JZAR JOURNAL OF ZOO AND AQUARIUM RESEARCH
www.jzar.org



Research article

# Pre and post session behaviour of captive bottlenose dolphins *Tursiops truncatus* involved in "Swim-with-Dolphin" events

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**Keywords:** animal welfare; human-animal interaction; swim-with-dolphin; *Tursiops truncatus*.

**Article history:**
Received: 21 Jan 2019
Accepted: 14 Oct 2019
Published online: 31 Oct 2019

## Abstract

Published studies suggest that some dolphins find swim-with-dolphin (SWD) sessions enriching or are hardly affected by them, while others find this stressful. In this study we investigated whether there are behavioural changes in dolphins after controlled SWD sessions in comparison with periods immediately before the session or at times when no session is due; and whether these behavioural changes indicate enhanced or reduced welfare. The study was undertaken at Dolphin Academy in Curaçao, Netherlands Antilles, between May and June 2017. Thirteen dolphins were subjects, four male and nine females with ages ranging from 4yrs to 32yrs. Observations of dolphins took place in any of the five semi-open water pools and consisted of 30-minute focal animal sessions. These were timed to occur during the 30 minutes immediately before the start of a scheduled SWD session ('before'), during the 30 minutes immediately following the same session ('after'), and during a 30-minute period when the animal was not about to be part of a session or had not just finished a session ('control'). Sessions for observation were chosen opportunistically according to the timetable used by the facility. Two ethograms were used, one for state behaviours and one for event behaviours. A total of 184 30-minute observations periods were completed, divided between the three different conditions. A minimum of six before-after pairs was possible for all subjects except one dolphin. Multiple regression produced significant models for several behaviours, but the significant predictors were mostly the pool in which observations occurred or the presence of disturbance or trainers, but not condition. It appears in our study that the welfare of the dolphins was neither compromised nor improved by taking part in the SWD sessions. There is no evidence in our data that taking part in a SWD session in itself has any impact on the behaviour of the dolphins, but that in all conditions (before, after and control) they spend time responding to the presence of trainers or disturbance, both in their own pool and in neighbouring pools. Further research should address the question whether the effects of disturbances and the presence of trainers are compromising or improving the welfare of the dolphins, and whether the increased interaction with trainers due to the SWD sessions is itself enriching for the animals.

## Introduction

The common bottlenose dolphin (*Tursiops truncatus*) is a familiar and widely distributed species of cetacean, occurring worldwide in temperate and tropical waters, especially near coasts and over continental shelves (Wang et al. 2014). It is the most frequently kept cetacean in captivity, with over 200 individuals held in 23 different institutions registered with Species360, the zoo and aquarium record keeping system (Species360 2014), and an unknown number held in research facilities or aquariums not registered with this system. Both in the wild and in captivity, encounters between dolphins and people are common, giving many opportunities for human-animal interactions (HAIs).

Historically, from classical antiquity through to modern times, the popular belief has developed that dolphins have some sort of affinity with humans, and seek them out because they enjoy interacting with them (Montagu 2003). The reality, however, is that while some wild-living dolphins undoubtedly have voluntarily chosen to associate and interact with people (e.g. Eisfeld et al. 2010; Lockyer 1990), these interaction events are uncommon and involve just a very small number of individual animals and are certainly not typical for the species (Wursig and Wursig 2003). On the contrary, many wild populations are increasingly being subjected to increased tourist pressure from dolphin-watching boats, and their responses to these boats are often negative. These responses include a decrease in resting

and increase in milling, that is, frequent changes of direction (Constantine et al. 2004); avoidance by diving and spending more time underwater (Lusseau 2003); and changes in both duration and frequency of behaviours such as resting, feeding and travelling (Arcangeli and Crosti 2009). In the long term there may be decreases in dolphin abundance as tour boat numbers increase (Bejder et al. 2006). Dolphins may also suffer injury and death as a result of being struck by tour boats (Lusseau et al. 2006). The evidence suggests that dolphins largely ignore recreational or commercial boats that pass through the area, but are adversely affected by boats that pursue them (Acevedo 1991; Constantine et al. 2004; Orams 2004).

All of this suggests that human attempts to interact with wild-living dolphins are generally aversive to the animals, though sometimes they may habituate to certain kinds of contact, and a small number of individuals may respond positively. This, then, raises questions about the effect of contact with humans experienced by captive dolphins, and to what extent it changes their behaviour and ultimately in which ways it affects their welfare. Many of the facilities that keep dolphins involve the animals in interactive events, such as shows, feeding and touching by the public, swim-with-dolphin programs, and dolphin-assisted therapy. In all of these events there is close contact between dolphins and trainers, resulting in extensive interaction between them and the consequent likelihood of the development of human-animal relationships (HARs) between particular dolphin-trainer dyads. There is some evidence that the welfare of zoo-housed animals can be improved by the development of positive HARs between animals and their keepers (Hosey and Melfi 2012, 2014; Ward and Melfi 2013). Quantitative empirical data on HARs with dolphins are lacking, but it has been suggested that training enhances the welfare of these animals, not only because it improves husbandry by encouraging voluntary participation of animals in husbandry procedures, but also because it promotes the development of positive HARs between the dolphins and their trainers (Brando 2010, 2012). Blood cortisol levels in harbour porpoise (*Phocoena phocoena*) were significantly reduced if the animals were trained to participate in in-water blood sampling, compared to the levels in the same animals when they were removed from the water and the sample taken on land (Desportes et al. 2007).

Interactive events where the animals are in contact with members of the public are probably less positive for the animals (Hosey 2008), because there are few, if any, opportunities for positive HARs to be built. The mere presence of members of the public is usually either negative (i.e. the animal responds by avoidance or aggression; e.g. little penguins: Sherwen et al. 2015), or neutral (i.e. the animal ignores) for many zoo-housed animals, with very few showing behaviours which indicate that the contact is positive or enriching for them (Hosey 2000). The precise way in which animals in zoos respond to unfamiliar people is influenced by the species of animal and its past history of HAIs, features of its enclosure, and the behaviour of the people, and probably also by personality or individual differences in the animals (Carlstead 2009; Hosey 2013). Animals that are well trained, and where contact with unknown people has been appropriately and positively habituated and generalised, can experience positive, and engage in novel, opportunities (e.g. husbandry care and human-animal interactions; dolphins: Neto et al. 2016; giraffe: Calle et al. 1988). It is possible, then, that involvement of animals in interactive events may help overcome their fear of, and aversion to, unfamiliar people, and hence enhance their welfare. This may happen because the training process for interactive events is itself enriching (Savastano et al. 2003), because participation in the event is enriching (Miller et al. 2011), because it enables the animals to experience repeated positive interactions with unfamiliar people, and hence reduces their aversion to people (Hosey 2013); or, indeed, all of those.

All three of these (i.e. training, an event, and opportunities for interaction with unfamiliar people) occur together in "swim-with-dolphin" (SWD) interactive events. Monitoring SWD events reveals little about the enriching properties of the training programme, but should inform on whether participating in the event and having opportunities for HAI are enriching for the dolphins, or conversely whether they are stressful and hence reduce welfare. Evidence from tourists' attempts to swim with wild dolphins suggest that it is disruptive for the animals' behaviour, and not particularly welcomed by them. At Bay of Islands, New Zealand, avoidance responses of dolphins to swimmers increased from 22% to 31% between 1994–1995 and 1997–1998 (Constantine 2001). In this study, it was estimated that the average dolphin was exposed to 31 swim attempts per year, and with that level of exposure were becoming sensitised to swim attempts. Of 89 dolphins studied at Panama City Beach, Florida, only seven permitted people to swim nearby (Samuels and Bejder 2004). In Gulf St Vincent, South Australia, dolphins significantly changed their behaviour in response to swimmers, particularly by increased milling, which suggests that the animals frequently interrupt more important behaviours (Peters et al. 2013).

Studies of SWD events with captive cetaceans have been less clear. These events differ in whether trainers are present to regulate interactions with swimmers (controlled) or not (uncontrolled), and whether they involve species other than *Tursiops truncatus.* Common dolphins (*Delphinus delphis*) in uncontrolled SWD sessions used a refuge significantly more within SWD sessions than when swimmers were not present (Kyngdon et al. 2003). However, the authors of that study suggested that it was due to reduced space in the part of the pool shared with swimmers rather than to avoidance by the dolphins. Their conclusion was that the animals' welfare was not compromised by the SWD sessions, which was also the conclusion of a study of Indo-Pacific humpback dolphins (*Sousa chinensis*) before and after controlled SWD events (Sew and Todd 2013). While the dolphins increased the use of the refuge or did not appear to find the events stressful, both studies lack data on which to base these conclusions. A study of three bottlenose dolphins, again before and after a controlled SWD event, found an increase in play behaviour in the dolphins after the events, again suggesting that the events were not detrimental to the animals' welfare (Trone et al. 2005). A larger study (Brensing et al. 2005) observed dolphins at two different facilities during uncontrolled SWD sessions that were part of a Dolphin Assisted Therapy programme. They found that the dolphins at one facility showed behaviours (avoidance, speed increase, intensification of subgroup) that indicated that the animals found the events stressful, whereas those at the other facility appeared to be attracted to the swimmers. In a comparison of controlled versus uncontrolled SWD sessions, Samuels and Spradlin (1995) found that well described high-risk interactions (agonistic and sexual) occurred frequently in uncontrolled sessions, but hardly at all in controlled sessions. Most of the interactive behaviours that take place in SWD events are actions that have been signalled by trainers and then reinforced (Frohoff and Packard 1995), which limits the usefulness of observations made within the SWD session in understanding how these sessions affect the dolphins.

This study investigated changes in behaviour of dolphins after controlled SWD sessions, as was done by Trone et al. (2005), but using a larger sample size, since they urged caution in interpreting their results, which were from just three animals. The published studies reviewed above suggest that some dolphins find SWD enriching or are hardly affected by it, while others find the event stressful. This may be because of differences in the conduct of the sessions, amount of training received for session participation,

**Table 1.** Sex, age and origin of the dolphins involved in the study, along with the number of 30-minute observation sessions in which they were observed.

| Animal | Sex | Age | Origin | No of 'before' sessions | No of 'after' sessions | No of 'control' sessions |
|---|---|---|---|---|---|---|
| Annie | f | 20 | wild caught | 6 | 6 | 3 |
| Caiyo | m | 13 | wild caught | 6 | 6 | 3 |
| DeeDee | f | 21 | wild caught | 6 | 6 | 3 |
| GeeGee | f | 33 | wild caught | 6 | 6 | 1 |
| Kayena | f | 8 | captive born | 6 | 6 | 3 |
| Machu | m | 5 | captive born | 6 | 6 | 3 |
| Pasku | m | 7 | captive born | 6 | 6 | 3 |
| Renata | f | 16 | wild caught | 7 | 7 | 3 |
| Ritina | f | 13 | wild caught | 7 | 6 | 2 |
| Romeo | m | 13 | wild caught | 6 | 6 | 3 |
| Roxette | f | 13 | wild caught | 1 | 1 | 2 |
| Serena | f | 5 | captive born | 6 | 6 | 3 |
| Tela | f | 16 | captive born | 6 | 6 | 2 |

and/or may be due to individual differences in the animals. This study investigates whether there are behavioural changes in dolphins after controlled SWD sessions in comparison with periods immediately before the session or at times when no session is due; whether these behavioural changes indicate enhanced or reduced welfare; and to what extent dolphin responses are the consequence of individual differences in the animals.

## Materials and methods

The study was undertaken at Dolphin Academy in Curaçao, Netherlands Antilles, between May and June 2017.

### *Subjects*

Thirteen dolphins were subjects, four males and nine females (Table 1). Ages of the animals ranged from 5 to 33 years. Five were captive born, the remainder were wild-caught.

### *Housing and husbandry*

Observations of dolphins took place in any of five possible pools; the locations of the individual animals in the pools were mainly stable, with few changes between pools, maintaining original social groups. Pools varied in size from 20x25m to 50x40m, with depths ranging between 3m and 6m. All pools were connected to the open ocean and thus had constant influx of fresh ocean water and any small living creatures that were in the water. All pools were natural shaped, with sand/rock bottoms and rock sides. Various sea animals lived inside the pools, ranging from a variety of fish to moray eels and small shrimp. Two of the pools offered access to the open ocean through underwater channels and gates. Both contained a submerged platform. The main pool contained two floating platforms. Of the remaining pools, one contained a floating platform; the other, which was more triangular shaped, contained two floating platforms as well as a submerged platform. These platforms were used by the trainers and customers to access the animals and/or enter the water. All pools were separated by netting and connected by gates.

Eight of the dolphins were trained to go out under supervision into the open ocean, and other, younger dolphins were in the process of being trained for this. The facility attempted to take trained dolphins out regularly, a session that lasted anywhere between 15 minutes to a full hour. Two animals were taken out for a scuba dive, snorkel, presentation, dolphin trip, or simply for racing around and exploring the surroundings.

Feeding sessions took place 5–6 times per day, varying slightly between 08:30 and 16:30, spaced between the SWD sessions.

### *Interactive events*

There were three interactive program sessions (i.e. SWD sessions) and three show sessions daily, and the planning was such that dolphins always had one session 'off' a day. Session length could range anywhere from 5 minutes to about an hour. Each session was also a training session, even when it was an interactive event. This means that on average, trainers spent around 4–5 hours a day with the dolphins.

Visitors involved in SWD sessions received an informative briefing before entering the water and they were only allowed to touch the sides, back or belly of the dolphins, not near or in the facial area. Visitors were not allowed to feed animals. There was also an opportunity for a 'show kiss' after the dolphin training demonstration, where people could receive a kiss on their cheek and a short opportunity to pet. The SWD sessions were managed by the trainers who tried to make the sessions as engaging and fun for the animals as possible, varying with different behaviours in the animal's repertoire, fast and slow, different amounts and types of reinforcements, and different locations around the pool. When dolphins did not want to participate, they were never forced to do so and could leave the session.

**Table 2.** Event behaviours observed during 30-minute all-occurrence observations. Events listed in Roman type are defined in Miller et al. (2011). Events listed in italic were observed in this study, but are not part of the ethogram in Miller et al. (2011). They are defined in Table 3.

| Category | Event behaviours included |
|---|---|
| Aggressive (AG) | Biting; Chin slapping; Jaw clapping; Open mouth; Pec slapping; Ramming individual; Tail slapping individual;; Teeth raking; *patrol; hanging belly-up; ventral upstation; head breech.* |
| Affiliative (AF) | Copulation; Group social ball; Nuzzling; Rubbing; Teething; *Social rub.* |
| High Energy (HE) | Breech; Jump/leap; Porpoising; Barrel roll; Corkscrew; Chase. |
| Repetitive (RP) | Circle swimming. |
| Other (OT) | Fluke-in dive; Fluke-out dive; Spy hop; Fast swim; Ventral swim; Side swim; Fluke out; Play with object; Bubbles; Chase fish; Chuffing; *Looking; Back flip; Dive; Drift; Breath hold; Wave machine; watch tv; hanging; station underwater* |

***Procedure***

Observations of dolphin behaviour took place during 30-minute focal animal sessions. These were timed to occur during the 30 minutes immediately before the start of a scheduled SWD session ('before'), during the 30 minutes immediately following the same session ('after'), and during a 30-minute period when the animal was not about to be part of a session, or had not just finished a session ('control'). 'After' is defined as the immediate 30-minute period after the session ended. Sessions for observation were chosen opportunistically according to the timetable used by the facility, but as far as possible were counterbalanced across conditions. Generally, the sessions were at about 08:30, 11:30, 13:30 and 16:00, but often started a few minutes later than scheduled times. Two ethograms were used, one for state behaviours and one for event behaviours. These were the same ethograms that were devised and used by Miller et al. (2011). State behaviours included: feed (pursuing or feeding on fish), social (physical contact with or orientation towards another dolphin), travel/swim (moving in one direction), rest (moving slowly or drifting in one direction), play (with other dolphins or with objects), repetitive (any repetitive behaviour), and other (behaviours which did not fit with any of those categories). Full definitions of these are given in Miller et al. (2011). State behaviours were collected by scan sampling, with scans at 1-minute intervals. If a dolphin was not visible at a scan, they were scored as 'out-of-sight'. Event behaviours were very short duration behaviours; Miller et al. (2011) defined and listed 32 of these, which they classified into five categories: aggressive (AG), affiliative (AF), high energy (HE), repetitive (RP) and other (OT). These are listed in Table 2; full definitions of individual event behaviours are given in Miller et al. (2011). During the course of this study, a number of additional event behaviours were observed which were not listed in Miller et al.'s (2011) ethogram. These are listed and defined in Table 3.

A total of 184 30-min observation periods were completed, divided between the three different conditions (Table 1). A minimum of six before–after pairs was possible for all subjects except for one individual, 'Roxette', who was, nevertheless, included in the analysis. Fewer control sessions were possible because of difficulties in scheduling these within the time available, but three were possible for most animals. Observations were made from a high vantage point from which the whole pool was visible, but which was not close enough for the observer to

**Table 3.** Definitions of event behaviours which were seen in this study which were not part of the ethogram published by Miller et al. (2011).

| Event Behaviour | Behavioural Category | Definition |
|---|---|---|
| Hanging | OT | The dolphin is stationed in front of the gate with the upper part of its head above the water while facing the environment outside the pool |
| Patrol | AG | The dolphin swims back and forth in front of the gate |
| Hanging belly-up | AG | The dolphin is stationed at the water surface in front of the gate with its belly up while facing the environment outside the pool |
| Ventral upstation | AG | The dolphin is stationed in front of the gate with its body completely underwater and its belly up while facing the environment outside the pool |
| Station underwater | OT | The dolphin is stationed in front of the gate with its body completely underwater while facing the environment outside the pool |
| Head breech | AG | The dolphin slaps the water surface with the underpart of the head. |
| Social rub | AF | The dolphin touches another dolphin with the pectoral fin or other body part. |
| Looking | OT | The dolphin tilts its head to one side and scans the environment with one eye |
| Watch TV | OT | The dolphin hangs still underwater watching through the net what is happening on the other side. |
| Back flip | OT | The dolphin jumps backwards out of the water and clears the surface completely |
| Dive | OT | The dolphin dives down without lifting the fluke |
| Drift | OT | The dolphin lays at the water surface and floats |
| Breath hold | OT | The dolphin stays laying on the bottom without moving |
| Wave machine | OT | The dolphin plays with the waves coming over the edge of the pool e.g. half breeching, spy hopping |

**Table 4.** Mean (±SE) proportion of scans for state behaviours shown by dolphins before and after SWD sessions, and in control periods.

| Behaviour | Mean±SE proportion of scans | | | Significance |
|---|---|---|---|---|
| | Before SWD | After SWD | Control | |
| Social | 0.20±0.03 | 0.20±0.03 | 0.16±0.04 | ns |
| Travel | 0.47±0.03 | 0.45±0.04 | 0.44±0.03 | ns |
| Rest | 0.05±0.03 | 0.12±0.05 | 0.05±0.02 | ns |
| Play | 0.06±0.02 | 0.04±0.02 | 0.05±0.03 | ns |
| Repetitive | 0.01±0.002 | 0.01±0.004 | 0.02±0.01 | ns |
| Other | 0.24±0.03 | 0.19±0.04 | 0.28±0.04 | P=0.02 |

**Table 5.** Mean (±SE) rates per minute of behavioural event categories for dolphins before and after SWD sessions, and during control periods.

| Event category | Mean±SE rate per minute | | | Significance |
|---|---|---|---|---|
| | Before SWD | After SWD | Control | |
| HE | 0.08±0.03 | 0.13±0.05 | 0.12±0.05 | ns |
| OT | 0.75±0.09 | 0.57±0.07 | 0.92±0.14 | p=0.004 |
| AG | 0.06±0.02 | 0.06±0.02 | 0.07±0.03 | ns |
| AF | 0.10±0.02 | 0.08±0.02 | 0.09±0.02 | ns |
| DIV | 3.78±0.24 | 3.45±0.29 | 4.53±0.39 | ns |
| Other | 0.24±0.03 | 0.19±0.04 | 0.28±0.04 | P=0.02 |

be able to interact with the dolphins. Observations were made by SB and NK. For two sessions, both observers made observations in order to determine inter-observer reliability. As well as the behaviours in the ethogram, observers also recorded which pool the session was observed in; whether or not trainers were present for any part of the session (even if they were not interacting with the animals); and whether any disturbance took place before or after the session (e.g. members of the public walking past, or work being undertaken in neighbouring pools).

***Data analysis***

For state behaviours, each state within each 30-minute observation period was expressed as a proportion (out of 30) of scans in which the state was observed. If fewer than 30 scans were completed (either because some were listed as 'out-of-sight', or because the scheduled SWD session started a couple of minutes early), they were expressed as a proportion of total visible scans. For each animal, proportions for each state were averaged across all trials within each condition, and these means were used in subsequent analyses. For event behaviours, the events were grouped into the categories shown in Table 2, and a mean rate per minute for that category calculated for each animal across all trials for each condition. These mean rates were used in subsequent analyses. Following Miller et al. (2011), behavioural diversity was also calculated by totalling the number of different behavioural events for each individual in each observation period, excluding AG and AF (because they required another dolphin present to be expressed) and RP (because it was a potential welfare indicator).

None of the data for behavioural states or behavioural events were normally distributed, and square root transformation failed to normalise the data, so comparisons between conditions were performed with Friedman's related measures ANOVA. If this gave a significant result, two related-samples Wilcoxon tests were used post hoc to determine the source of the difference. Bonferroni correction was applied to the post hoc tests, so the alpha level for a significant difference was set at 0.01. Multiple regression was carried out using the behaviours in each behavioural category as dependent variables, with dolphin identity (subject), pool, session condition ('before', 'after' or 'control'), presence of trainers, and presence of disturbance as possible predictors. Multiple regression is compatible with non-normal data (Osborne and Waters 2002; Lumley et al. 2002). All analyses were carried out using SPSS version 20.

## Results

***Inter-observer reliability***

Scores of the two observers in the two inter-observer reliability trials were highly correlated (r=0.776, P<0.01 for Trial 1, r=0.928, P<0.001 for Trial 2, both 9 d.f.), indicating high agreement between observers.

***State behaviours***

Mean proportions for state behaviours of dolphins before and after SWD, and during control periods, are shown in Table 4. There were no significant differences between conditions for any behaviour categories except *other* (Friedman test, $\chi^2$=7.96, df=2, n=13, P=0.02). Post hoc pairwise comparisons showed that this was due to a significant difference between 'after' and 'control' (Wilcoxon test, Z=2.49, P=0.01), with 'after' proportions being significantly less than 'control'. There was no significant difference between 'before' and 'after' SWD, or between 'before' and 'control'. Across all conditions there were significant individual differences in all state behaviours except *repetitive* (Kruskal Wallis tests, all df=13, social: $\chi^2$=59.97, P<0.001; play: $\chi^2$=51.1, P<0.001; travel: $\chi^2$=47.27, P<0.001; rest: $\chi^2$=51.88, P<0.001).

***Event behaviours***

Mean rates of behaviour of dolphins for the different event categories are shown in Table 5. There were no significant differences between conditions for any event categories except OT (Friedman test, $\chi^2$=11.23, df=2, n=13, P=0.004). Post hoc pairwise comparisons showed that this was due to differences between 'control' and 'after' (Wilcoxon test, Z=-2.66, P=0.008), but not between 'before' and 'control', or 'before' and 'after'. Further analysis of those individual behaviours within OT for which there were sufficient data showed that no single behaviour was responsible for this difference.

***Predictor variables***

All state behaviours were significant in multiple regression models except *Rest,* and all event behaviours except AF. The strongest model was for OT event behaviours (F(5, 180)=12.401, P<0.001, $R_2$=0.256), which accounted for nearly 26% of the variance, and where the significant predictors were pool and disturbance. The most frequent OT behaviours were ventral swim, looking, side swim and fluke-in dive. These each gave significant but weak

**Table 6.** Summary of significant predictors for state and event behaviours resulting from significant regression models. Asterisks denote significant predictors.

| | | $R^2$ | Predictors | | | | |
|---|---|---|---|---|---|---|---|
| | | | Subject | Pool | Condition | Trainers | Disturbance |
| Diversity | HE | 10.3 | * | | | | |
| | AG | 9.4 | | * | | | |
| | AF | not sig | | | | | |
| | OT | 25.6 | | * | | | * |
| | Diversity | 10.1 | | | | * | |
| States | Social | 12.0 | | * | | * | * |
| | Travel | 13.3 | | | | | * |
| | Rest | not sig | | | | | |
| | Play | 9.4 | * | | | | |
| | Repetitive | 7.7 | | * | | | |
| | Other | 9.4 | | | | * | |

regression models. Regression models for the other behaviours, while weaker in explanatory power, were nonetheless significant (with the exception of *rest* and AF). Significant predictors across all the models are summarised in Table 6. They show that condition was not a significant predictor for any behaviour, whereas pool, trainers and disturbance between them accounted for the variation in most of the behaviours.

## Discussion

### *Variables affecting changes in behaviour*

The results presented here suggest that, while some dolphin behaviours do change when they are involved in SWD sessions, the changes are not caused by the session of SWD itself. Instead, it appears that before or after the session, the presence of trainers (even if only for short periods), the occurrence of some kind of disturbance in or around the pool, or the particular pool that the dolphin is in, are responsible for most of the changes observed in the dolphins' behaviour. This is particularly evident for OT event behaviours, which suggests that the dolphins were very attentive to events happening outside the pool and show what appears to be a mixture of vigilance and anticipation. 'Pool' was a significant predictor for four of the behavioural categories, probably because of a close relationship between this variable and the variables of disturbance and presence of trainers. One of the pools was close to the trainers' facilities and the aquarium entrance, while other pools were close to public walkways, or had areas which were not accessible to the public. Therefore, it is likely that differences in behaviour due to different pools reflected differential disturbance by the public or presence of trainers when observations were being carried out. It is, however, possible that the group composition of dolphins within the pool at the time of observation also influenced behaviour, though there are no data to test this.

Anticipatory behaviours were found in a group of bottlenose dolphins at Parc Asterix prior to scheduled shows (Jensen et al. 2013). These consisted of the animals decreasing their activity levels, spending more time at the surface, moving towards the starting point of a session, and becoming more alert to trainers and their activities around the pool. In that study, shows occurred on a fixed schedule with little variation in starting times. In the present study, starting times of sessions were mainly predictable, though the session in which an animal participated varied from day to day. Thus, arguably, in the present study, the animals may have been particularly attentive to cues that could indicate to them the imminence of a session, even if they did not always receive a session but the activities were around or near the pool that had the session 'off'. Anticipatory behaviours were also reported in one of three Indo-Pacific humpback dolphins (*Sousa chinensis*) at a facility in Singapore (Sew and Todd 2013), in this case before a SWD session. Bottlenose dolphins have also been shown to demonstrate increased anticipatory behaviours prior to training sessions (Clegg et al. 2017a). More recently, Clegg et al. (2018) have shown that dolphins show more anticipatory behaviour before the opportunity to interact with trainers than they do with the provision of toys, and that this correlates with the amount of participation in the following event. This supports the possibility that interaction with trainers is itself enriching; this appears to be the case in the present study. However, it is possible that a dependency on the trainers as the only source of food could be the main driver of the focus and attention to the trainer (Brando 2010, 2018), and this warrants further investigation.

Few changes in dolphin behaviour as a result of taking part in controlled SWD sessions have been reported in the literature. In the study by Trone et al. (2005), which used only three animals, play increased after an interaction session. Only one of the three *Sousa* dolphins studied by Sew and Todd (2013) showed any difference in behaviour (stationary behaviour decreased) after the SWD session. More changes in behaviour seem to occur during unstructured SWD sessions compared to structured sessions (Brensing et al. 2005; Samuels and Spradlin 1995). Thus, it can be argued that SWD sessions in the present study had no effect on dolphin behaviour, apart from anticipatory behaviours, because

the SWD sessions were controlled but not temporally predictable due to the 'off sessions' the animals were given on a daily basis.

***Welfare indicators***

The question remains as to whether the dolphins find the SWD sessions aversive or enriching. Several behavioural indicators of welfare have been suggested for dolphins. Commonly used positive indicators, suggestive of enhanced welfare, include play (Clegg et al. 2017b) and behavioural diversity (Miller et al. 2011). Negative indicators, suggestive of impaired welfare, include abnormal behaviours such as stereotypic circular swimming (Clegg et al. 2017b), which may occur more in expectation of feeding or training (Gygaz 1993), and a potentially alternative explanation on the increased use of a refuge area (Trone et al. 2005).

In this study, repetitive behaviours only occurred rarely, and were observed in just 18 of the observation sessions, resulting in a very low scan frequency (Table 4). Play was more frequent, but still only occurred in 24% of observation sessions. Thus, two important indicators of negative and positive welfare, respectively, occurred infrequently in the data, and showed no significant changes with condition. A third indicator, behavioural diversity, gave somewhat ambiguous results. Although the Friedman's comparison showed no significant differences in behavioural diversity across the three conditions, the significance level was 0.056, with post hoc tests showing both 'after' and 'before' being significantly lower than control. If participation in SWD sessions was enriching for the dolphins, it would be expected for behavioural diversity to increase after a session, but it is difficult to interpret the weak significance level in terms of the welfare of the animals.

It has been suggested that a rewarding relationship with trainers, as evidenced by taking notice of trainers, is positive for dolphin welfare (Brando 2010), and that frequent interaction with trainers at unscheduled times is enriching for the animals (Galhardo et al. 1996). The increased attention that the dolphins in the present study paid when trainers, or activities which could signal the imminent arrival of trainers, were present, is consistent with this suggestion, and also accords with the increased anticipatory behaviours shown by dolphins when interaction with trainers is imminent (Clegg et al. 2018). The data presented here suggest that taking part in SWD sessions in itself is largely inconsequential for the dolphins (i.e. neither aversive nor enriching), but that anticipation of interacting with trainers may be rewarding for them.

***Individual differences***

Dolphins demonstrate individual personalities that are relatively stable over time and over different situations (Highfill and Kuczaj 2007). Consequently, there may be considerable differences in behaviour between different dolphins (Galhardo et al. 1996; Soriano et al. 2015), and in response to environmental enrichment, including the opportunity to interact with humans (Eskelinen et al. 2015). In the data of this study, 'subject' was the only significant predictor for HE event behaviours and play state behaviour (Table 7). Play is of particular interest as it is widely thought of as an indicator of positive welfare. Among the dolphins, one (Annie) showed no play at all under any of the conditions, and only four (GeeGee, Machu, Caiyo and Kayena) showed play under all three conditions. Welfare is, of course, a property of the individual rather than the group, and more data are needed to determine whether individual differences in the behaviour of these dolphins have consequences for individual welfare.

## Conclusion

It appears that the welfare of the dolphins is neither compromised nor improved as a result of taking part in the SWD sessions. This study offers no evidence that taking part in a SWD session in itself has any impact on the behaviour of the dolphins. However, in all conditions ('before', 'after' and 'control') dolphins spend time responding to the presence of trainers or human activities around the pool, both around/in their own pool and in neighbouring pools, suggesting that human-animal interaction with familiar people is rewarding for them. Further research should address the questions of whether welfare is affected at the level of individual animals, and whether the increased interaction with trainers and/or visiting public due to the SWD sessions is in itself enriching for the animals.

## Acknowledgments

We would like to thank the staff at Dolphin Academy for giving us access to the dolphins and the SWD sessions, and for providing us with information about the animals and their housing and husbandry. Prof. Vicky Melfi kindly accessed Species360 and provided us with data on dolphin holdings worldwide. We thank Maddie Hopkinson for putting all of our data into SPSS.

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