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THE EFFECTS OF HUMAN-DOLPHIN INTERACTION PROGRAMMES ON THE BEHAVIOUR OF THREE CAPTIVE INDO-PACIFIC HUMPBACK DOLPHINS (*SOUSA CHINENSIS*)

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ABSTRACT. — Performances by dolphins have long been an integral part of marine parks whereas human-dolphin interaction sessions are a relatively new phenomenon. However, few studies have examined the effect of either of these types of activities on captive dolphin behaviour. Here, the behaviours, enclosure utilisation, and social interactions of three dolphins at Underwater World, Singapore (UWS), were quantified to see if any changes occurred 'before versus after' two types of dolphin interactions sessions: swim-with-the-dolphin (SWD) and meet-with-the-dolphin (MWD) programmes. Focal sampling was used to quantify the percentage of time spent on different behaviours and instantaneous scan sampling to quantify enclosure utilisation and social interactions. Significant differences were found among the dolphins for the overall percentage of time spent on each behaviour category. The SWD programme, however, appeared to not have compromised the dolphins' welfare, with at least one individual displaying anticipatory behaviours towards the programme. Swimming and locomotion behaviours increased after the MWD sessions for all dolphins, suggesting this programme elicited some form of excitement. This work provides the first quantitative insight into captive behaviour of the Indo-Pacific humpback dolphin (*Sousa chinensis*) and will contribute to their future management.

KEY WORDS. — captivity, cetacean, meet-with-dolphin, Singapore, swim-with-dolphin

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INTRODUCTION

Cetaceans have been kept in captivity as exhibit animals since the middle of the 19th century. Two beluga whales were displayed in New York City in 1860 by P. T. Barnum but, because they were kept in freshwater, they died a few days later (Jiang et al., 2008). In 1913, five bottlenose dolphins were captured and exhibited by the New York Museum, the last of which perished after 21 months in captivity. It was only a quarter of a century later that a captive dolphin would be taught to entertain human audiences. In 1938, during a feeding session at The Marine Studios in Florida, Cecil M. Walker realised that the bottlenose dolphins at the facility could be trained (Jiang et al., 2008). This discovery marked the beginning of dolphin performances at dolphinaria around the world.

As the husbandry of cetaceans improved over time, so did the demand for them (Mignucci-Giannoni, 1998). Since the 1860s, 35 different species of cetaceans have been kept in captivity, with varying degrees of success (Mayer, 1998). The five most frequently exhibited species are the common bottlenose dolphin (*Tursiop truncatus*), orca (*Orcinus orca*), beluga (*Delphinapterus leucas*), false killer whale (*Pseudorca crassidens*), and the Pacific white-sided dolphin (*Lagenorhynchus obliquidens*; see Mayer, 1998). Due to its ability to tolerate captivity and aptitude for training (Mayer, 1998), the bottlenose dolphin is by far the most widely held cetacean (Mignucci-Giannoni, 1998).

Marine parks and aquaria that maintain dolphins generally provide opportunities for the public to passively view them and/or experience live performances. A more recent development is personal interaction via swim-with-the-dolphin (SWD) type programmes (Desmond, 1999). Since the first use of common bottlenose dolphins (*Tursiop truncatus*) in SWD programmes in 1985, similar activities have been adopted by aquaria worldwide and have become a popular avenue through which the public is able to experience close encounters with these charismatic animals. Such interaction sessions do present some risk to human participants, with cuts and rashes occasionally reported (Hunt et al, 2008). Dolphins are also potentially vulnerable when they are unable to avoid unwanted interactions with participants. However, interaction sessions that are under control by a trainer greatly reduce behaviours that may put participants or dolphins at risk (Samuels & Spradlin, 1995). The National Marine Fisheries Service (NMFS) is the United States federal agency responsible for enforcing the Marine Mammal Protection Act (MMPA) of 1972 for the conservation and management of all cetaceans (whales, dolphins and porpoises) and most pinnipeds (seals and sea lions; Spradlin et al., 1999) in the USA. An extensive review conducted by the NMFS on the effects of SWD programmes on dolphin behaviour produced insufficient data to make definitive conclusions or recommendations (NMFS, 1990).

Quantitative studies on human-dolphin interactions on captive dolphin behaviour are limited in number (e.g., Samuels & Spradlin, 1995; Kyngdon, 2003; Trone et al., 2005). Samuels & Spradlin (1995) concluded that, with the provision of adequate refuge areas, SWD under trainer control did not result in atypical behaviour such as stereotypy. However, they were unable to conclude whether or not swim interactions compromised the welfare of the dolphins involved. Kyngdon (2003) studied the effects of SWD interactions on female short-beaked common dolphins, *Delphinus delphis*, and found that, other than an increased use of a refuge area and occasional displays of frustration such as body slaps, there were no behavioural changes that might indicate negative effects on well-being. Trone et al. (2005) examined the short-term and long-term impact of swim sessions conducted under trainer control on the behavioural repertoires of the dolphins involved. They concluded that there were no significant changes when comparing behaviour before with behaviour after SWD events other than an increase in play behaviour after the swim sessions. This increase in play suggested that the dolphins' participation in these swim programmes had not had a negative impact on their well-being (Trone et al., 2005). The studies by Samuels & Spradlin (1995), Kyngdon (2003), and Trone et al. (2005) tested their hypotheses using all the participating dolphins as a group; no study to date has analysed results dolphin-by-dolphin.

In 1999, six (four females and two males) Indo-Pacific humpback dolphins (*Sousa chinensis*) were brought to Underwater World, Singapore (UWS) from Oasis Sea World in Thailand. UWS and Oasis Sea World are presently the only two marine parks in the world to house this species. The Indo-Pacific humpback, or pink dolphin, is one of four cetacean species sighted in Singapore waters, the other three being the Indo-Pacific bottlenose dolphin (*Tursiops aduncus*), the Irrawaddy dolphin (*Orcaella brevirostris*), and the Indo-Pacific finless porpoise (*Neophocaena phocaenoides*). *Sousa chinensis* are found in warm temperate and tropical seas and are widely distributed throughout the Indo-Pacific, from southern China and northern Australia in the east, to the west of South Africa (Couquiand-Douaze, 1999; Jefferson, 2000). In the wild, they generally inhabit shallow waters (<20 m deep) close to shore (Ross et al., 1994), often travelling in small schools (Jefferson & Karczmarski, 2001; Parsons, 2004). In Algoa Bay, South Africa, the predominant nearshore behaviour was foraging/feeding (Karczmarski et al., 2000) and similar findings have been reported from Hong Kong (Parsons, 2004). From 1999 to 2010 the UWS dolphins were held in a sandy-bottom beach lagoon, called The Dolphin Lagoon, located at Palawan beach, Sentosa Island, Singapore. In Jul.2010, the dolphins were relocated to a specially made dolphinarium at UWS's main building complex as the lease for Dolphin Lagoon at Palawan Beach had expired.

Similar to other marine parks, UWS offers the public the opportunity to view a dolphin show: called "Meet-with-the-dolphin" (MWD), as well as the chance to participate in their "Swim-with-the-dolphin" (SWD) programme. Thus far, no work has been conducted to determine whether any of the captive Indo-Pacific humpback dolphins undergo behavioural changes as a result of these sessions. Here, we aimed to identify and quantify the effects of the interaction sessions (MWD and SWD programmes) at UWS on the behaviour, enclosure utilisation, and social interaction of the three dolphins involved. The results will provide baseline data useful for their future management in captivity.

MATERIAL AND METHODS

The dolphinarium at UWS. — The dolphinarium at UWS consists of a main pool (approximately 37 m long, 20 m wide, and 3.5 m deep; ~2200 m^3) adjacent to three holding pools; all the pools are made of concrete and lined with epoxy paint. An amphitheatre with a seating capacity of 600 people encircles approximately one half of the main pool and an elevated glass enclosed viewing gallery is situated ~4 m above the ground (Fig. 1). The three dolphins that participated in the dolphin interaction sessions were the subjects for the entire length of the study. Two of these dolphins, A and B, are females approximately 20 to 25 years old and were part of the original group brought to Singapore from Thailand. They have been participating in dolphin interaction sessions since May 2000 (Quah, 2000). The other dolphin, C, is a male born in Singapore in 2002 who has been participating in dolphin interaction sessions since he was 2 years old.

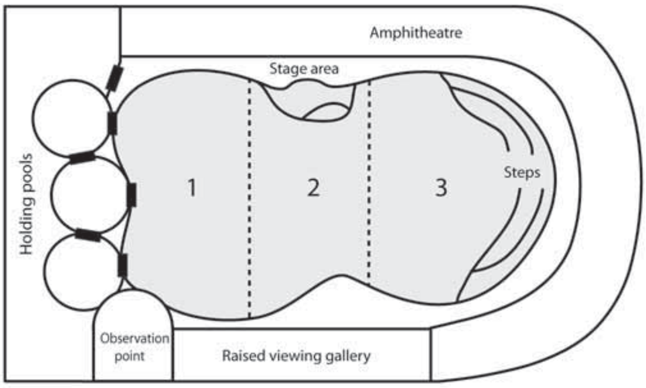

Fig. 1. Diagram of the dolphin lagoon consisting of the main pool (Length: 37 m, Width: 20 m, Depth: 3.5 m) alongside three holding pools. Locations that were utilised during scan sampling are marked out (1–3).

Interaction sessions. — During the study period, the dolphinarium ran a daily programme of dolphin interaction sessions. There were two SWD sessions and three MWD sessions each day. During the morning SWD session (0945 hours), a maximum of nine members of the public could participate, while up to 12 could during the afternoon slot (1330 hours). Each session lasted ~45 min and the number of trainers and dolphins involved at one time depended on the number of participants. Under the guidance of the trainer in the water, the guests were allowed to touch and hug a dolphin, take a ride whilst holding on to its dorsal fin (dorsal tow), ask the dolphin for trained behaviours through hand signals, and feed it. Out of the water, the dolphins were asked to paint a picture for the participants and trainers also provided instruction on basic husbandry techniques.

MWD sessions were shows open to all UWS visitors. Under trainer instruction, the dolphins balanced a basketball on their rostrum, jumped through hoops and performed various other trained behaviours such as leaping out of the water. Each MWD session lasted for ~15 min. Directly after each MWD session, there was a photograph-taking opportunity for the visitors. The trainer would encourage the dolphin to mount the steps at the end of the main pool and visitors could place their hand on the back of the dolphin and pose for a picture.

Sampling strategy. — Dolphins were observed from the elevated glass-enclosed viewing gallery overlooking the main pool (Fig. 1). Given the distance and position of the gallery, and the fact the observer was sitting still behind a glass wall, it was assumed that the behaviour of the dolphins was unaffected by the presence of the observer. Individual dolphins were easily identifiable based on their unique markings, such as the extent of grey pigmentation on their bodies. Behaviours were observed and recorded using focal-animal sampling (Altmann, 1974; Crockett & Ha, 2010) and instantaneous scan sampling (Altmann, 1974) techniques. Observations were carried out during two 20-min periods, one that preceded and another that followed the SWD and MWD activities. The first 20-min observation session ended 10 min before either the SWD or MWD session began. The second 20-min observation began 10 min after the conclusion of either the SWD or MWD session. The 10 min gaps were implemented before and after the interaction programmes to reduce the effect the presence of participants of the SWD programme and the public audience for the MWD programme might have had on the dolphins' behaviour.

A focal dolphin was selected based on a schedule created using random number tables and observed continuously for the 20-min period, during which the time spent on each behaviour (social, aggressive, submissive, abrupt, stationary, aerial, play and locomotion; See below) was recorded. This process of selecting and observing a dolphin was repeated throughout the day. Concurrently, at minute intervals, instantaneous scan sampling was carried out to record the location (section 1, 2 or 3 of the pool) of each dolphin (Fig. 1) plus, if within 1 m (an arbitrarily chosen distance), the identity of its neighbour. Scans were conducted from the left to right of the main pool, taking a total of 15 s for all three dolphins. Hence, a 20-min sampling period comprised of 15 min of continuous sampling while a total of 5 min was utilised for scan sampling. Data collection was discontinued if visibility was impaired by events such as heavy rain, or if activities such as feeding or training occurred. Data sets with ≥15 min of total sampling were retained whereas those with <15 min of sampling were discarded.

Behavioural categories. — Each observed behaviour was classified according to whether it involved either dolphin-dolphin interactions or solitary behaviours. Solitary behaviours transpired when the focal dolphin participated in an activity alone, i.e., with no other dolphins within 1 m. Dolphin-dolphin social behaviours occurred when two or more dolphins participated in a joint activity.

Individual behaviours were based on the catalogue devised by Apiccino & Tizzi (2006) for common bottlenose dolphins (*Tursiop truncatus*). The 62 behaviours identified were then pooled into eight general categories: social, aggressive, submissive, abrupt, stationary, aerial, play, and locomotory. (i) Social behaviour consisted of two dolphins touching each other in a non-aggressive manner on any part of the body. (ii) Aggressive behaviour was classified as one dolphin either displaying agnostic behaviour or attacking another dolphin; this included one dolphin appearing to be more dominant and the other seeming more submissive. Hence category (iii): Submissive. (iv) Abrupt behaviour included sudden activities such as dodging another dolphin's approach. (v) Stationary behaviours were low energy activities that mainly consisted of behaviours performed on the spot (e.g., resting or spy hopping). (vi) Aerial behaviour occurred when any part of the dolphin's body was raised above the water's surface. (vii) Play behaviour occurred when the dolphin interacted with an object or water (i.e., play object or play water; Kyngdon et al., 2002; Trone et al., 2005). (viii) Locomotory behaviour mostly comprised of moving through the water column while engaging in solitary activities (e.g., side swim, belly up). It is important to note that swimming was treated as the default behaviour and not classified within the eight behaviour categories.

Statistical analysis. — The percentage of time spent on each behaviour was calculated for each 20-min sampling period (i.e., one replicate). These co-varying multivariate data were used as input variables in Permutational Multivariate Analyses of Variance (PERMANOVAs; Anderson, 2001; Anderson, 2005).

Secondly, using the locations 1, 2, and 3 indicated in Fig. 1, a modified "Spread of Participation Index" (SPI) was calculated for each animal to determine the enclosure utilisation (Plowman, 2003).

The modified formula: $\text{SPI} = \dfrac{\sum |fo - fe|}{2(N - fe\ \text{min})}$

Where f_o is the observed frequency of observations in a zone, f_e the expected frequency of observations in a zone relative to its zone size assuming even use of the whole enclosure,

$|f_o - f_e|$ the absolute difference between f_o and f_e, N the total number of observations in all zones and $f_{e\ min}$ the expected frequency of observations in the smallest zone. The index varies from 0 (indicating maximum enclosure use, all zones used in proportion to their size) to 1 (indicating minimal enclosure use, only one zone used). A decrease in SPI index would thus indicate an increase in enclosure utilisation, whereas an increase in SPI index would mean a decrease in enclosure utilisation. The data were tested for normality and homogeneity of variance. One-way Analysis of Variance (ANOVA) followed by post-hoc Tukey HSD was used to analyse parametric data. In the event that either assumption was violated and could not be corrected by transformation, PERMANOVA was applied.

Finally, for the analysis of observed association and interactions between the three dolphins, association indices were constructed from the formula in Martin & Bateson (2007):

$$\text{Index of association} = \frac{Nij}{Ni + Nj + Nij}$$

Where N_{ij} is the proportion in which dolphin i and dolphin j are seen together; N_i is the proportion in which dolphin i is seen without dolphin j and N_j the proportion in which dolphin j is seen without dolphin i.

RESULTS

For the SWD programme, a total of 59 samples (19 for Dolphin A; 22 for Dolphin B; 18 for Dolphin C) were recorded before the sessions and a total of 68 samples (23 for Dolphin A; 25 for Dolphin B; 20 for Dolphin C) after the sessions. For the MWD programme, 74 samples (25 for Dolphin A; 25 for Dolphin B; 24 for Dolphin C) were recorded before the performances and 45 samples (15 for Dolphin A; 14 for Dolphin B; 16 for Dolphin C) after the performances. Due to low frequencies of occurrence, aerial and play behaviours were removed from the analyses.

Behaviour changes before and after the SWD programme. — For all three dolphins, the greatest amount of time was spent on locomotory behaviours, followed by stationary behaviours and lastly social behaviours. Significant differences in overall behaviour were exhibited for before versus after the SWD programme (PERMANOVA, $F = 3.5059$, $df = 1$, $P = 0.005$) as well as among the dolphins (PERMANOVA, $F = 2.6964$, $df = 2$, $P = 0.005$; see Fig. 2). No significant multivariate before/after × dolphin interactions was found.

Analysing the dolphins individually, a significant difference between the two periods (i.e., before and after) was found only for Dolphin B ($P = 0.006$) and only for stationary behaviours which decreased. Pairwise comparisons among the dolphins indicated significant differences in overall behaviour between dolphins A and C ($P = 0.02$) as well as between dolphins A and B ($P = 0.02$), but not between dolphins C and B ($P = 0.32$).

Behavioural changes before and after the MWD programme. — Similar to the results for the SWD programme, the dolphins spent the highest proportion of their time performing locomotion behaviours followed by stationary and social behaviours (Fig. 3).

Significant differences between the two periods (i.e., before and after) of the MWD programme (PERMANOVA, $F = 5.2888$, $df = 1$, $P = 0.001$) and among the dolphins (PERMANOVA, $F = 3.6082$, $df = 2$, $P = 0.001$) were found. There were no significant multivariate before/after × dolphin interactions.

Analysing the dolphins individually, significant differences in behaviour before and after the MWD programme were found for dolphins A ($P = 0.012$) and B ($P = 0.02$) but not dolphin C ($P = 0.3816$). Dolphin A showed a significant increase in social behaviours and a significant decrease in locomotion behaviours. Dolphin B exhibited a significant decrease only for locomotory behaviour. Pairwise comparisons showed a significant difference in overall behaviour between dolphins A and B ($P = 0.008$) and between dolphins B and C ($P = 0.006$) but not between dolphins A and C ($P = 0.3816$).

SPI before and after the SWD programme. — Significant differences in SPI index were found for before versus after the SWD programme (PERMANOVA, $F = 10.08$, $df = 1$, $P = 0.002$) as well as among dolphins (PERMANOVA, $F = 27.75$, $df = 2$, $P = 0.001$). There also existed a significant multivariate before/after × dolphin interaction (PERMANOVA, $F = 6.79$,

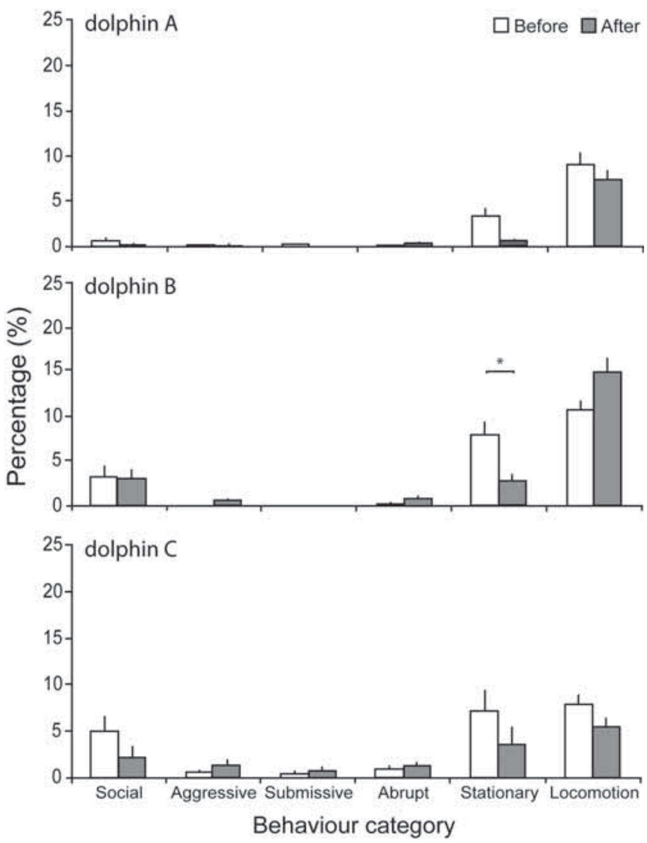

Fig. 2. Proportion of behaviours exhibited by the individual dolphins before and after the SWD programme. *P<0.05; **P<0.01; ***P<0.001.

df = 2, *P* = 0.001). The SPIs before and after the SWD programme were significantly lower for dolphins A (*P* = 0.001) and B (*P* = 0.001) but no significant difference was found for dolphin C (*P* = 0.4226) (Fig. 4).The significantly lower SPI for dolphin A was possibly due to an increase in swimming (default motion) and, for dolphin B, an increase in locomotory behaviours. Pairwise comparisons among dolphins showed that the SPI for dolphin B was significantly different from both dolphins A (*P* = 0.001) and C (*P* = 0.001) but there was no significant difference (*P* = 0.1429) in SPI between dolphins A and C.

SPI for the MWD programme. — For all the dolphins, there were significant differences for the SPI for before versus after the MWD programme (PERMANOVA, *F* = 86.64, *df* = 1, *P* = 0.001; Fig. 5). Significant differences were also found among the dolphins (PERMANOVA, *F* = 8.66, *df* = 2, *P* = 0.001) however, there was no significant multivariate before/after × dolphin interaction. Pairwise comparisons revealed that dolphin B's SPI was significantly different from that of dolphins A (*P* = 0.006) and C (*P* = 0.004) but there was no significant difference (*P* = 0.2577) in SPI between dolphins A and C.

Index of association. — Dolphins B and C had the highest association index, followed by dolphins A and C, and lastly dolphins A and B (Fig. 6). For all the dolphins, the index decreased after the SWD programme, but increased after the MWD programme. Tests could not be conducted to identify whether these differences were significant as the software required (De Vries, 1993) was not available.

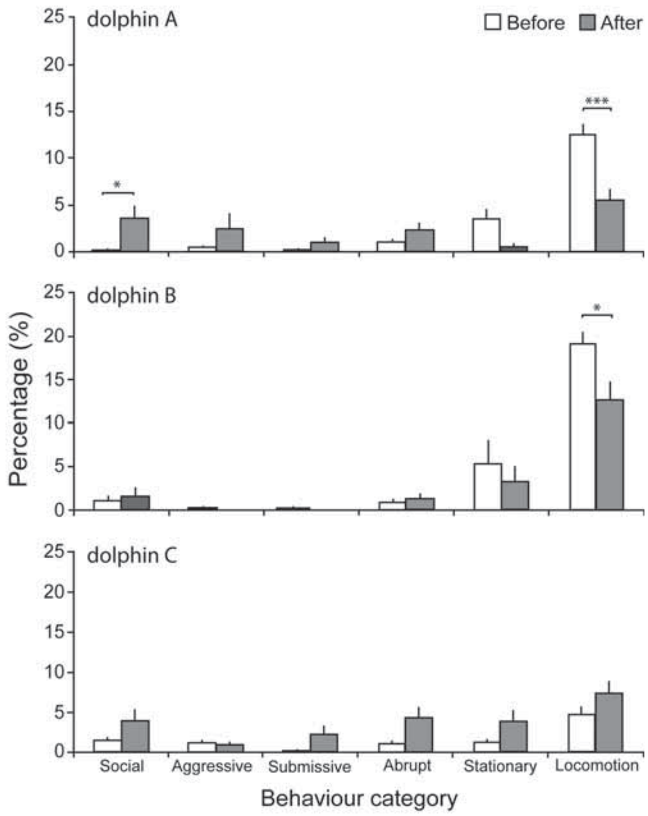

Fig. 3. Proportion of behaviours exhibited by the individual dolphins before and after the MWD programme. *P<0.05; **P<0.01; ***P<0.001.

DISCUSSION

With the ongoing demand by marine aquaria for cetaceans, there is a clear need to ensure that captive environments do not compromise their welfare. Similarly, the effects of human-dolphin interactions on captive dolphin behaviour should be studied. The data presented here on interaction programme-related behaviours, within-group dynamics, and enclosure utilisation are novel for captive Indo-Pacific humpback dolphins and can contribute to the future management of this species. Research involving captive cetaceans often consists of small sample sizes (e.g., Kyngdon, 2003; Trone et al., 2005), therefore treating these animals as a population

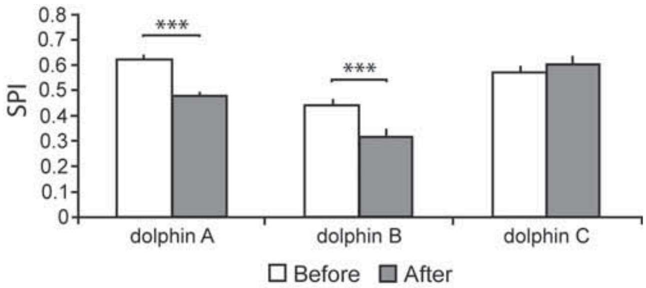

Fig. 4. Average SPI before and after the SWD programme. *P<0.05; **P<0.01; ***P<0.001.

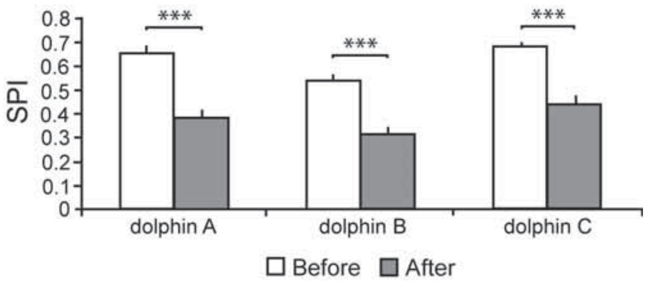

Fig. 5. Average SPI before and after the MWD programme. *P<0.05; **P<0.01; ***P<0.001.

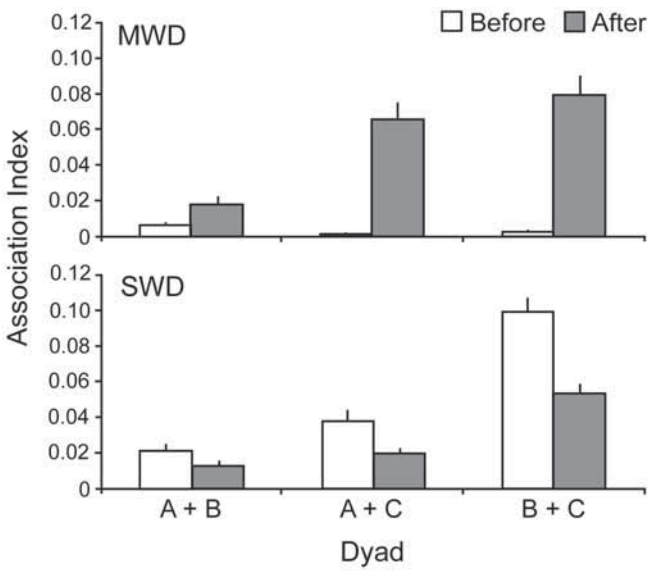

Fig. 6. Association index of each dyad before and after each programme.

representative of the species is problematic. Hence, our results are interpreted dolphin-by-dolphin.

SWD programme. — Significant differences in behaviour before and after SWD sessions were only found for one dolphin: dolphin B, one of the older females. 'Spy hopping', and related activities, which were the source of the significant difference in stationary behaviours, seemed to be anticipatory in nature as they were often performed in Area 1, i.e., where the trainers entered the main pool. Dolphins A and C did not exhibit significant differences in behaviour before versus after the SWD sessions. This result was similar to Trone et al. (2005) where the short-term and long-term impact of SWD sessions on the behavioural repertoires of the common bottlenose dolphins (*T. truncatus*) involved were studied. They concluded that the lack of behavioural changes exhibited indicated that participation in the programmes did not compromise the dolphins' welfare.

Both dolphins B and A exhibited significant decreases in SPI, meaning an increase in enclosure utilisation, after the SWD sessions. For dolphin B, the significant decrease in stationary behaviours after the SWD programme had a corresponding increase in locomotion behaviours. This increase in locomotion behaviours could have led to an increase in enclosure utilisation, explaining the observed decrease in SPI for dolphin B. However, unlike dolphin B, dolphin A exhibited a decrease in locomotion behaviours. For dolphin C, there was no significant difference in SPI before versus after the SWD session and hence seemed to be the least affected.

All three dyads exhibited a reduction in association index after the SWD programme. For dolphin B, the decreasing association index means the aforementioned increase in locomotion behaviours after the SWD session occurred without another dolphin <1 m away. For dolphin A, the decrease in locomotion behaviours, together with the decrease in association index, suggests that the significant decline in SPI was a result of increased swimming (default behaviour) without another dolphin <1 m away. Dolphin C showed a decrease in locomotion behaviours with no significant difference in SPI, meaning that there was an increase in swimming without another dolphin <1 m away.

Changes in behaviour can indicate compromised animal well-being (Frohoff, 2000). Hence, the lack of significant differences in behaviour for dolphins A and C between the two observation periods (i.e., before and after SWD), together with the stationary behaviours exhibited by dolphin B before the SWD programme, suggest that the SWD sessions at UWS did not have a negative effect on these individuals.

MWD programme. — Human presence increased before the MWD session, and dolphins B and A exhibited higher 'surface scanning' (i.e. forward progress with the head of the dolphin exposed and the water level below the eye) behaviour during this time compared to after the MWD session. This may represent vigilance, which has been observed to increase in other zoo animals such as ungulates in the presence of humans (Thompson, 1989). The significantly higher percentage of social behaviour for dolphin A after the MWD programme (when the crowds had dispersed) might also be related to the number of visitors within the area, as a similar increase has been observed in primates such as the cotton-topped tamarin, once humans are absent (Glatston et al., 1984).

Unlike the SWD programme, all three dolphins exhibited a significant decrease in SPI (meaning an increase in enclosure utilisation) after the MWD session. For dolphin A, the significant increase in social behaviours, which often involved travelling from one section of the pool to another, could cause the decrease in SPI. For dolphin B, the significant decrease in SPI with a significant decrease in locomotion behaviours indicates an increase in swimming. For dolphin C, there was a significant decrease in SPI in the absence of significant behavioural changes. Similar to dolphin B, this could be explained by an increase in swimming.

The association index for all three dyads increased after the MWD session. This was especially so for the dyads of 'A-C' and 'B-C', and was often characterised by chasing. The increase in association index, the significant increase in enclosure utilisation, and the decrease in locomotion behaviour observed in all three dolphins, indicate an increased percentage of time spent on swimming together after the MWD programme. The increased swimming, together with the chasing in the three dolphins suggests the MWD programme elicited some form of excitement. With the effect of performances/shows such as the MWD programme largely gone unstudied, the increased amount of swimming observed for all dolphins after the programme should be monitored.

Other observations. — Trone et al. (2005) reported an increase in play behaviour after SWD sessions, possibly indicating that the dolphins' participation in these swim programmes had not had a negative impact on their well-being. In the present study, play behaviour was observed so seldom (0.035%) that it was removed from all analyses. Play has been found to be a spontaneous behaviour in both wild and captive dolphins (Paulos et al., 2010) and is generally considered a crucial component in the development of animals (Kuczaj et al., 2006). Play also seems to occur in the absence of environmental, physiological and social stressors (Martin & Caro, 1985) and as such could be an indication of psychological well-being (Markowitz, 1982) in zoo-housed animals. The low level of play recorded here was, to some degree, due to the narrow definitions applied. "Play is notoriously difficult to define" (Paulos et al., 2010, p. 717) and much more work on *Sousa chinensis* is required before a full suite of play behaviours can be established. For example, on a few occasions, dolphins A and B played with a leaf that had fallen into the main pool and, on another occasion, A played with a small plastic bag. These instances suggest that there are opportunities for the stimulation of play behaviour, and associated well-being, through environmental enrichment.

It should be noted that the implementation of the 10 min observation gaps before and after the interactions may potentially have led to the loss of important information as the immediate pre- and post effect of the SWD and MWD programmes on the dolphins' behaviour would not have been recorded. However, as mentioned in the Material and Methods, partitioning out the effects of the participants' and audience's continuing presence from the effects of an interaction programme itself would be very challenging.

Finally, the possibility of habituation, i.e., a reduction in the response of individuals over time as they realise that the stimulus is neither beneficial nor has an adverse effect on them (Bejder et al., 2009) cannot be excluded. Due care must be taken not to misinterpret habituation as having little or no effect on individuals as this could lead to inappropriate management decisions which might result in compromising the wellbeing of the individual (Bejder et al., 2009). Changes in behaviour are not always sensitive enough to identify a response toward a stimulus; physiological changes can sometimes be detected despite a low or absent behavioural reaction (Beale & Monaghan, 2004). Monitoring both behavioural and physiological responses of the dolphins exposed to the interaction programmes studied here would provide a more comprehensive understanding of any effects these programmes have on them.

CONCLUSIONS

In summary, the SWD programme did not seem to have compromised the welfare of the dolphins involved, with one dolphin (dolphin B) exhibiting anticipatory behaviours before the programme and the other two dolphins displaying no significant behavioural changes 'before versus after' the programme. However, after the SWD session solitary swimming did increase for dolphin A, as indicated by the significant increase in enclosure utilisation and reduced association index. Dolphin C also showed an increase in solitary swimming but, unlike dolphin A, exhibited no significant increase in enclosure utilisation. Based on increased locomotion behaviours (but without another dolphin, as indicated by the lower association index) dolphin B increased her enclosure utilisation after the SWD session. For the MWD programme, the presence of visitors seemed to have an effect on the dolphins, with two of the older dolphins (A and B) exhibiting behaviours characteristic of vigilance. Significant decreases in SPI, coupled with decreases in locomotion behaviours for the two older dolphins, indicated more time spent on swimming after the MWD programme. For dolphin C, the increase in locomotion behaviours contributed to the significant decrease in SPI. This increased 'swimming' and locomotion behaviours, coupled with the chasing observed after the MWD programme, resulted in an increase in association index for all three dyads suggesting the MWD programme elicited some form or excitement. The present study provides an insight into captive behaviour of the Indo-Pacific humpback dolphin (*Sousa chinensis*), of which little is known. Future work could further examine the increased amount of 'swimming' observed for all dolphins after the MWD programme and also identify any behavioural outcomes of adding environmental enrichment. Finally, it would be interesting to determine whether the behaviour frequencies related to the interaction programmes change as the dolphins age.

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