals will probably only be beneficial for institutions that are already regularly developing training protocols, have good staffing resources and would like to prioritise their research agenda.

Background

In recent decades zoos have increased outputs of their research programs (Hosey et al. 2019; Kögler et al. 2020; Lina et al. 2020), suggesting animals in ex-situ collections possess considerable scientific value, beyond their roles in education and insurance populations (Kögler et al. 2020). While historically associated with comparative psychology (Hosey et al. 2019), contemporary zoo research encompasses various disciplines including veterinary, ecology, conservation and physiology (Hosey et al. 2019; Kögler et al. 2020; Lina et al. 2020). However, much research still focuses on animal behaviour, especially in vertebrates (Hosey et al. 2019; Lina et al. 2020; Fernandez 2022). Fernandez and Timberlake (2008), state research on the control and analysis of behaviour is an area that could support research collaborations between zoos and universities, since zoos offer unique environments for examining behaviour, that academic researchers would not typically have access to.

Training plays an important role in facilitating the care and welfare of animals in zoos and aquaria (Fernandez and Timberlake 2008; Fernandez 2022). Training through positive reinforcement is widely used in zoos and aquaria, playing a role in animal management to reduce abnormal behaviours, stress during relocations, medical procedures, and health checks (Melfi 2013; Fernandez 2022). It promotes exercise, mental and physical stimulation (Desportes et al. 2007; Ortiz et al. 2020). Furthermore, training improves animal-keeper relationships, provides awareness via education demonstrations, while boosting welfare and enrichment (Fernandez and Timberlake 2008; Pomerantz and Terkel 2009; Melfi 2013; Ward and Melfi 2013; Melfi 2014; Westlund 2014; Spiezio et al. 2017 Fernandez 2022). We propose that training also serves as a valuable tool for conducting controlled behavioural sensory experiments, facilitating problem-solving behaviours in captive animals, which can be more challenging to encourage in zoo environments.

Many zoos develop animal training programmes for research, particularly for marine mammals (Mumaw 1988; Brando 2010; Houser et al. 2010; Spiezio et al. 2017; Milne et al. 2020). Specialised research institutions conduct controlled behavioural research on trained marine mammals, such as Mote Marine Lab (USA), Marine Science Centre (Germany), Marine Biological Research Centre (Denmark) and US Navy Marine Mammal Program (USA). Pinnipeds, in particular, have been extensively used in training for research, including tasks such as tactile object discrimination of different shaped and sized objects (Kastelein 1988; Dehnhardt 1990; 1994; Grant et al. 2013b), visual contrast sensitivity (Hanke et al. 2009; 2011), hydrodynamic sensing (Wieskotten et al. 2010ab; Gläser et al 2011; Miersch et al. 2011; Krüger et al. 2018), and time sensing (Heinrich et al. 2020). Discrimination tasks offer controlled, replicable studies on cognition, problem-solving, and sensory perception, while improving welfare (Kastelein 1988; Dehnhardt 1990; 1994; Grant et al. 2013b; Milne et al. 2021). Aligning these tasks with an animal's dominant senses, such as using whisker-based tactile perception in pinnipeds, could further improve their effectiveness.

A recent study conducted a series of three alternative forced choice discrimination tasks, involving a visual task and two tactile tasks, with a California sea lion *Zalophus californianus* (Milne et al. 2021). For the first time, they demonstrated precise task-specific control a sealion had over their whiskers, an observation previously only documented in human fingertips (Gibson 1962; Lederman and Klatzky 1987). While Milne et al. (2021) demonstrated that pinnipeds can be trained in multiple stages of object discrimination, it remains unclear whether this intervention can be widely implemented across various institutions and species. This is an important step considering its broader applicability in zoo research, offering insights into pinniped cognition, sensory abilities, and species-specific whisker behaviours, enabling cross-species comparisons to explore the evolutionary aspects of pinniped sensing. However, discrimination tasks of this nature are time-consuming, and not all individuals successfully learn them. In Milne et al. (2021), only one out of four sea lions learned all three tasks, with the process taking over a year to complete. Therefore, the impact of this training needs to be fully assessed before embarking on such a long-term research commitment. Our research aims to evaluate the effectiveness of implementing and refining the training intervention described by Milne et al. (2021), in SeaQuarium, Rhyl a new institution, and across two additional pinniped species: South African fur seals *Arctocephalus pusillus pusillus* and harbour seals *Phoca vitulina*. Following the methodology of Milne et al. (2021), we trained six seals on three discrimination tasks: one visual task assessing brightness, and two tactile tasks, using their whiskers to differentiate between textures and sizes. For the tactile tasks, the seals were trained to wear a blindfold to ensure that vision was not used.

Action

Animals

Four female South African fur seals: Nelly (8), Gina (4), Flo (4) and Bubbles (4) and two female harbour seals: Ina (20) and Pamina (18) were selected and housed at Seal Cove, SeaQuarium of Rhyl. These seals have been trained for many years for medical, welfare, and educational purposes. Throughout research training the seals continued daily routines, including regular participation in training, penning and demonstrations. The training methodology employed was positive reinforcement, where food served as both a reinforcer and reward, with a whistle as a bridging stimulus. The seals entire diet was provided through penning, demonstrations, public interactions, feeding and training sessions (including research sessions). The reinforcement schedule varied with seasonal fish species availability, which included Atlantic mackerel *Scomber scombrus*, Atlantic herring *Clupea harengus* and European sprat *Sprattus sprattus*. During training, fish were typically given in single pieces as a consistent reinforcer. "Jackpot Rewards" were given to provide something more stimulating or valuable than their usual reinforcer, and often used to mark a breakthrough or completion of a particularly challenging behaviour. These were given when the seals performed a new behaviour for the first time and consisted of a whole fish or larger quantities of single pieces provided as a scatter feed. Reinforcement was consistent, with all correct responses rewarded, and during data collection jackpot rewards were removed to prevent bias. Training occurred at various times and durations, based on the seal's behaviour, staffing, research sessions and daily schedules, which altered seasonally. The order of seal participation was opportunistic throughout. Three trainers were involved, one head trainer overseeing procedures, training and completion of training stages. The other two were experienced trainers, participating in training, completion of training and data collection with seals. For stages that required two trainers, rotations were implemented to prevent seals from becoming accustomed to specific individuals. Procedures were ethically approved by both SeaQuarium of Rhyl and Manchester Metropolitan University (Ref: 36106).

Apparatus

The apparatus was designed specifically for this research, consisting of a aluminium bespoke rig for three discrimination tasks: brightness, texture and size. In the brightness task, seals relied on vision. For the texture and size tasks seals were blindfolded, using their whiskers for tactile identification. For each discrimination task, seals were introduced to three different fish shaped stimuli, including one target stimulus (S+) and two distractor stimuli (S-), totalling nine different stimuli (Figure 1). Model stimuli were 3D printed to create silicon moulds. A non-silicone mould release agent layer (Ambersil) was sprayed onto the silicon mould to prevent sticking. The stimuli were all cast using SmoothOn Simpact™ 85A Rubber (SmoothOn distributors Bentley Advanced Materials) in the silicon moulds. Stimuli could easily be remade as they showed imperfections from wear and tear caused over time by saltwater exposure and seal teething during initial training. Minor tactile imperfections may have arisen between the stimuli, causing the brightness task to not be purely visual, but rather multi-sensory.

The setup consisted of the bespoke rig with three fixed bars for attaching the stimuli and two camera mounts for positioning GoPro HERO10 cameras on top and to the side of the rig, filmed at 120 fps, (Figure 2b-d, 3d-e). Stimuli were attached to T-shaped bolts that inserted into the fixed bars. Stimuli were not fixed and could be switched around on the rig using a pseudo-random table (Gellarman 1933), with positions changing after each trial, (Figure 2 d-e, 3 b-d). The bars, where the stimuli inserted at their central point, were evenly spaced with 30mm between each position (Figure 3), and stimuli remained stationary when introduced underwater or trying to be removed by the seals (Figure 2de, 3bc). This setup improved upon research by Milne et al. (2021), where spacing between the bars varied (20-40mm). In the size task, the widths of the stimuli varied (Figure 1), causing the gap between stimuli to evidently differ during this task (Figure 3d).

Training procedures

During the training intervention and data collection, ~1000 members of the public watched the training daily. Training began with the brightness task, followed by texture and then size. Brightness training occurred over a 16-week period, from May to October 2022. Texture training took over 22-weeks, from October to March 2023. Size training lasted 20-weeks, from May to November 2023. Breaks were incorporated into the training during school holidays for daily routine changes and reduced staff availability. All seals participated voluntarily and could leave the training space at any time.

Task training

Training for the discrimination tasks occurred in the show or exhibit pool, with each training stage outlined in Table 1. Although Stages 1–4 could be completed with one trainer, two trainers were involved from Stages 3–6, once all three stimuli were introduced (Table 1). This helped desensitise the seals, as two trainers were required during data collection. Trainer 1 was the primary trainer, responsible for handling the seals, including giving cues, bridge, reinforcer/reward and blindfold. Trainer 2 played a secondary role, managing the rig set up and moving stimuli when needed. Seals progressed systematically through Stages 1-6. South African

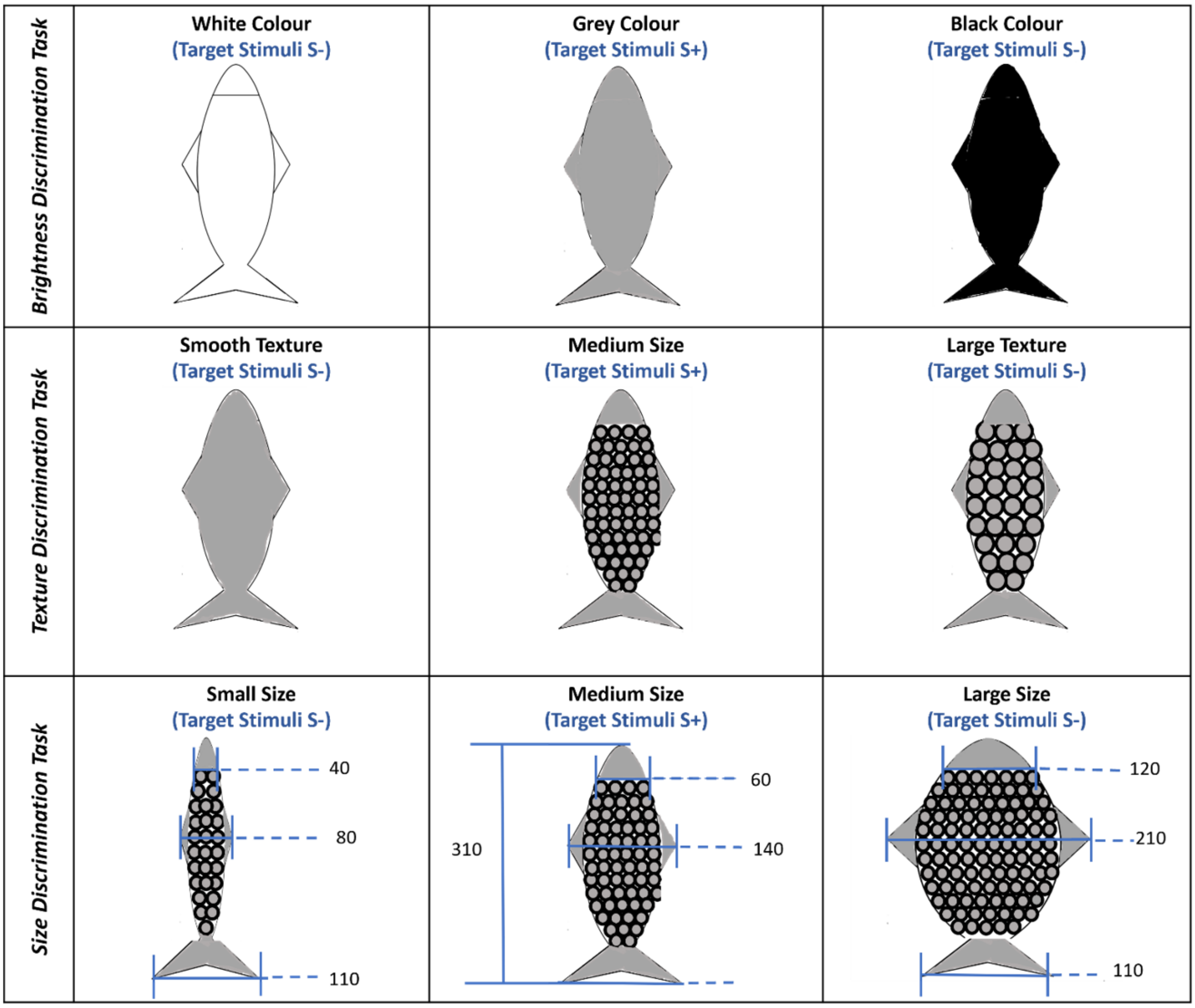

Figure 1. Fish model stimuli used for the three discrimination tasks: The target stimulus S+ was sized at 310 mm x 30 mm(l/d) with widths of 110 mm at the tail, 140 mm at the fin across the body and 60 mm at the head. The brightness task stimuli were all identical in texture (smooth), material, shape and size (standard S+), with only the colour being different. The S+ was coloured grey while the two-distractor fish stimulus (S-) were one coloured white and one coloured black. The texture task stimuli were all the same colour, material, shape and size (standard S+). Only the texture differed: S+ a medium texture stimulus (round protruding circles of Ø 0.4 mm, similar to Lego bricks); and for the two S-, one smooth texture and one large textured (round protruding circles of Ø 0.9 mm, similar to large Lego bricks). The size task used the same S+ as in the texture task, all stimuli had the same medium texture, colour and material, with only the size changing. The S- consisted of one small sized (widths measuring 40 mm at the head, 80 mm at the fin and 110 at the mm tail) and one large sized stimulus (widths of 120 mm at the head, 210 mm at the fin and 110 mm at the tail).

Table 1. Overview of training stages for discrimination tasks: Outline of the various stages of training including stage numbered and brief description of the activity involved at each stage.

Training stage		Stage description	Figure
1	S+ Recognition	Seals trained to "target" S+ stimulus	2a
2	S+ vs. Hand	Seals trained to distinguish S+ from trainer's hand	2b
3	S+ vs. S-	Seals trained to distinguish and identify S+ vs. S- distractors	2c
4	Rig Introduced	Rig introduced to seals on land (full set up) with S+ and S-	2d
5	Underwater Rig	Rig introduced to seals underwater (full set up) with S+ and S- no blindfold	2e
6	Blindfold	Trained blindfold application added to trained tactile tasks (texture, size)	2f

fur seals completed Stages 1-4, exclusively on land, followed by underwater training for Stages 5-6. Conversely, harbour seals preferring water-based training, completed Stages 1-4 at the water's edge, with their front flippers on the beach for stability and body submerged, subsequently, Stages 5-6 were carried out underwater. Blindfold training ran parallel to task training and was also done on the land for the fur seals and at the water's edge for harbour seals, with their front flippers on the beach for stability.

Seals had prior training in behaviours relevant to this study, including daily eye drop training, (which involved covering their eyes), and hoop-catching, a useful prerequisite to blindfold training, as seals were accustomed to objects passing over their face. Seals were previously "target" trained, where they held their nose to an object until given a bridge, usually a whistle to release. For this research, the verbal "choose" cue was trained, prompting the seal to release target from the trainer, search and select a stimulus. During training, if a seal chose incorrectly by targeting the S-, the "choose" cue was repeated ≤3 times to allow another opportunity (no reinforcer). After three unsuccessful attempts, the "no" cue was given (no reinforcer) and the seals

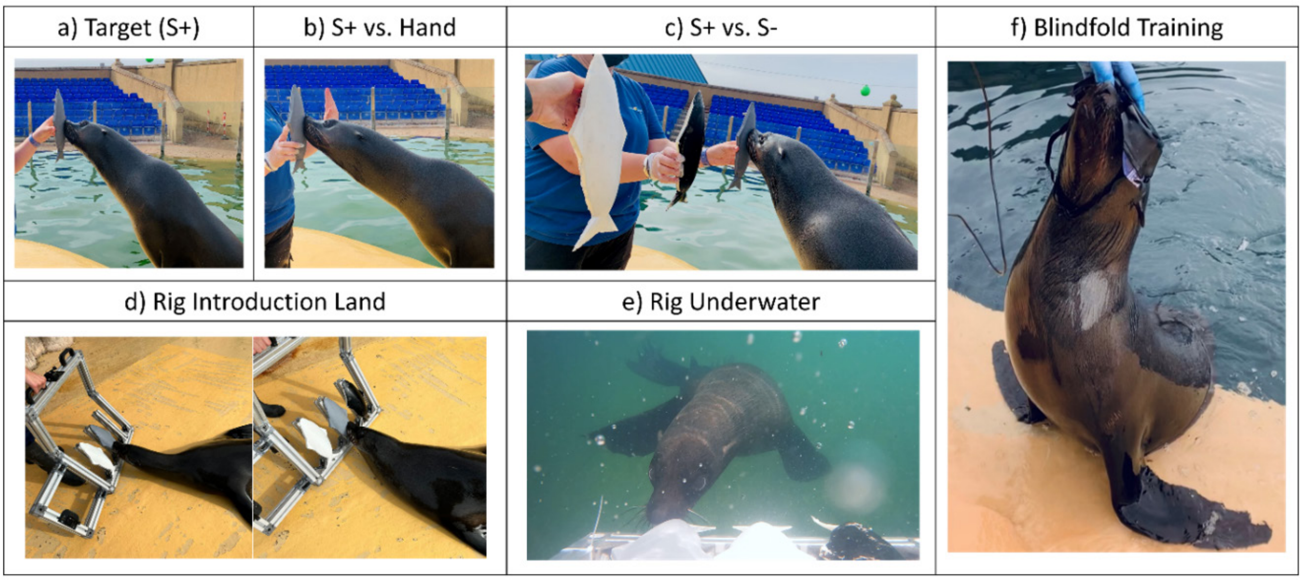

Figure 2. Discrimination task training. a) stationing on the S+; b) discriminating the S+ from the trainer's hand; c) discriminating the S+ from S-; d) rig introduction with stimuli e) underwater introduction, f) blindfold training. Training could take place on land, with the trainer, using the rig, or underwater.

were asked to complete unrelated pre-trained behaviours before retrying. The "no" cue was not explicitly trained; rather the seals were positively reinforced for correct responses. However, upon hearing the "no" cue, seals returned to Trainer 1, (onto the beach for South African fur seals or water's edge for harbour seals). This process was repeated three times, after three retries, Trainer 1 worked on unrelated pre-trained behaviours before returning the seal back to their pen or the opposite pool, ensuring each session ended positively.

We minimised re-cuing, referring to the repeated presentation of a cue when the seal does not respond as expected, by strategically reinforcing desired responses and avoiding reinforcement of prior behaviours controlling for potential effects. The success rate of trials, seals made the correct choice, was recorded. Seals were considered trained on a behaviour when they could consistently perform it correctly, achieving >80% accuracy in three consecutive sessions. A refusal behaviour was defined as the seal using the quick-release mechanism to remove the blindfold, indicating a choice not to wear the blindfold and not participate. If this occurred consecutively three times, the research training session was ended, and the seal was asked to complete unrelated pre-trained behaviour. This behaviour emerged in the South African fur seals during training Stage 6, when beginning to associate the blindfold with the texture task. Occasionally, the seals removed the blindfold but still proceeded to complete the task, which was allowed during training as part of learning, but never reinforced.

Seals were also previously trained a "hold" cue, instructing them to wait in a designated spot. This was particularly useful during the earlier stages, when only one trainer was present, allowing time for the trainer to position the stimuli onto the rig before the seal was cued a behaviour, (Figure 1). Seals underwent acclimatisation to the rig while simultaneously learning to wear the blindfold. Blindfold training began with placing black latex material on and around the seals' body and face gradually progressing to covering their eyes, then introducing the blindfold (Figure 2f). The South African fur seals blindfold was made from child-sized safety goggles covered in black latex material, featuring a resizable chinstrap, quick-release mechanism and leash for easy retrieval by the trainer (Figure 2f). Harbour seals wore a softer, neoprene mask, similar to those used in Grant et al. 2013, again fitted with a resizable chinstrap, quick-release mechanism and leash. The final stage involved all seals wearing the blindfold underwater (Figure 3cd). During training, the trainers used the "choose" cue to prompt the seal to find and target the S+ guiding them underwater with one hand so they could swim towards the rig. The rig was positioned approximately two meters away on the right side allowing the seal to enter the pool from the beach (fur seals) or poolside (harbour seals) where they received the blindfold, and space to fully submerged before approaching the rig.

Data collection

Once the behaviours were deemed learnt for that task (achieved >80% accuracy in three consecutive sessions), data collection

Useful Prerequisites	Pre-Training	Desensitisation	Brightness	Texture	Size
	Eye Covering and Drops Hoop catching	Enrichment	"Target" "Choose"	"Target" "Choose"	"Target" "Choose"
Training Outcome	Blindfold Training	Rig Introduction	Brightness	Texture	Size
Training Stages	• Blindfold Desensitise • Blindfold Placement • Mask Positioning • Underwater Training	• On Land • Underwater	• Target (S+) • S+ vs Hand • S+ vs S- • Land • Underwater	• Target (S+) • S+ vs Hand • S+ vs S- • Land • Underwater • Blindfolded Underwater	• Target (S+) • S+ vs S- • Land • Underwater • Blindfolded Underwater

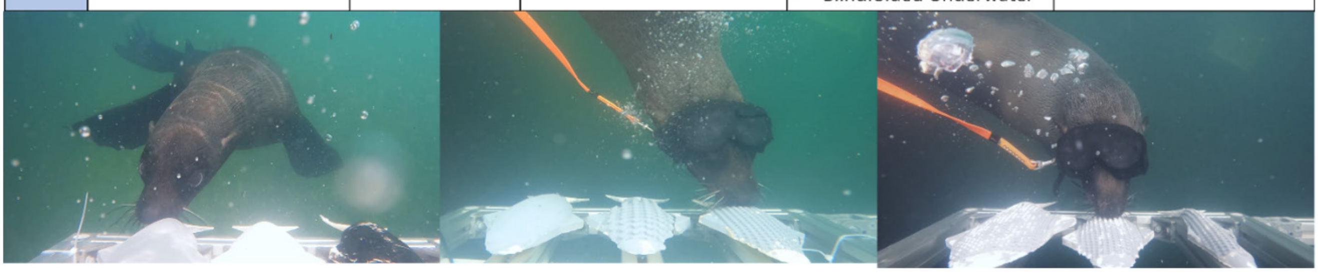

Figure 3. Overall training summary diagram of all aspects of training associated with the discrimination task research. a) Prerequisites were useful behaviours that the seals knew prior to this research. Pre-training tasks were trained concurrently with the brightness task. The brightness task was trained first, followed by texture, then size. Each training outcome was associated with a set of training stages. Seals moved onto the next stage when they achieve >80% correct in three consecutive sessions. b) Blindfold training involved stationing on to a hand; c) Brightness discrimination task; d) Texture discrimination task; e) Size discrimination task. S+ = target stimulus, S- = distractor stimuli

began. During data collection, seals completed ~15 trials per session, with 2-3 sessions per day, totalling ~30 trials per seal. Each trial began with the seal being called by Trainer 1 (either onto the beach for South African fur seals or at the water's edge for harbour seals) and targeting Trainer 1's hand. For tactile tasks, seals were blindfolded at this point to prevent any visual cues, while Trainer 2 repositioned the stimuli. Once the stimuli were arranged, the "choose" cue was given to release the seals, allowing them to search for and target the S+. The length of each trial varied based on the seals search time. During data collection the "choose" cue was only used once to initiate the start of each new trail. A correct trial was defined as the seal holding target on the S+, followed by a bridge and reinforcement. To prevent the seals from anticipating when the bridge would be given, the duration of holding target on their chosen stimuli was varied for 3-5 seconds. Incorrect trials occurred when a seal chose the S- resulting in no bridge, a "no" cue, no reward and the removal of the rig from the water, prompting the seal to return to Trainer 1; (fur seals returned onto the beach while, harbour seals remained at the water's edge, waiting by Trainer 1). After each trial, the task was reset (regardless of choice S+ or S-). Resets included the rig being removed from the water, the seal returning to Trainer 1 and the stimuli positions randomly switched by Trainer 2. Refusal behaviours during data collection were allowed up to three times before ending the research session, the seal was asked to complete unrelated pre-trained behaviours by Trainer 1 before being returned to the other pool.

Consequences

In the brightness task (Figure 3b), all seals encountered the initial S+ for the first time. Since this was their first exposure to any discrimination task, it required more trials to complete compared to subsequent tasks (Supplementary Material Table 1). Indeed, as the seals were trained to 'target' on to the chosen stimuli by holding their nose against its surface, a tactile element was always present across all three tasks. However, during the visual task (brightness), the seals exhibited a clear preference, by swimming directly toward the S+ (>90%), without alternating between the S-. This behaviour suggests they did not depend on tactile cues and upon reaching the stimulus seals remained stationary, indicating vision was likely the primary sense used during the swim-up approach. For the texture and size tasks, the S+ changed (Figure 1, 2cd, 4). Since the size task followed the texture task, all seals were able to identify the S+ with 100% accuracy, as it remained the same from the texture task. Consequently, the texture task involved a greater number of trials due to the change in the S+ from the brightness task (Figure 1, 2, Supplementary Material Table 1). The blindfold was also introduced during the texture task, with blindfold training taking longer compared to other stages (Supplementary Material Table 1).

South African fur seal training

All four South African fur seals began training for this research simultaneously, with blindfolding, rig introduction and brightness training occurring concurrently (Figure 2a, 4). While all South African fur seals became accustomed to the rig, only half of them met the required threshold for data collection. Two of the four seals encountered challenges during training (Table 2, Supplementary Material Table 1). Nelly could reliably discriminate between the S+ and S-. However, after selecting the S+ three times consecutively, she would refuse to continue with further trials, sitting on the beach, resulting in the lowest number of sessions (Table 2, Supplementary Material Figure 1). Nelly participated in the brightness task and part of the texture task, but it was decided she would not proceed with other training (Table 2, Supplementary Material Figure 1). Flo could not successfully complete the texture task due to a strong right-hand bias, despite various training techniques attempted to overcome this (Table 2, Supplementary Material Figure 1). A similar bias was observed in the study by Milne et al. (2021).

Training was therefore stopped before Flo could successfully complete the texture training. Gina and Bubbles met the required criteria (>80% accuracy) to be considered successful, for all three discrimination tasks, over a period of 19 months (Table 2, Figure 4). Overall, Gina took the longest to learn the texture task. Specifically, Stage 6: underwater blindfold training, required the most trials during both the texture (180) and size tasks (130), (Figure 4bc). Bubbles also took the longest to learn the texture task, with the most trails in training stage in Stage 6 too, in both the texture, (160) and size task (130), (Figure 4ef). Gina and Bubbles both successfully completed all aspects of training for all three discrimination tasks and proceeded to data collection.

Table 2. Training progress for each pinniped. The X indicates complete training (>80% correct over three consecutive sessions). Dashes correspond to where training started but did not reach the threshold or could not be completed. Abbreviations: NBF (not blindfolded), BF (blindfolded).

Pinniped species	Seal	Rig introduction	Blindfold task	Brightness task	Texture task		Size task	
					NBF	BF	NBF	BF
South American fur seals	Bubbles	X	X	X	X	X	X	X
	Gina	X	X	X	X	X	X	X
	Flo	X	X	X	X	-	-	-
	Nelly	X	X	X	X	X	-	-
Harbour seals	Ina	X	X	X	X	X	-	-
	Pamina	X	X	X	X	X	-	-

Harbour seal training

Ina and Pamina, completed the training for blindfold, rig introduction and brightness task, occurring concurrently (Table 2, Figure 2a). Despite becoming accustomed to the rig and wearing the blindfold, both encountered difficulties combining these two aspects (Table 2, Supplementary Material Figure 1). Pamina reliably discriminated the S+ during the brightness task and reached the required threshold for completing all aspects of training, for all three discrimination tasks (Figure 5a). Although Ina met the threshold and participated in the brightness task, her success rate fluctuated, dropping considerably across all stages (Figure 5a). Both participated in the training for the texture task, successfully learning to wear the blindfold and the task. However, they were unable to complete the training, reaching only Stage 5, underwater without the blindfold. (Figure 4cd, 5). Ina took the most trials to complete both the brightness and texture tasks (Figure 5cd). Ina needed more trials than Pamina to differentiate between the S+ and S- underwater during the texture task (Figure 5, Stage 5). In the brightness task, Pamina was quicker to learn Stages 1-4, (200 trials) compared to Ina (235 trials). However, both seals needed the most trials for Stage 5 underwater task training without the blindfold, in the brightness task (Figure 5c). Both Harbour seals completed all aspects of training for the brightness tasks only.

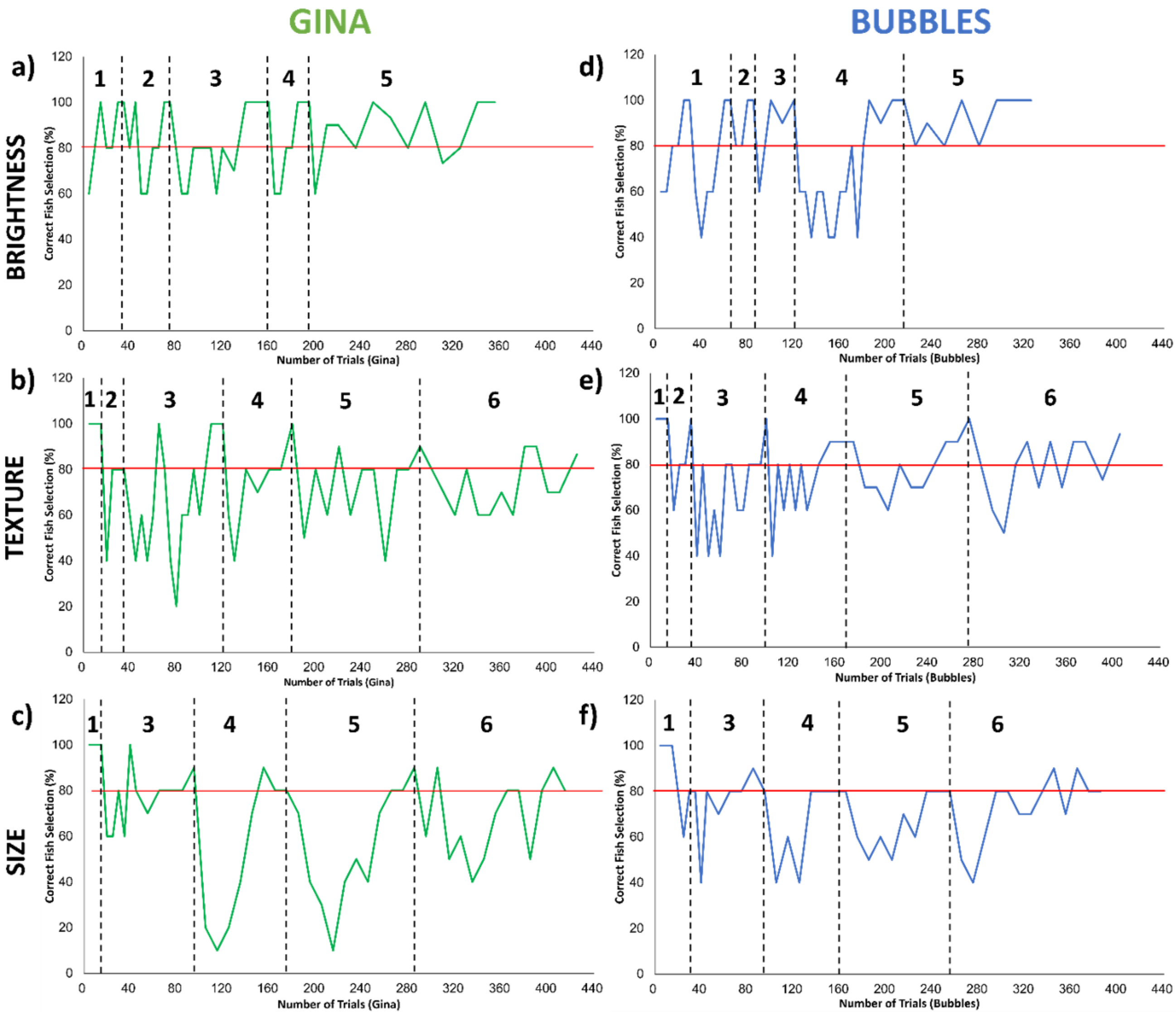

Figure 4. The South African fur seal's complete training curves for the discrimination tasks. Training of each stage was complete when the seals achieved >80% correct over three consecutive sessions a) Gina Brightness Task, b) Gina Texture Task; c) Gina Size Task; d) Bubbles Brightness Task; e) Bubbles Texture Task and f) Bubbles Size Task. Training stages were as follows 1) S+, 2) S+ vs. Hand, 3) S+ vs. S-, 4) Fish Rig on Land, 5) Fish Rig Underwater and 6) Blindfold Complete Task.

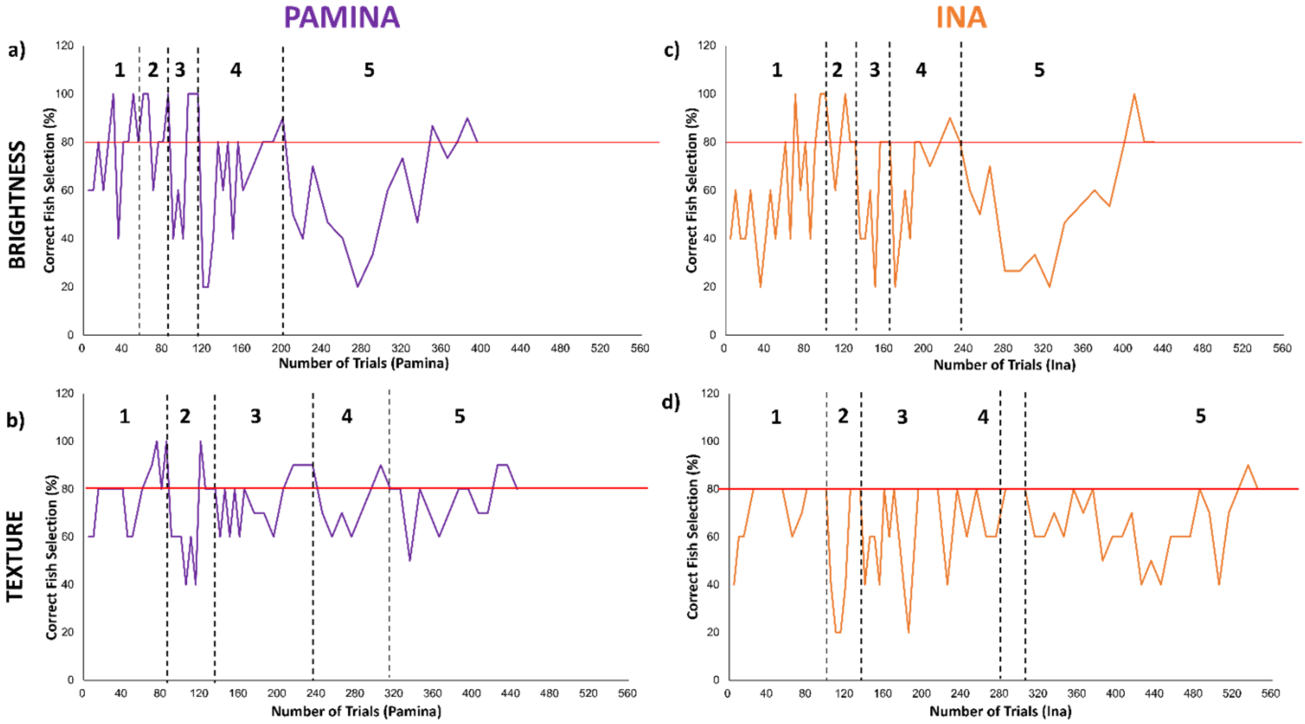

Figure 5. The Harbour seal's training curves for the brightness and texture discrimination tasks. Training of each stage was complete when the seals achieved >80% correct over three consecutive sessions a) Pamina Brightness Task, b) Pamina Texture Task, c) Ina Brightness Task and d) Ina Texture Task. Training stages were as follows 1) Target, 2) Target vs. Hand, 3) Target vs. Distractor, 4) Fish Rig on Land, 5) Fish Rig Underwater.

Conclusion

Here we demonstrate trained pinnipeds can adapt existing behaviours to accomplish a series of complex tasks for behavioural research. Although individuals competently completed training stages, they encountered difficulties, particularly when blindfolded. Each seal took varying amounts of time to complete the training stages, reflecting individual challenges and diversity. This aligns with previous research on seal behaviour and personality (Ward and Melfi 2013; Vere et al. 2017). While most training usually employs visual and auditory stimuli (Brando 2010), we suggest incorporating tactile stimuli could provide valuable cues for tactile specialists like pinnipeds (Milne and Grant 2014; Milne et al. 2020). Developing studies of this nature can enhance the impact of zoo research by establishing collaborations with academic researchers and conducting fundamental research. Presenting research to the public is inspiring and improves visitor experiences and perception (Anderson et al. 2003). However, implementing intensive research interventions may pose challenges for institutions with resource constraints. While it is possible to train complex and controlled research tasks, this highlights the time-consuming nature of the work, the need for multiple trainers and the complexity of balancing research alongside daily zoo activities. Institutions that are already committed to developing training protocols and prioritising research stand to benefit most from similar research programmes if they have sufficient staff support. Once established, such training protocols can facilitate various impactful research endeavors, especially in the field of controlled behavioural experiments.

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