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The effects of education programmes on Atlantic bottlenose dolphin (Tursiops truncatus) behaviour

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Abstract

*Atlantic bottlenose dolphins (*Tursiops trucatus*) are found in zoos and aquaria throughout the world. As the number of facilities with dolphin shows and interaction programmes increases, it becomes more important to understand the effects of such programmes on dolphin behaviour. The present study examined the short-term effects of dolphin shows and interaction programmes on the behaviour of Atlantic bottlenose dolphins at six facilities. Rates of affiliative behaviour, aggressive behaviour, repetitive behaviour and percentage of time spent socialising were found to be unrelated to dolphin shows or interaction programmes. Additionally, dolphins exhibited higher rates of behavioural diversity, diversity of swimming style, and play behaviour following shows and interaction programmes. These results suggest that dolphin shows and interaction programmes can be an important part of an enrichment programme for dolphins in zoological institutions. However, individual differences should be considered when animals participate in these types of programmes.*

Keywords: *animal management, animal welfare, dolphin interaction programmes, dolphin shows, dolphin swim-with programmes, environmental enrichment*

Introduction

Atlantic bottlenose dolphins (*Tursiops truncatus*) are commonly exhibited in zoos and aquaria. These facilities often utilise the animals in dolphin shows and/or interaction programmes. The goal of dolphin shows and interaction programmes is to engage the guests while educating them about dolphins and conservation of the marine environment. Currently, there is an increasing trend in the number of dolphin shows and interaction programmes, with little scientific documentation on the effects of these programmes on the animals. While some have suggested that these types of programmes can be stressful to the animals (Frohoff 2004; Rose *et al* 2006), others hold the view that these programmes can be an enriching experience for the animals by increasing stimulation and control over the environment (Goldblatt 1993; McBain 1999). The latter would suggest that these programmes promote rather than compromise the welfare of the animals (Mason *et al* 2007).

In the wild, coastal populations of Atlantic bottlenose dolphins have been most commonly found to range in group size from 2 to 15 individuals (Odell 1976; Shane 1977; Gruber 1981; Leatherwood & Reeves 1983; Shane *et al* 1986; Wells *et al* 1987). These groups typically consist of adult females and their offspring, mixed or single-sex subadult groups or adult male alliances (Shane *et al* 1986). Although much remains to be learned about the complexity of these associations, it seems clear that associations between wild dolphins are important. Given their natural history, sudden or drastic changes in social relationships could be a potential indicator of negative well-being for dolphins within a zoo or aquarium environment.

Other potential indicators of negative well-being that have been suggested for dolphins include submissive posturing to other dolphins or humans, inappetive behaviour, stereotypic or abnormal behaviour (eg circle swimming), abrupt changes in behaviour and agitation (Sweeny 1990; Frohoff 2004). Abrupt changes in behaviour could include an increase in breathing rates, changes in group cohesion, an increased speed of swimming, or increases in communicative displays and vocalisations (Frohoff 2004). While it is likely that inappetive, stereotypic or abnormal behaviour would be indicative of negative well-being, many of the other behaviours occur within multiple contexts. An increase in breathing rate or swimming speed could occur during playful activity. Submissive posturing could simply occur as a function of social rank, and increases in vocalisations have also been suggested as a potential sign of a positive experience for other species (Boissy *et al* 2007).

Precise definitions of behavioural events and documentation of the context in which they occur are important in helping to validate behavioural indicators of negative and positive well-being. However, any self-destructive or abnormal repetitive behaviour should be examined as it could be a sign of compromised welfare (Mason *et al* 2007).

While sudden changes in associations or abnormal behaviour might represent a negative indicator of well-being for dolphins within a zoo or aquarium environment, behavioural diversity may represent a positive indicator. Wild dolphins can spend 18 to 69% of their time travelling, 8 to 77% of their time feeding and 4 to 31% of their time socialising (Leatherwood 1979; Barham *et al* 1980; Lear & Bryden 1980; Goodwin 1985; Shane *et al* 1986; Shane 1990b; Hanson & Defran 1993; Moller & Harcourt 1998; Bearzi *et al* 1999; Bearzi 2005; Sini *et al* 2005). Differences in populations, prey availability and environment may account for much of the variability seen within these studies. In addition to variability in activity budgets, bottlenose dolphins also show great variability in behavioural events. For example, over thirty different feeding strategies have been documented for bottlenose dolphins (Shane 1990a). The variability seen within behavioural states and behavioural events suggests that behavioural diversity could be an important indicator of well-being for dolphins within human care.

Support for the notion that behavioural diversity is related to well-being comes from other studies within zoological institutions (eg Rushen *et al* 1993; Swaisgood & Shepherdson 2006). Frequency of play and exploration of the environment have also been found to increase as a result of environmental enrichment (eg Renner & Lussier 2002; Swaisgood *et al* 2005). Behavioural diversity, exploration and play have all been suggested as potential indicators of well-being for dolphins in zoos and aquaria (Galhardo *et al* 1996). A review of the literature pertaining to animal welfare in laboratories and farm animals suggests that motivation to play in mammals may indicate a state of good welfare since conditions associated with poor animal welfare (eg insufficient food supply, extreme cold weather, etc) suppress play behaviour (Boissy *et al* 2007). Similarly, animals within a stressful environment or under conditions of compromised animal welfare would be unlikely to explore their environment (Boissy *et al* 2007). Providing an enriched environment that meets the behavioural needs of animals would likely result in an increase in play behaviour, exploration, and consequently an increase in behavioural diversity in social mammals, such as dolphins.

To date, there is little information available on the effects of dolphin shows and interaction programmes on dolphin well-being. Two different studies, one on common dolphins (*Delphinus delphis*) and one on bottlenose dolphins, concluded that there were no detrimental effects of interaction programmes on the behaviour of dolphins (Kyngdon *et al* 2003; Trone *et al* 2005). Additionally, Trone *et al* (2005) observed an increase in play behaviour following interaction programmes but could not be certain that this was an effect of participating in the programmes. Kyngdon *et al* (2003) observed an increase in touch (two dolphins' fins touching in non-aggressive manner) and abrupt (rapid circles, aerial behaviour, fast swim, body slaps, etc) behaviours following the programme. The differences between studies could be a result of species' differences or individual differences with small sample sizes. The only multi-institutional study examining interaction programmes focused on the safety of the dolphins and human participants in controlled versus uncontrolled interactions (Samuels & Spradlin 1995). The results showed that controlled programmes were safer for both the participants and dolphins when compared to uncontrolled interactions (Samuels & Spradlin 1995). Similar to the other studies, the authors also concluded there were no observed short-term detrimental effects for the dolphins that resulted from participation in these programmes. Currently, there is no information available on the effects of dolphin shows on the animals' behaviour.

Most studies examining dolphins in zoos or aquaria have been limited in sample size and are limited in the ability to generalise across facilities. With the increasing trend in the number of facilities with dolphin shows and interaction programmes, it is important to document the effects of these programmes on dolphin behaviour. The goal of the current study was to examine the short-term effects of dolphin shows and interaction programmes on Atlantic bottlenose dolphin behaviour, including the examination of potential positive and negative indicators of well-being. The present study represents the first multi-institutional study examining the effects of these programmes on overall behaviour.

Materials and methods

Subjects and exhibits

The subjects included 18 Atlantic bottlenose dolphins from six facilities throughout the United States. These institutions included the Brookfield Zoo (Brookfield, IL), Disney's *The Seas* (Lake Buena Vista, FL), Dolphin Connection (Duck Key, FL), Indianapolis Zoo (Indianapolis, IN), Minnesota Zoo (Apple Valley, MN), and Texas State Aquarium (Corpus Christi, TX). At the time of the study, the subjects ranged from 4 to 42 years of age with a median age of 14 years. Subjects were chosen in order to have a cross-section of animals representing an approximately equal amount of adult and juvenile animals and equal amount of males and females. Table 1 provides a summary of the dolphins at each facility, including individuals that were not focal animals, information on group composition and the times and types of programmes offered at each facility. While dolphin shows were similar at all facilities, interaction programmes differed. Programmes at the Brookfield Zoo and Texas State Aquarium were out-of-water programmes (ie, participants interacted with dolphins from the side of the exhibit), while the programmes at the Indianapolis Zoo and Disney's *The Seas* were in-water programmes. The Dolphin Connection offered both out-of-water and in-water interaction programmes.

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Table 1 Atlantic bottlenose dolphins located at the six institutions.

Dolphin	Group	Sex	Date of birth	Focal animal	Programme type	Programme times
Brookfield Zoo					DS, (DIP)	1130, 1300, 1430, (1530), 1600h
D01	1	F	11/3/2005			
D02	1	F	10/30/2003	*		
D03	1	F	9/17/1993	***		
D04	1	F	1/1/1982	***		
D05	2	M	2/2/2002			
D06	2	M	10/19/2001			
D07	3	M	1/1/1975			
D08	3	M	1/1/1974			
Disney's The Seas					DIP	0945h
D09	1	M	4/5/1992	**		
D10	1	M	1/1/1981	**		
D11	2	M	6/13/2000			
D12	2	M	4/3/1994			
Dolphin Connection					DIP	1000, 1130, 1300, 1430, 1600h
D13	1	M	9/1/2003	**		
D14	1	M	4/18/2001	**		
D15	1	F	4/1/1987			
D16	1	M	1/1/1983			
D17	1	M	1/1/1973	**		
D18	1	F	1/1/1967			
Indianapolis Zoo					DS, (DIP)	(1000), 1030, 1230, 1430, (1500), 1630h
D19	1	F	8/20/2001	***		
D20	1	F	11/16/2000	***		
D21	1	F	1/1/1985			
D22	2	F	1/1/1985	*		
D23	2	M	1/1/1985			
D24	2	M	1/1/1985	*		
D25	2	F	1/1/1983	**		
Minnesota Zoo					DS	1000, 1200, 1400, 1600h
D26	1	F	8/16/2002	*		
D27	1	M	1/1/1965	*		
Texas State Aquarium					DS, (DIP)	1030, 1230, (1400), 1530h
D28	1	M	7/10/1996	***		
D29	1	M	10/11/1994	***		
D30	1	M	7/23/1992	*		

* Focal animal participating in dolphin shows.
** Focal animal participating in interaction programmes.
*** Focal animal participating in both types of programme.
DS: Dolphin show.
DIP: Dolphin interaction programme.

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Table 2 Definitions of behavioural events used for data collection.

Behaviour	Definition
Biting (AG)	The dolphin opens and closes mouth quickly and with force onto another dolphin. This can include a pectoral fin, fluke or other body part
Chin slapping (AG)	The dolphin lifts head from water and smacks or slaps the surface of the water with the lower jaw
Jaw clapping (AG)	A sudden closing of the jaws in the direction of another individual
Open mouth (AG)	Open jaws in the direction of another individual
Pec slapping (AG)	The dolphin smacks or slaps its pectoral fin on the surface of the water
Ramming individual (AG)	Forcefully hitting another individual with the rostrum or melon
Tail-slapping individual (AG)	The dolphin makes contact with another dolphin using its fluke, usually smacking the individual with its fluke
Tail-slapping water (AG)	The dolphin makes contact with its fluke to the surface of the water, usually smacking the surface with its fluke
Teeth raking (AG)	The dolphin opens its mouth and makes forceful contact with another dolphin by rubbing/sliding its jaws on this other dolphin
Copulation (AF)	The dolphin is interacting with another dolphin sexually as is evidenced by genital-to-genital contact
Group social ball (AF)	Three or more dolphins swim around each other, often biting and mouthing each other. This is often associated with sexual play. It is extremely difficult to identify the individual behaviours that each animal is doing
Nuzzling (AF)	The rubbing of the rostrum or melon against another individual
Rubbing (AF)	The ventral abdominal region makes contact against another individual
Teething (AF)	A gentle rubbing of teeth against the skin of another individual
Breech (HE)	At least half of the dolphin's body leaves the water and lands on lateral or ventral side at the surface
Fluke-in dive (OT)	The dolphin surfaces and then dives down under the water with the fluke remaining below the surface of the water
Fluke-out dive (OT)	The dolphin surfaces and then dives down under the water raising its fluke up in the air and out of the water
Jump/leap (HE)	A large aerial locomotion in which all of the dolphin's body comes completely out of the water
Porposing (HE)	Small bows usually performed several times in a row characterised by small forward motion leaps out of the water. The dolphin's head may re-enter the water as the tail is exiting the water
Spy hop (OT)	The dolphin moves in such a way that the upper part of the body rises above the water in a vertical position
Fast swim (OT)	Dolphin sustains an increased speed, swimming in one direction, for more than three seconds, producing a wake at the surface
Ventral swim (OT)	Dolphin swims inverted with ventral side pointing towards the surface for more than 3 s
Side swim (OT)	Dolphin swims on side, usually close to the surface for more than 3 s
Barrel roll (HE)	Dolphin spins 360° while remaining in the same location
Corkscrew (HE)	Dolphin spins 360° while swimming through the water
Fluke out (OT)	Dolphin extends fluke above the surface of the water while pointing rostrum towards the bottom of the exhibit
Chase (HE)	The dolphin swims quickly and actively after one or more dolphins for more than three seconds
Play with object (OT)	Dolphin interacts with an object which can include holding, carrying, balancing or pushing the object; interactions will only be counted once if within 5 s of the previous interaction
Bubbles (OT)	The dolphin produces bubbles and/or bubble rings with the blowhole, mouth flukes, or other body part, and interacts with these bubbles; interactions will only be counted once if within 5 s of the previous interaction
Chase fish (OT)	A rapid increase in speed; observed in dolphin swimming in normal orientation or side-swim pursuing a fish; lasting for a minimum of 3 s
Chuffing (OT)	Dolphin forces air out of its blowhole creating a 'chuffing' noise
Circle swimming (RP)	Animal swims in circle (clockwise or counter-clockwise) in a repetitive pattern from one point returning to the same point using approximately the same path. Animal must circle > two times to be recorded

AG: Aggressive; AF: Affiliative; HE: High-energy; RP: repetitive; OT: Other.

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Table 3 Definitions of behavioural states used for data collection.

Behaviour	Definition
Feed	Any of a variety of behaviours distinguished by such things as repeated dives in varying directions in one location pursuing fish, feeding circles, feeding splashes, fish kicks, feeding rushes and fish tosses
Social	Physical contact with one or multiple dolphins, or oriented toward another dolphin within one body length, and often displaying surface behaviours, with no forward movement
Travel/swim	Moving steadily in one direction
Rest	Moving very slowly or drifting in one direction
Play	Involves displays, chasing other dolphins or interacting with objects such as toys or bubbles
Repetitive	Any repetitive behaviour, such as circle swimming
Other	Behavioural state is other than previously defined
Non visible	Focal individual is not located at minute level

Four of the six facilities were similar in exhibit design, with Disney's *The Seas* and the Dolphin Connection being the most different. The Brookfield Zoo, Indianapolis Zoo, Minnesota Zoo and Texas State Aquarium each had four dolphin exhibits. These exhibits included a main area where dolphins performed in shows, two holding exhibits and a medical exhibit. At the Indianapolis Zoo and Texas State Aquarium, interaction programmes were conducted in one of the holding exhibits. The Brookfield Zoo conducted interaction programmes in both the main exhibit and holding exhibits. The Indianapolis Zoo has an underwater dome that extends into the middle of the main exhibit for visitors to view the animals. For each of these four institutions, the dolphins were the only species present in the exhibits.

In contrast, Disney's *The Seas* and the Dolphin Connection both have other species in the exhibits. Disney's *The Seas* has other collection animals, mostly species of fish that can pass through a barrier that separates the dolphins from the rest of the aquarium. It has a main exhibit and two holding areas, one of which can function as a medical area. Dolphin Connection is a semi-natural exhibit where wildlife, such as fish, sharks and rays can be found within the exhibit. Dolphin Connection has one large area sectioned off with a fence, split in half by a deck with fences creating two large areas at opposite ends and two holding areas in the middle.

Design and procedure

Focal animal sampling was used with a combination of instantaneous scan sampling and all occurrence sampling of certain behaviours to differentiate between behavioural state and brief occurrence behaviours (Altmann 1974; Mann 1999). An ethogram (Tables 2 and 3) was created, based on definitions from past studies to collect activity budgets (behavioural states), behavioural events (brief occurrences) and social affiliations (Tavolga & Essapian 1957; Würsig & Würsig 1979; Defran & Pryor 1980; Shane *et al* 1986; Shane 1990b; Samuels & Gifford 1997; Mann & Smuts 1999). Focal observations lasted for 30 min with scans occurring every minute for behavioural states and social affiliations, including identification of individual dolphins within one body length (3 m) of one another. All occurrences of specific behavioural events were recorded into 1-min blocks for comparison between the conditions (Table 4).

Observation times were based on the schedules of dolphin shows and interaction programmes at each of the institutions. The conditions for the study consisted of non-programme 1, pre-interaction, post-interaction, pre-show, post-show, and non-programme 2. These conditions were chosen to assess animals' behaviour immediately before and after a show/interaction (pre-interaction and post-interaction) and to compare that to the animals' behaviour at times not associated with shows/interactions (ie, non-programme 1 and 2). Table 4 is a summary of the start times for each of the conditions. The focal animal to be observed was randomly assigned for each observation and all observations took place above water to remove potential confounds. The first author conducted all behavioural observations at each facility. Data were collected from September to December 2007. During this time, 450 behavioural observations were conducted. The average number of observations per animal was 25 (range, 12–43). Fewer observations were conducted on two subjects participating in interaction programmes at one institution due to animals being removed from programmes for animal management reasons. Additionally, there were fewer observations for two additional animals participating in interaction programmes due to a lack of programme participants, which resulted in programmes being cancelled.

Reliability testing

Reliability testing was conducted using three 30-min tapes to ensure consistency in data collection throughout the study (Caro *et al* 1979). Inter-observer reliability was conducted between the primary observer and another observer prior to data collection at the first institution. This was to ensure valid interpretations of behavioural information collected at each of the institutions. Intra-observer reliability was assessed before data collection at each of the institutions by the primary observer using the

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Table 4 Results on other behavioural events for dolphins participating in dolphin shows.

Event	*F*-test	Condition (I)	Condition (J)	Mean difference (I-J)	SEM
Ventral swim	6.979**	NP1	PRS	–0.005	(± 0.010)
			POS	–0.147*	(± 0.056)
			NP2	–0.031	(± 0.028)
		PRS	POS	–0.142*	(± 0.050)
			NP2	–0.026	(± 0.021)
		POS	NP2	0.116**	(± 0.034)
Side swim	21.277**	NP1	PRS	0.006	(± 0.004)
			POS	–0.080**	(± 0.017)
			NP2	–0.001	(± 0.007)
		PRS	POS	–0.086**	(± 0.018)
			NP2	–0.007	(± 0.007)
		POS	NP2	0.079**	(± 0.016)
Fluke-in dive	0.011	–	–	–	–
Fluke-out dive	1.357	–	–	–	–
Spy hop	14.945**	NP1	PRS	–0.167**	(± 0.031)
			POS	–0.041	(± 0.026)
			NP2	–0.011	(± 0.011)
		PRS	POS	0.125**	(± 0.027)
			NP2	0.156**	(± 0.035)
		POS	NP2	0.030	(± 0.031)
Fluke out	0.985	–	–	–	–
Play with object	5.590**	NP1	PRS	0.005	(± 0.010)
			POS	–0.055*	(± 0.025)
			NP2	–0.007	(± 0.007)
		PRS	POS	–0.060*	(± 0.021)
			NP2	–0.011	(± 0.008)
		POS	NP2	0.049*	(± 0.020)
Bubbles	2.422	–	–	–	–
Chase fish	–	–	–	–	–
Circle swimming	1.754	–	–	–	–
Chuffing	0.846	–	–	–	–

For *F*-tests, df = 3,33.
* $P < 0.05$; ** $P < 0.01$.
NP1: Non-programme 1; PRS: Pre-show; POS: Post-show; NP2: Non-programme 2.

three 30-min tapes. Analysis was conducted by running a correlation coefficient looking at frequencies of behaviour recorded either between observers before the study (inter-observer) or for the primary observer throughout the study (intra-observer). Reliability was achieved at a level of $r > 0.90$ for both inter- and intra-observer observations throughout the duration of the study.

Data analysis

Behavioural categories were used to examine high-energy, aggressive and affiliative behavioural events (Table 2). Rates were calculated for these categories based on the total number of behavioural events observed, divided by the duration of time the animals were visible within each condition. Additionally, behavioural diversity was investi-

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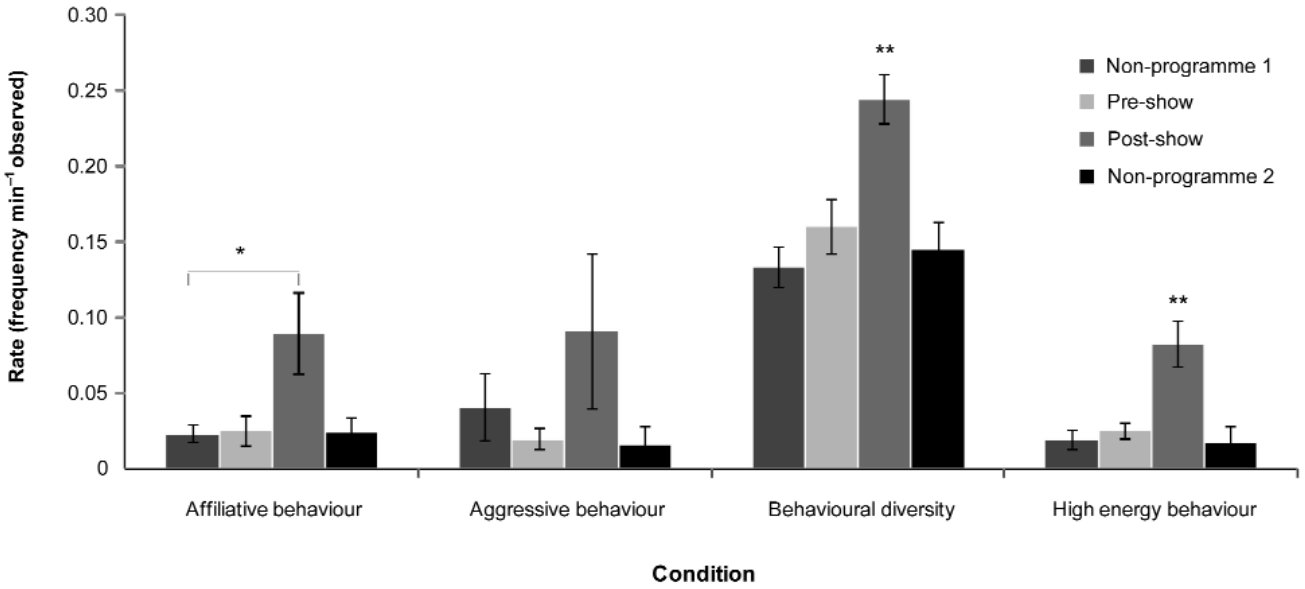
Figure 1



Categories of behavioural events for dolphins participating in dolphin shows * $P < 0.05$; ** $P < 0.01$.

gated by totalling the number of different behavioural events for each individual within each observation, excluding aggressive, repetitive and affiliative behaviours. Repetitive behaviours were excluded from the behavioural diversity category due to being a potential indicator of compromised animal welfare. Aggressive and affiliative behaviours were excluded from the behavioural diversity category due to the fact that other individuals had to be present in order for these behaviours to occur. Rates were also created for the behavioural events that were not included in one of the previously defined behavioural categories (eg aggressive, affiliative, behavioural diversity) to prevent a form of pseudo-replication (Table 2). A repeated measures analysis of variance (ANOVA) was used to examine the differences between conditions for agonistic behaviour, affiliative behaviour, high energy behaviour, behavioural diversity and individual behaviours. A Tukey's *post hoc* for individual comparisons was used to follow-up all significant results.

Activity budgets were created for each dolphin from the behavioural-state information based on percentage of visible scans. A repeated measures multiple analysis of variance (MANOVA) was conducted to examine the differences between conditions for behavioural states with a Tukey's *post hoc* for individual comparisons to follow-up all significant results. An index of association was used to examine affiliation between the different individuals across conditions. The index of association was created by taking the total number of scans two individuals were in a pair or group, divided by the total number of visible scans (Ginsberg & Young 1992). Indices of associations between individuals were then analysed to examine differences between conditions. A significant change in association was defined as one in which the index of association changed by more than two standard deviations between conditions. Additionally, association patterns were examined by creating a rate of affiliation. The rate of affiliation was determined by taking the total number of scans an individual was in a pair or group, divided by the total number of visible scans, and the total number of animals in the exhibit. An ANOVA was used to examine the differences between conditions for rate of affiliation with a Tukey's *post hoc* for individual comparisons to follow-up all significant results.

Results

Dolphin shows

Analysis of behavioural events revealed that the behaviours of barrel roll, bite, chase fish, copulation and teeth rake were not observed during the course of this study. These behaviours were excluded from further analysis. Analysis of aggressive behavioural rates revealed no significant differences between the conditions, ($F_{3,33}$ = 1.370, P = ns). However, a significant difference in behavioural diversity, affiliative and high-energy behaviours was observed ($F_{3,33}$ = 14.187, $P < 0.01$, $F_{3,33}$ = 4.947, $P < 0.01$, and $F_{3,33}$ = 9.231, $P < 0.01$, respectively). Figure 1 is a summary of the follow-up results of behavioural event categories for subjects participating in dolphin shows. Analysis of rates of other behavioural events is shown in Table 4. Results show a higher rate of ventral swims, side swims and playing with objects in the post-show condition compared to the non-

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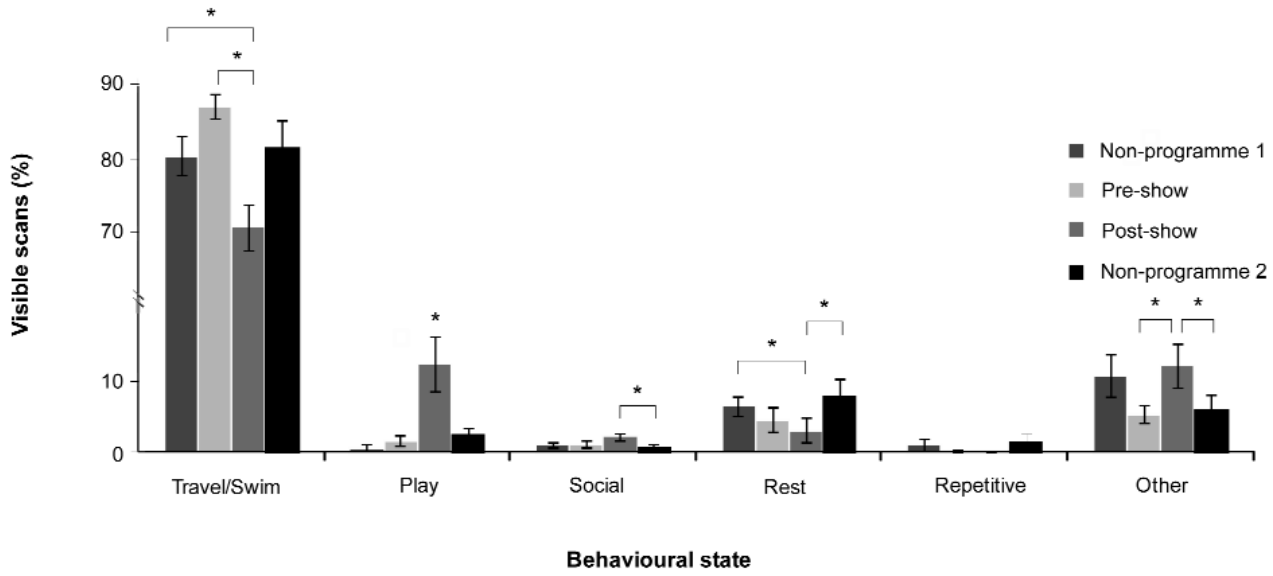
Table 5 Percentage of associations that significantly changed between conditions for dolphins participating in dolphin shows.

Condition	NP1–PRS	NP1–POS	NP1–NP2	PRS–POS	PRS–NP2	POS–NP2
Significant decrease in association	22.22%	5.56%	0.00%	11.11%	0.00%	33.33%
Significant increase in association	5.56%	5.56%	11.11%	11.11%	22.22%	33.33%
No change	72.22%	88.89%	88.89%	77.78%	77.78%	33.33%

Figure 2



Activity budgets for dolphins participating in dolphin shows. * $P < 0.05$.

programme 1, pre-show or non-programme 2 conditions. Alternatively, spy hopping was found at higher rates during the pre-show condition compared to the non-programme 1, post-show or non-programme 2 conditions.

Analysis of activity budget data revealed that feeding was not observed and was excluded from additional analysis. Analysis of activity budget data revealed a significant difference between the conditions ($F_{15,93} = 2.686$, $P < 0.01$). Follow-up results indicated significantly more time was spent socialising, playing and engaged in other behaviours in the post-show condition compared to the non-programme 2 condition (Figure 2). Additionally, playing and other behaviours were significantly higher in the post-show condition compared to the pre-show condition, and playing was higher in the post-show condition compared to the non-programme 1 condition. Alternatively, resting and travelling were lower in the post-show condition compared to the non-programme 1, non-programme 2 and non-programme 1 and pre-show conditions, respectively. No significant differences were found between conditions for repetitive behaviour.

Examining rates of affiliation revealed an average rate of 0.14 between dolphins (range 0.12–0.15; SEM [± 0.03]). A comparison of rates of affiliation between the conditions revealed no significant differences ($F_{3,33} = 0.887$, P = ns). The maximum percent of significant association changes observed was 33.33% between any two conditions (Table 5).

Dolphin interaction programmes

Analysis of all behavioural events revealed that the behaviours of barrel roll, biting, copulation, ramming individual and teeth raking were not observed. These behaviours were excluded from additional analysis. Analysis of affilative behavioural rates revealed no significant differences among the conditions, ($F_{3,33} = 2.479$, P = ns). However, a significant difference in behavioural diversity, aggressive and high energy behaviours was observed ($F_{3,33} = 12.662$, $P < 0.01$, $F_{3,33} = 5.559$, $P < 0.01$, and $F_{3,33} = 4.617$, $P < 0.01$, respectively). Follow-up analysis of the behavioural event data for animals participating in interaction programmes is summarised in Figure 3. Analysis of other behavioural rates is shown in Table 6. Results show a higher rate of ventral swims and side swims in the post-interaction condition compared to the non-programme 1, pre-interaction or non-programme 2 conditions and higher rates of side swims in the non-programme 2 condition compared to the pre-inter-

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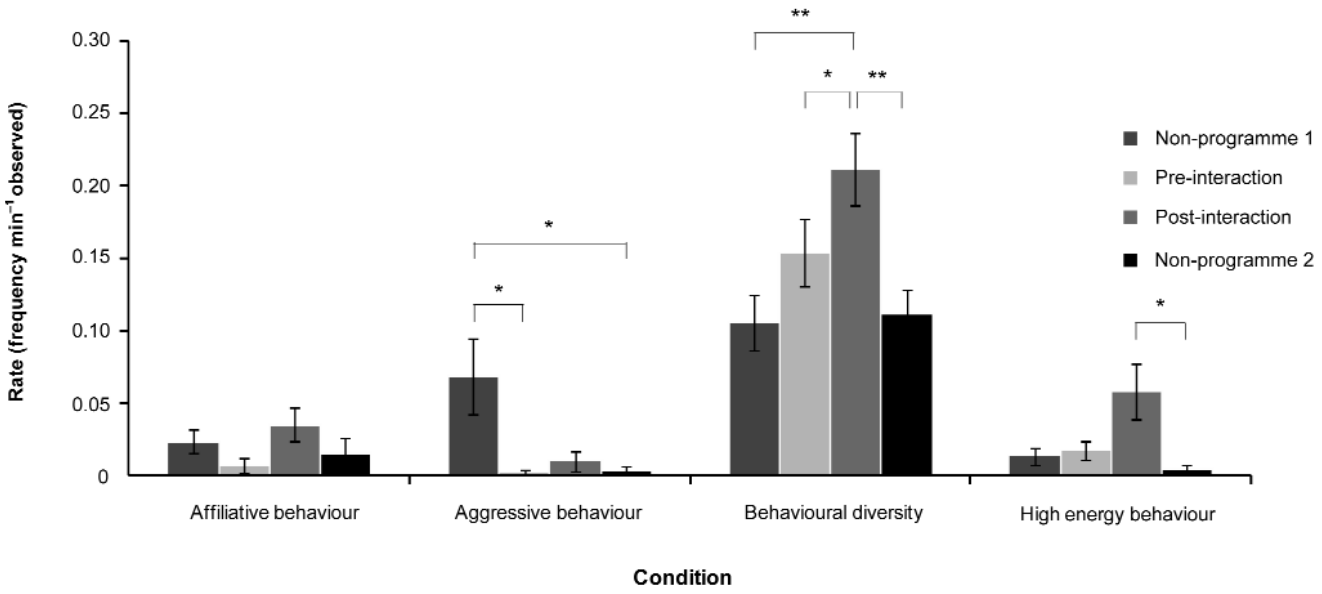
Figure 3



Categories of behavioural events for dolphins participating in interaction programmes. * $P < 0.05$; ** $P < 0.01$.

action condition. There was also a higher rate of fluke-out dives in the pre-interaction condition compared to the post-interaction condition.

During formal observations, feeding was not observed; this behaviour was excluded from additional analysis. Analysis of activity budgets revealed a significant difference between the conditions ($F_{15,93} = 1.963$, $P < 0.05$). Dolphins were found to spend significantly more time playing and less time resting in the post-interaction condition compared to the non-programme 1 condition (Figure 4). Additionally, resting was also lower in the post-interaction condition compared to pre-interaction and non-programme 2 conditions. Dolphins spent more time socialising in the non-programme 1 condition compared to the non-programme 2 condition and more time engaging in other behaviours in the post-interaction condition compared to the non-programme 2 condition. No significant differences were found for travel/swim or repetitive behaviour.

Examining rates of affiliation revealed an average rate of 0.09 between dolphins (range 0.08–0.10; SEM [± 0.03]). A comparison of rates of affiliation between the conditions revealed no significant differences ($F_{3,33} = 0.258$, P = ns). The maximum percent of significant association changes observed between two conditions was 27.78% (Table 7).

Discussion

Examination of the results revealed no behavioural indicators to support the concept that dolphin shows or interaction programmes compromise the well-being of the animals. Associations between dolphins and rates of affiliation remained relatively constant throughout all conditions for both types of programmes. Although differences were found in affiliative, aggressive and social behaviour, close examination of the conditions reveals these differences are not likely indications of a negative response. The higher rates of aggressive behaviour for dolphins participating in interaction programmes were observed during the non-programme 1 condition. If similar rates had been observed during the non-programme 2 condition, then the differences observed would more likely be attributed to an effect of these programmes. If the rates during non-programme 2 were at the higher levels observed during the non-programme 1 condition, this would represent a decrease in aggression during interaction programmes, which has previously been considered a benefit of training (Laule 1993; Laule & Desmond 1998). The other difference observed in social behaviour included a higher percentage of time socialising and higher rates of affiliative behaviour following dolphin shows compared to the non-programme 1 and non-programme 2 conditions. Similar to differences observed during the interaction programmes, past research on primates would suggest that increased socialisation could be considered a positive effect of training rather than a negative response (Laule 1993; Laule & Desmond 1998).

Increases in stereotypic behaviour can be a sign of frustration and have been linked to compromised animal welfare (Mason 1991). The repetitive behaviour (eg circle swimming), observed in a portion of the individuals, was at low levels. There were no differences found in percentage of time engaged in repetitive behaviour among the condi-

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Table 6 Results on other behavioural events for dolphins participating in interaction programmes.

Event	*F*-test	Condition (I)	Condition (J)	Mean difference (I-J)	SEM
Ventral swim	5.065**	NP1	PRI	–0.013	(± 0.016)
			POI	–0.150*	(± 0.066)
			NP2	–0.041	(± 0.029)
		PRI	POI	–0.138*	(± 0.057)
			NP2	–0.028	(± 0.019)
		POI	NP2	0.109**	(± 0.044)
Side swim	11.320**	NP1	PRI	0.006	(± 0.008)
			POI	–0.102**	(± 0.027)
			NP2	–0.006	(± 0.009)
		PRI	POI	–0.108**	(± 0.032)
			NP2	–0.012*	(± 0.004)
		POI	NP2	0.096**	(± 0.030)
Fluke-in dive	2.127		–		
Fluke-out dive	3.354*	NP1	PRI	–0.008	(± 0.018)
			POI	0.053	(± 0.028)
			NP2	0.063	(± 0.037)
		PRI	POI	0.061*	(± 0.021)
			NP2	0.072	(± 0.037)
		POI	NP2	0.011	(± 0.022)
Spy hop	3.752*	NP1	PRI	–0.295	(± 0.144)
			POI	–0.076	(± 0.047)
			NP2	–0.031	(± 0.028)
		PRI	POI	0.219	(± 0.123)
			NP2	0.264	(± 0.123)
		POI	NP2	0.045	(± 0.053)
Fluke out	1.000	–	–	–	–
Play with object	1.766	–	–	–	–
Bubbles	1.199	–	–	–	–
Chase fish	1.399	–	–	–	–
Circle swimming	0.656	–	–	–	–
Chuffing	0.750	–	–	–	–

For *F*-tests, df = 3,33.
* $P < 0.05$; ** $P < 0.01$.
NP1: Non-programme 1; PRI: Pre-interaction; POI: Post-interaction; NP2: Non-programme 2.

tions for animals participating in dolphin shows or interaction programmes. This suggests that the circle swimming behaviour observed in certain individuals was not associated with participation in these programmes. As noted earlier, any form of repetitive behaviour can be an indication of compromised animal welfare and should be examined thoroughly (Mason *et al* 2007). However, the cause or motivation for the observed stereotypic behaviour was not immediately obvious.

There are some measures that suggest these programmes can be a form of enrichment for participating animals. Possible measures to demonstrate well-being that have been suggested in previous literature include behavioural diversity, exploration of the environment, and frequency

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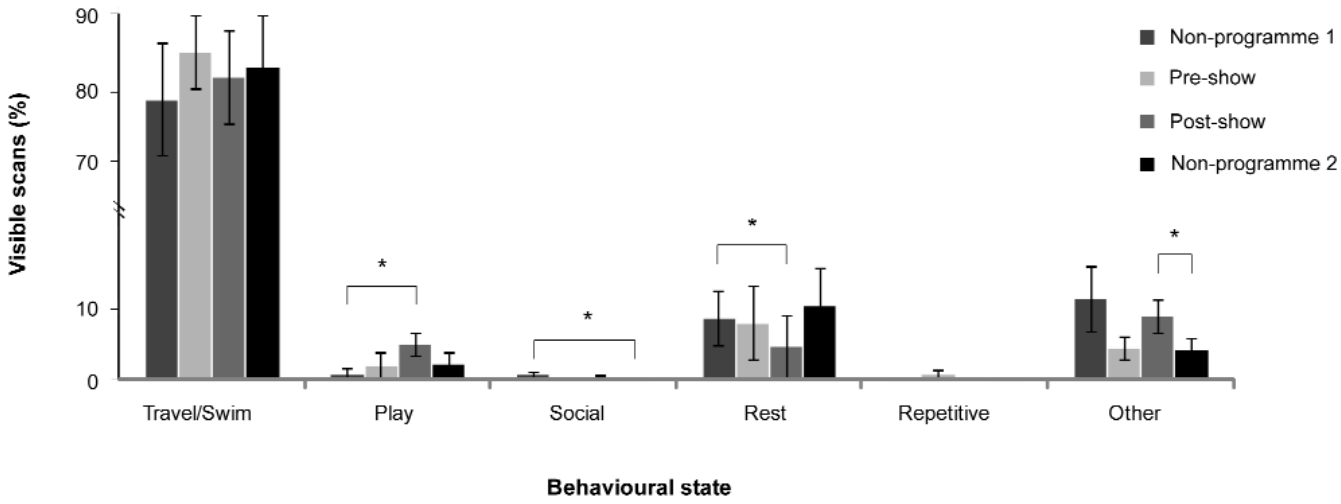
Figure 4



Activity budgets for dolphins participating in interaction programmes. * $P < 0.05$.

Table 7 Percentage of associations that significantly changed between conditions for dolphins participating in interaction programmes.

Condition	NP1–PRI	NP1–POI	NP1–NP2	PRI–POI	PRI–NP2	POI–NP2
Significant decrease in association	27.78%	5.56%	22.22%	5.56%	0.00%	11.11%
Significant increase in association	0.00%	0.00%	0.00%	5.56%	5.56%	0.00%
No change	72.22%	94.44%	77.78%	88.89%	94.44%	88.89%

of play (Rushen *et al* 1993; Galhardo *et al* 1996). Conclusions from studies with other species have shown that environmental enrichment can increase these same behaviours (eg Renner & Lussier 2002; Swaisgood *et al* 2005). Although limited information is available on dolphins, it would be expected that similar results would occur with species-appropriate enrichment.

In the current study, dolphins participating in both types of programmes had significantly higher rates of behavioural diversity following the programmes, a pattern that is likely related to animal well-being (eg Renner & Lussier 2002; Swaisgood *et al* 2005). In addition to overall behavioural diversity, there were higher rates of ventral swims and side swims following the programmes, suggesting either an increase in diversity of swim style or a swimming form of play behaviour. Dolphins in the wild have been observed bow riding the front waves of moving boats in a ventral fashion (Fish & Clifford 1991). Although the exact reason for diversity in swimming style could not be determined, an increase in behavioural diversity or play would further suggest that both types of programmes can be enriching for participating animals.

Previous literature has linked play behaviour to animal well-being, with a decrease in motivation to play in poor environments (Boissy *et al* 2007). In the current study, the percentage of time playing was found to be highest following both dolphin shows and dolphin-interaction programmes. However, there were some differences between these two types of programmes. The percentage of time spent playing after dolphin shows was significantly higher than the non-programme 1, pre-show and non-programme 2 conditions. These differences were not all observed for dolphins participating in interaction programmes. However, closer examination reveals the same pattern comparing the different types of programmes, suggesting that the differences observed were likely a result of increased variability in percentage of time spent playing for individuals participating in interaction programmes. Although differences were found between the two types of programmes, Trone *et al* (2005) found an increase in play behaviour following interaction programmes.

Activity levels also increased during observation periods immediately following both dolphin shows and dolphin interaction programmes. This was demonstrated by a lower percentage of time resting and an increase in high energy behaviours following the programmes. Resting behaviour was lower for dolphins following dolphin shows when compared to the non-programme 1 and non-programme 2

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conditions. During the pre-show condition, resting rates were similar to the post-show condition. This was likely a result of animals anticipating participation in the programmes, as suggested by the higher rates of spy-hopping behaviour observed during the pre-show condition. Animals were likely searching for the trainers at this time. The behaviour of dolphins participating in interaction programmes was similar except for the post-interaction condition where dolphins spent significantly less time resting compared to the pre-interaction condition. Although different, the patterns of spy-hopping behaviour also suggested the animals were searching for the trainers at this time. There also was an increase in rates of high energy behaviour following both types of programmes compared to the non-programme 2 condition. Only dolphins participating in shows had higher rates of high energy behaviour following the programmes compared to the non-programme 1 and pre-show conditions. Once again, there were differences between dolphin shows and interaction programmes likely due to greater variability in behaviour between individuals participating in interaction programmes. Promoting exercise or increased activity levels can be considered an important part of the care of these animals.

During dolphin shows and interaction programmes, trainers cue dolphins using hand signals to perform certain behaviours. For example, dolphins participating in shows are often cued to perform a series of leaps around the pool as a group. Similarly, a dolphin interaction might include cueing a dolphin to station for a period of time in the ventral position allowing trainers to talk about veterinary procedures with visitors. Both of these examples could be considered complex behaviours; when cued by the trainers, the dolphins can receive reinforcement by altering their behaviour. Although the dolphins participating in these programmes do not have full control over the situation, altering their behaviour results in reinforcement (eg food, tactile, cueing for another behaviour). Past research has shown that animals are usually more willing to work for food as opposed to just being fed (eg Markowitz & Woodworth 1977; Menzel 1991). The behaviours that are cued and the reinforcement that is provided are varied by the trainers. This suggests that the training used for dolphin shows and dolphin interaction programmes provides an activity that is complex, unpredictable and ensures some control or choices within the environment. These attributes of complexity, unpredictability and control are considered an important part of environmental enrichment (Swaisgood & Shepherdson 2006).

The differences that were observed between the two programmes (dolphin shows and dolphin interaction programmes) are likely due to individual differences in response to the programmes for the dolphins participating in interaction programmes. Visual inspection of the results revealed that at least one dolphin from each institution had an increase in behavioural diversity and play behaviour following the programmes at those facilities. This suggests that the differences reflect individual differences between dolphins rather than institutional differences. Although the results of the present study suggest these programmes can be an enriching experience, any institution with Atlantic bottlenose dolphins should consider individual differences when selecting dolphins to participate in either interaction programmes or dolphins shows. Potential reasons for these differences might include age, sex or differences in dolphin personality and could be a topic of further research.

Animal welfare implications

If zoological institutions are to provide the highest quality of care for dolphins, it is important to fully understand the effects of dolphin shows and dolphin interaction programmes on their behaviour. Although the current study did not address long-term effects, the results show the potential enriching value of these programmes. The increases in behavioural diversity, variation in swimming style, activity levels and play behaviour following both types of programmes are likely a result of the complexity, unpredictability and choices afforded to the animals during these programmes. In addition, consistent results were obtained between conditions in association patterns, social behaviour and rate of affiliation for both types of programmes suggesting that there were no short-term detrimental effects from participating in these programmes. Overall, the results suggest that dolphin shows and interaction programmes can be an important part of an enrichment programme for dolphins within a zoo or aquarium environment. The methods utilised in the current study could be a tool for institutions to examine differences in response to programmes to ensure appropriate selection of dolphins for participation in these types of programmes while maintaining high levels of animal welfare.

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