SPONTANEOUS ACTIVITIES OF CAPTIVE PERFORMING BOTTLENOSE DOLPHINS (*TURSIOPS TRUNCATUS*)

L Galhardo[1†], M C Appleby[1], N K Waran[1] and M E dos Santos[2]

[1] Institute of Ecology and Resource Management, University of Edinburgh, West Mains Road, Edinburgh EH9 3JG, UK

[2] Unidade de Investigação em Eco-Etologia, Instituto Superior de Psicologia Aplicada, Rua Jardim do Tabaco, 44, 1000 Lisboa, Portugal

[†] Contact for correspondence and requests for reprints: Travessa do Possolo, 17, 4º piso, 1350 Lisboa, Portugal

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Abstract *Animal Welfare 1996, 5:* 373-389

Despite the number of dolphins that have been kept in dolphinaria, and the many behavioural studies that have been conducted on captive dolphins, few have focused on their welfare. Some behaviours have been described in detail, but insufficient attention has been paid to the diurnal variations in their occurrence.

*Behavioural observations were conducted upon two groups (two and six individuals each) of captive bottlenose dolphins (*Tursiops truncatus*) over a period of six weeks. Behavioural descriptions were produced and the amount of time the animals spent engaged in different behaviours was sampled. General trends of both groups and differences in patterns of variation throughout the day were also analysed. The use of area by the dolphins and their degrees of association were recorded. Considerable individual variation and differences between the two groups were observed.*

In comparing the behaviour of different dolphins and in considering their welfare it is necessary to take into account their marked degree of individuality. The observations have shown that behavioural data such as variability of behaviour patterns, spontaneous variations in the daily activities and frequency of playing and exploration may constitute good welfare indicators. It is argued that social diversity, appropriate physical characteristics of the pools, existence of play objects in the pools, easy access to visual contact with people, and frequent interactions with the trainers throughout the day at unscheduled times may be important ways of improving environmental stimulation.

Keywords: *animal welfare, behaviour, dolphins, environmental enrichment, individual differences*

Introduction

The bottlenose dolphin, *Tursiops truncatus* (Montagu 1821) inhabits a wide range of habitats. Having a cosmopolitan distribution, it uses open coasts, bays, lagoons, harbours, estuaries, oceanic island coasts, and pelagic waters in all seas, avoiding only the very high latitudes (Leatherwood & Reeves 1983). Group sizes are much influenced by ecological conditions and on-going activities, ranging from small units of two or three animals during periods of foraging to large aggregations of several hundred travelling in deep waters. Bottlenose

dolphins are very social animals. They have a rich behavioural repertoire and complex social signs which they use in social interactions. Some studies in the wild have shown that these animals live in flexible 'fusion-fission' societies, with long-term bonds occurring between mothers and their offspring and even between adults of the same sex. Clearly, an individuals specific relationships are important in the animals' social arrangements. Group organization seems to be mostly matrilineal, and segregation based on age and sex has been reported in various populations (Scott *et al* 1990).

The bottlenose dolphin has been the cetacean most widely kept in captivity. The era of keeping cetaceans in captivity began in 1930 at Marineland, Florida. Since then dolphinaria have spread throughout the world. Up to 1986, at least 2700 bottlenose dolphins were reported to have been taken into captivity (Klinowska & Brown 1986). Nowadays, in Europe, almost all countries have at least one dolphinarium, with the exception of the UK.

A dolphinarium is a complex of pools of different sizes with sea water or artificially salted water. The dolphins are kept in groups of varying sizes, sometimes together with members of other species. They are generally subjected to a more or less fixed schedule of routines that include training sessions, shows, feeding sessions, etc. The schedule of these activities varies very much amongst dolphinaria and, in each one, with seasons. The training of captive dolphins, using positive reinforcement techniques, aims to establish (or to adapt from their natural behaviours) a repertoire of behaviours useful for exhibition, research or practical tasks such as open-ocean work. The quality of this training experience is of paramount importance to their long-term welfare. The avoidance of stressful regimes, the adoption of veterinary procedures that stimulate the animals' cooperation, and the maintenance of adequate environmental stimulation are all factors that facilitate the training procedures and promote the general well-being of the dolphins.

The captive environment may change the frequency of natural behaviours, exclude some (eg cooperative foraging as observed in the wild), amplify the occurrence of certain other behavioural categories (eg vocalizations above the surface, complexity of certain leaps) and perhaps modify the social structure (Defran & Pryor 1980). The dolphins' time budgets are also different since the captive conditions are certainly distinct from those in the wild. Therefore it is common to see a captive dolphin spending more time engaged in playing or resting than it would in the natural environment, where an important part of the day is spent foraging. Even being aware of the numerous behavioural possibilities of bottlenose dolphins, there are certain behaviours that strongly suggest some degree of abnormality, even if similar patterns are seen in the wild. These usually include those which imply some kind of injurious behaviour, excessive aggression, or behaviours that are repetitive in time and space and seem to lack any function. Many authors have reported them in captive dolphins (Lilly 1963; Caldwell & Caldwell 1972; Greenwood 1977; Klinowska & Brown 1986; Sweeney 1990).

Despite the fact that many behavioural studies have been conducted on captive dolphins (eg Tavolga & Essapian 1957; Tavolga 1966; Caldwell & Caldwell 1972; Saayman *et al* 1973; Puente & Dewsbury 1976), the main focus has not been on their welfare (Klinowska & Brown 1986; Gygax 1993). Reports of detailed recommendations suggesting standards that should be applied to dolphinaria already exist (Klinowska & Brown 1986; Steering Group 1988). However, the same reports highlight the need for further investigation.

If high mortality rates and disease incidence can be considered clear indicators of poor welfare, their absence does not necessarily mean that the animals are in the most favourable

conditions. In fact, there are numerous subtle situations that may cause poor welfare without provoking an immediate state of illness (eg boredom, social pressures, food preferences, etc). Thus, factors such as physical appearance, variability of behaviour patterns, spontaneous variations in the daily activities and frequency of playing and exploration, may play a very important role in showing how the animals are coping with their environment. Since it appears that marine mammals only exhibit symptoms of illness very late in the disease development (Sweeney 1990), monitoring of behaviour may be of paramount importance in the prevention of diseases as well as in the improvement of general welfare.

This study aimed to provide a quantitative description of the overall behaviour of bottlenose dolphins apart from their performing and training routines. The study of individual behaviour patterns, diurnal variations of behaviour, use of area and associations between the animals, was done in an attempt to discriminate the appropriate behavioural features to assess the dolphins' welfare. The analysis of this information in relation to some management routines and physical characteristics of dolphinaria may also contribute to improve their welfare.

Materials and methods

Housing and physical conditions, the dolphins and management routines

The spontaneous behaviour of two groups of dolphins was systematically observed for six weeks in July and August 1993, in two dolphinaria in Portugal, owned and managed by the same company. For the purposes of the paper they will be named, dolphinarium A ('Golfinhos de Miami', located at the Lisbon Zoo) and dolphinarium B ('Zoomarine', a marine park in Albufeira, in the south of Portugal). In both places the dolphins have regular medical care and periodical water analyses are carried out.

Both dolphinaria consist of a complex of three pools with the characteristics shown in Figure 1 and with the dimensions expressed in Table 1. Both have the holding pens isolated from the public and protected with a covering, which creates some shade. The main pool of dolphinarium B has underwater viewing panels 1.80m high, covering a width of approximately 15m.

Table 1 Dimensions of the pools in dolphinaria at Lisbon and Algarve.

Dolphinaria	Dimensions of main pool	Dimensions of each holding pen	Total water volume
A (Lisbon)	19x13m; 4m deep 230m^2 surface area	11m diam; 4m deep 108m^2 surface area	c1600m^3
B (Albufeira)	25x15m; 6m deep 330m^2 surface area	10m diam; 6m deep 105m^2 surface area	c3000m^3

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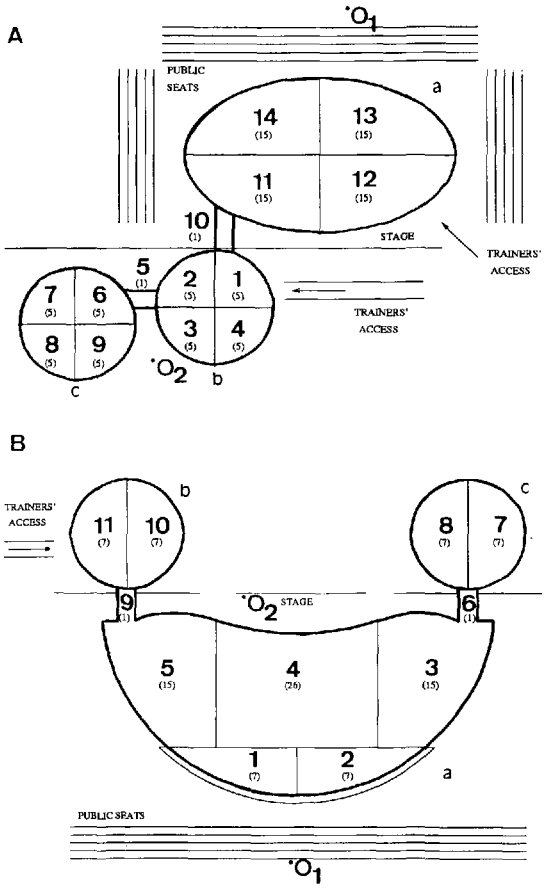

Figure 1 **The dolphinaria at Lisbon (A) and Albufeira (B): pools a, b and c and the numbered areas used for recording positions. Figures in brackets show proportion (%) of total area. O_1 and O_2 indicate observation positions.**

The group studied in dolphinarium A consisted of two dolphins and the one in dolphinarium B was composed of six dolphins. The family relationships among the dolphins are expressed in Table 2. All of the dolphins were born in captivity. Their contacts with humans occur during shows, training sessions, the administration of medicines and/or medical examinations and also during free meals or periods of informal interactions between the animals and the trainers. The number of meals and daily allowance of food varies with the individual needs of dolphins. In dolphinarium A the average was 6 daily meals, whereas at dolphinarium B this number ranged from 8 to 14. During the period of observations, the dolphins performed three shows a day. In dolphinarium A, there was one in the morning and two in the afternoon, all with the approximate duration of 30 minutes. In dolphinarium B two of the shows were carried out in the afternoon and one in the evening, all lasting for about 50 minutes. In dolphinarium A all the ambience of the show (music, activity in the display pool area, etc) began approximately one hour earlier due to a performance of sea lions,

which lasted half an hour and finished some minutes before the dolphin show. In dolphinarium B, the preparation for the show (eg music, placing the food and the various toys in the right places) started only about fifteen minutes before.

Table 2 The study animals.

Name	Sex	Age at time of study (years)	Length (metres)	Origin/ Parentage	Dolphinarium	Observations
Pinocchio	Male	16	2.52	USA/ unknown	A	Arrived Portugal (Lisbon) 1988
Missy	Female	14	2.53	USA/ unknown	A	Arrived Portugal (Lisbon) 1988
Happy	Male	3	2.00	Portugal (Lisbon) /Pinocchio & Pincesa	B	Date of birth: 19 December 1989 Transported to dolphinarium B, after mother's death 1992
Sam	Male	30	2.60	USA/ unknown	B	Arrived Portugal (Albufeira) 1991
Cher	Female	26	2.55	USA/ unknown	B	Arrived Portugal (Albufeira) 1991
Baby	Male	9 months	1.60	Portugal (Albufeira)/ Sam & Cher	B	Date of birth: 25 October 1992
Niko	Male	13	2.43	USA/ unknown	B	Arrived Portugal (Albufeira) 1991
Colby	Female	13	2.48	USA/ unknown	B	Arrived Portugal (Albufeira) 1991

Data collection and sampling methods

The places where the observations were conducted are shown in Figure 1 (O_1, O_2). The periods of observation were chosen to avoid any need for modifications in the usual routine. The total area of the pools was subdivided (Figure 1) to record the position of the dolphins during the observations. A pilot study was conducted during which *ad libitum* observations were made covering two 24-hour cycles when the ability to recognize the individual dolphins was developed and eighty five behaviour patterns were observed (Galhardo 1993), some of which have already been described in other studies done in the wild and in captivity (eg Tavolga & Essapian 1957; Weaver 1987; Jordão 1992; Gygax 1993). These behaviour patterns are listed in Table 3; the full ethogram is available on request from the first author. No monitoring of underwater vocalizations was made, and the sampling covered mostly the behaviours observable at the surface.

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Table 3 **Activity categories created for the data analysis. Behaviour patterns are from the ethogram in Galhardo (1993).**

Activity category	Description	Behaviour Patterns
Playing	All the behaviour patterns related to play but which do not imply interactions with other individuals. It may also include some exploratory behaviours, when these could be clearly observed.	Playing water, watching glass, surfacing/submerging, spraying, mouth opening, headstanding, playing bubbles, vocalizing, leaping, spyhopping, stroking water, manipulating objects, spinning, rotating in the spyhopping position.
Resting	The majority of the stationary behaviours.	Floating (dorsal, vertical, lateral, ventral, gliding, dorsal floating with headnods, rubbing while floating, chin resting while floating, body resting.
Interacting	Includes all kind of contacts between dolphins regardless of their nature (eg play, sexual interactions, aggression, suckling) and patterns of swimming obviously linked to interactions.	Interacting, whirling, vocalizing, touching, mouthing, chasing, leaping/arching, ventral/ventral swimming, backwards swimming, forward rolling, tail slapping, biting, stroking, breaching, suckling.
Swimming	Patterns of swimming performed by dolphins either on their own or synchronized with others (but never conspicuously interacting).	Normal, inverted, lateral, parallel and synchronized swimming, forward rolling.
Alertness	Behaviours (mainly head movements) that imply the dolphins' attention directed towards the area around the pool, which occurred mostly at specific places, ceasing totally after some event (a meal, a show, an interaction with a trainer) had taken place.	Head up surfacing/horizontal, peek/head up submergence (head up sequence), spyhopping, vocalizing, vertical peaking, leaping, head up, horizontal peeking, glancing, head up swimming, vertical surfacing, chin resting with the eyes open.
Other	Behaviours whose function was not clear, or those that occurred in so many different contexts that it was not possible to place them in any other category.	Headstanding, tail upwards, rubbing.

A similar sampling method was used for both study sites. Six observation times were chosen (Table 4). Focal animal sampling (Altmann 1974; Martin & Bateson 1986) using intervals of 30 seconds was conducted, interspersed with scans of the group. In addition, rare events were recorded *ad libitum*. A tape recorder, with an earphone attached, was used as a beeper, indicating thirty second intervals throughout the sampling.

In dolphinarium A, 36 minute observation periods were carried out, scheduled as follows: one focal sampling of 5 minutes and a scan of the group, both repeated three times in each sampling period. This procedure yielded 15 minutes of focal sampling per animal and six scans of the whole group. Similar samplings were done six times throughout the day (Table 4) and repeated on three days.

Table 4 Sampling times in each dolphinaria.

Sampling times	Dolphinarium A (Lisbon)	Dolphinarium B (Albufeira)
700h	Early morning period (no staff)	Early morning period (no staff)
900h	Period preceding trainers' arrival	Period preceding trainers' arrival
1100h	Period before the first show	Interim period
1330h	Interim period	Period before the first show
1930h	Period after a show	Period after a show
2330h	Nocturnal period (no staff)	Nocturnal period (no staff)

In dolphinarium B, for the focal sampling, the group was divided into two subgroups of three dolphins each, both observed randomly and in independent periods. Each observation period was scheduled as in dolphinarium A, lasting 54 minutes: 15 minutes of focal samplings of three dolphins, interspersed with nine scans (1 minute each) of the whole group. Similar samplings were done six times per day (Table 3) and repeated two times for each subgroup.

Data analysis

For the purposes of the analysis, the recorded behaviours were grouped into six activity categories: playing, resting, interacting, swimming, alertness, and 'other' (Table 3). Very little time was spent in the 'other' category so this was excluded from further analysis. The data discussed in this paper was based only on the scan samplings. Therefore, the 'proportion of time' calculated for the above mentioned behavioural categories is actually the proportion of all sample points on which that behaviour was occurring (Martin & Bateson 1986). The same applies whenever frequencies were calculated. The description of individual and diurnal variation in behaviour as well as the reported preferences in use of area, were all based upon the average proportion of time each animal spent in each category of behaviour or in each area.

The consistency with which the dolphins performed certain categories of behaviour over the days (at the same hours) was tested using Kendall's concordance test (Siegel & Castellan

1988). The Shannon diversity index (Begon *et al* 1991) was used to assess the diversity of each dolphin's behaviour throughout the day, in the same procedure as Gygax (1993). For each dolphin, all the area-behaviour combinations that occurred during the six daily scan periods were recorded. Every shift between areas and/or changes in behaviour created a new data point. Thus, a number of area-behaviour combinations for each of the six observational periods of the day were obtained. The indices were then calculated based on the equation:

$H = \Sigma [P_i \times \ln P_i]$ where P_i = frequency of area-behaviour combinations i.

A Chi-square test (Siegel & Castellan 1988) was carried out to see whether or not synchrony of behaviour between animals increased significantly when they were in the same area. For illustration of the results, an adaptation of sociogram representation was used (Martin & Bateson 1986). The total number of times that each dolphin interacted with another was then calculated. The relative frequency of interactions was obtained by dividing the total number of interactions by the frequency that the animals were observed in the same area.

Results

Variations in individual behaviour

The variation of the proportion of time spent in different categories of behaviour amongst the animals of both dolphinaria is shown in Figure 2. In dolphinarium A, Missy and Pinocchio showed very similar patterns and frequencies of behaviour. Swimming occupied the largest proportion of their time (42% on average), followed by alertness (23%) and resting (19%). Both dolphins showed a substantial diversity of alert behaviours. Less time was spent interacting and playing but in very similar proportions (7% and 8%, respectively).

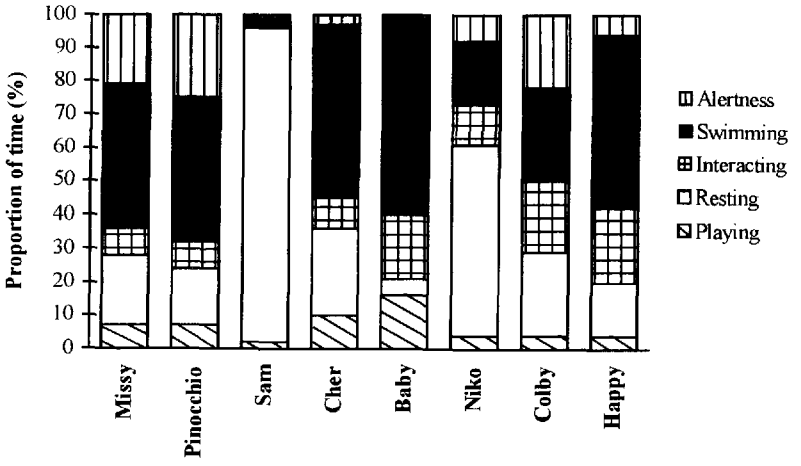

Figure 2 **Proportion of time (%) spent in different categories of behaviour by dolphins in both dolphinaria.**

The six dolphins of dolphinarium B (Sam, Cher, Baby, Niko, Colby and Happy) did not show such similar distribution of their behaviour. Sam's behaviour was dominated by resting (94% of the total time). Cher and her offspring Baby spent approximately half of the time

swimming (52% and 58%, respectively). Almost all the rest of Cher's time was occupied resting and playing; she interacted very little and did not show very much alertness. Baby spent more time interacting and he was the dolphin that showed the highest frequency and most diverse patterns of play. The rest of the dolphins played very little. Niko spent a substantial part of the day resting (57%) and the rest of the day interacting and swimming (12% and 19%). Colby's behaviour categories were quite evenly distributed between categories. Happy spent much of the day swimming (52%), showing the biggest diversity of swimming patterns. Together with Colby and Baby, he showed the highest number of interactions. Happy spent very little time resting and being alert.

Distribution of activities throughout the day

The activities of the dolphins in dolphinarium A were generally distributed in a very similar way throughout the day. The highest frequency of play behaviour occurred at 1330h but some play was also seen at 0700h, both periods being characterized by the absence of trainers. Most interactions also occurred in the early morning. Both animals were consistent in the distribution of their interactive behaviour throughout the days (Missy, Kendall's test = 0.733, $P < 0.05$; Pinocchio, Kendall's test = 0.815, $P < 0.01$). However, only Missy showed significant consistency in the distribution of play behaviour (Kendall's test = 0.717, $P < 0.05$). Resting occurred at all times, but was more frequent towards the end of the day (after the last show and in the nocturnal period) and in the early morning (0700h). During the *ad libitum* observations resting episodes were observed after most shows. The degree of alertness increased at 0900h and 1930h, times respectively related to the trainers' arrival and departure. The data also showed that there was a high degree of alertness around 1100h, when activity associated with the show started.

At dolphinarium B, on average, all categories of behaviour occurred at all times of day and some of them with very little patterning (eg playing, resting). Despite the variations, swimming and resting remained always the most frequent activities throughout the day.

The first two observation periods of the day (0700h and 0900h) showed a high proportion of time spent resting (41% and 39%, respectively). Swimming (29% and 39%) and interacting (17% and 18%) also occupied an important part of these periods. Alertness and playing registered quite a low frequency even though alertness slightly increased around 0900h, when the trainers arrive, whereas the play behaviour decreased. At 1100h the most frequent activity was swimming (44%). This was the time of day when less interactions and more alertness occurred and corresponded to the period when no routines were carried out with the dolphins. A similar pattern was shown at 1930h, after the second show of the day. Resting (36%) was the most important activity at this time, followed by swimming. At 1330h, before the first show, the distribution of the behaviour categories showed a very similar pattern to that described for the early morning period (0700h). At 2330h swimming and resting were the most common patterns (40% of the time each), while interactions occupied the rest of the time. Playing and alertness were absent in the nocturnal period (2330h).

Diversity of area-behaviour combinations shown by Missy and Pinocchio (Figure 3a) in dolphinarium A, followed a very similar variation, with Pinocchio showing a slightly lower degree of diversity. This difference was particularly noted at 1930h. In fact, at this time of the day he was almost always alert (when trainers left the area), whereas Missy interspersed

alert behaviours with resting. Generally, the diversity of behaviour of both dolphins decreased towards 1100h (the time of the first show) and Missy's increased towards the end of the day, decreasing again after 1930h.

Concerning dolphinarium B, the diversity of area-behaviour combinations varied in Colby, Happy and Niko in a similar way (Figure 3b). In the morning period, Niko showed slightly less diversity than the other dolphins. In these three dolphins, an important decrease occurred at 1100h (the interim period). After that diversity increased again until 1330h, and started to decrease towards the end of the day. Cher and Baby had a similar trend of variation in their diversity of behaviour (Figure 3c). The period in which they showed most diversity of behaviour was between 1100h and 1930h, with a peak at 1330h (just before the first show). After 1930h it greatly decreased. Sam was the animal for which area-behaviour combinations were least diverse throughout the day. He showed a very slight decrease from the beginning of the day towards the end (Figure 3d).

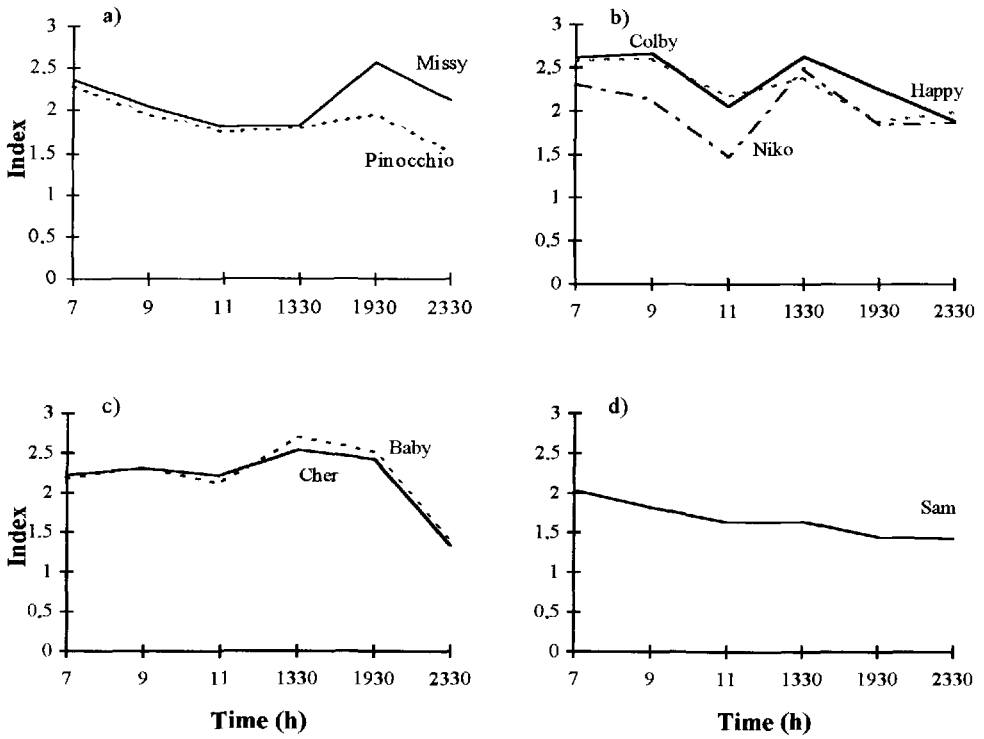

Figure 3 **Diversity in behaviour : Shannon index for diversity of area-behaviour combinations in (a) dolphinarium A, and (b-d) dolphinarium B.**

Use of Area

Pinocchio and Missy (dolphinarium A) also followed very similar patterns in terms of use of area; they seem to have clear preference for certain parts of the pools (eg area 1, in pool b, was the most used area, whereas pool c was only visited occasionally). This preference is even clearer when the use of areas throughout the day was investigated. At 0700h, they

spent the majority of the time swimming around the pools (mainly pool b), with patterns of interactive behaviour (ventral/ventral swimming). At 0900h, when many alertness patterns started to be shown, there was a clear preference for areas 1 and 12, from where they could easily see the trainers coming (swimming around pool b was also frequent). At 1100h access to pool a was closed. At this time, the dolphins spent a considerable amount of time circling together around pool b, at a moderate or fast speed (deep or at the subsurface). The only exceptions to this behaviour were the alert patterns shown in area 1 (either towards the trainers' access corridor or towards the gate between pool a and b), or attempts at interactions with the trainers and sea lions in their movement to the stage. The most important part of the interim period (1330h) was spent in area 13, where the toys were placed. At 1930h, this pattern changed to a distribution of use of area very similar to that at 0900h. In fact, the dolphins preferred to spend this period in areas 1 and 12 again (which also corresponded to an increase of alertness). The time spent swimming around the pools was extremely low. In the nocturnal period, area 11 in pool a and area 2 in pool b were the most used for resting. The dolphins also spent a considerable amount of time swimming around both pools. Because their swimming at night was mostly in the form of 'parallel swimming', it is very likely that this is another resting pattern.

In dolphinarium B, area 5 was the most used area, immediately followed by area 3, both in the main pool (a). Time spent swimming around pool a, and time spent in area 4 and 9 were similar. The use of pool b and areas 1 and 2 in pool a was rather infrequent. The dolphins did not use pool c. However, there are some important individual differences. In fact, Sam chose to spend the majority of his time in area 3 and in channel 6. In an opposite pattern, Niko preferred area 5 and channel 9. Both dolphins visited the other areas only occasionally. Cher used the pool areas in a more uniform way than the other dolphins. However, she spent more time swimming around pool a than in any other areas of the pools. In dolphinarium B, no special relation between time of day and use of area was found.

Association between individuals

In general, Pinocchio and Missy (dolphinarium A) spent much time together in the same area. The times of day in which these animals shared the same area most were at 1330h (78%) and at 2330h (72%). For the majority of time spent in the same area (69%), the two dolphins were performing the same category of behaviour (56%; $\chi^2 = 25.6$, $df = 1$, $P < 0.01$). Of the time spent in the same area, Pinocchio and Missy interacted for only 13 per cent.

At dolphinarium B, the animals that spent most time sharing the same area were Cher and Baby (78%). Niko, Colby and Happy also spent a considerable amount of time in the same area. Sam was the animal that spent least time in the same area as other dolphins, followed by Cher (excluding the time she spent with Baby). The degree of synchrony amongst the group of animals in this dolphinarium is illustrated in Figure 4. Cher and Baby showed the highest degree of synchrony (63%). Neither Cher nor Baby showed a degree of synchrony higher than 20 per cent with the other dolphins. Colby and Happy spent 32 per cent of the time in the same area, performing the same behaviour. Niko spent 24 per cent of the time synchronized with both Colby and Happy. The synchrony of Sam with other animals is very low, not exceeding 10 per cent of the amount of time spent in the same area in any case.

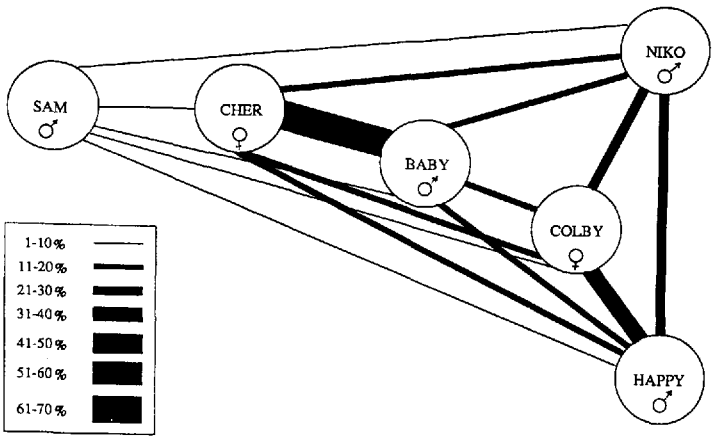

Figure 4 **Time spent in the same area performing the same behaviour by the dolphins in dolphinarium B. The width of the lines between the circles represents proportions of time.**

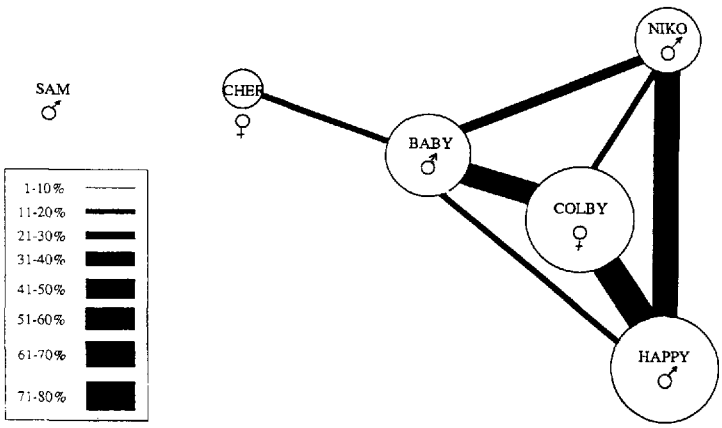

Figure 5 **Relative interaction frequency between individuals in dolphinarium B. The width of the lines between the circles represents the proportions of time spent interacting. The different diameter of the circles represent the total number of interactions performed by each individual. The absence of lines or circles indicates absence of interactions.**

In terms of their patterns of interactions it was observed that Sam did not interact with any other animal (Figure 5). Cher only interacted with Baby. Baby established about the same number of interactions with Cher (the mother) and Colby (the other female of the group). Few interactions were maintained by Baby with Niko and even less with Happy. The majority of Niko's interactions were directed to Happy. Some were seen between him and both Colby and Baby. Colby and Happy were the animals that showed the highest number of interactions and the majority of these were directed to each other. A quite significant

number of Happy's interactions occurred between him and Niko. Not surprisingly, the results show that 'time spent in the same area' is not equivalent to the 'time spent interacting'. Comparing Figures 4 and 5, relevant differences may be noted between the high level of interactions Colby/Happy and the little time they spent in the same area. Also it is interesting to note that while Baby spent the majority of time with his mother, the relative interaction frequency was much higher with Colby, with whom he spent much less time.

Discussion

Almost all the behaviour patterns mentioned above have been seen in the wild (eg Weaver 1987) and in other dolphinaria (eg Tavolga & Essapian 1957; Tavolga 1966). The abundance of head movements above the surface seems to be characteristic of dolphins in captivity. It was noted that many of these behaviours were stimulated by specific features of the pool environment (eg pulling hoops, opening mouth towards balls) or by interactions with humans (eg opening mouth, spraying). Such features (above water) seem to play a very important role in the dolphins' behaviour and welfare, since they constitute a complex and very rich dimension to explore. In fact, they contribute to increase the variability of behaviour, avoiding symptoms of boredom.

It is unlikely that dolphins' behaviour in different dolphinaria will ever be the same. All dolphinaria have particular physical features and typical patterns of interactions between the dolphins and humans. Also, each animal tries to cope with the environment in different ways, since its behaviour and adaptive mechanisms are the result of numerous individual factors (eg genetic characteristics, past experiences, health state). The understanding of these contributes to define the individuals' temperament and, therefore, may be of great help in the solution of many welfare problems (Manteca & Deag 1993a).

This study has shown an important degree of individuality in the spontaneous behaviour of the observed dolphins. In fact, individuals differ in terms of frequencies and patterning of their behaviour as well as in the use of area. The differences were stronger in the larger group (dolphinarium B). In the smaller one, the behaviour of both dolphins was similar, even though subtle differences between them were consistently detected. Regardless of their marked degree of individuality, it was possible to define trends in the dolphins' behaviour and to describe several traits of their social structure. Some degree of behavioural influence amongst animals of the same group was detected (eg many forms of play were unique to each dolphinarium). Such behavioural idiosyncrasies, defined as social roles by Manteca & Deag 1993b, have also been reported for primates and cattle. Those authors suggest that, within a group where social bonds have been established, the effect of environmental stressors may be diminished. Thus, the existence of a social role in both populations of dolphins may be regarded as a feature that may contribute to their welfare.

Play activities may be particularly important to the well-being of captive dolphins. Play is an important condition for well-being, it may even constitute a priority when an animal does not need to struggle for survival (Wemelsfelder 1993). In this study, the total amount of time the dolphins spent playing was smaller than would be expected from the literature (McBride & Kritzler 1951; Brown & Norris 1956; Caldwell & Caldwell 1972; Tayler & Saayman 1973). One possibility is that some less obvious play patterns were incorrectly included in other categories of behaviour. However, since the earlier studies mentioning play have not been quantitative, it would be worthwhile to investigate in further detail the role

of play in captive dolphins. In dolphinarium A, the distribution of this activity throughout the day showed a pattern that did not always seem to be linked to the presentation of external stimuli. In fact, at 1330h the dolphins were given access to toys (in area 13) and they spent much of their time playing, whereas at 1930h, under the same conditions, they never did so. In dolphinarium B, more playing might have been expected, especially in the case of Happy, since he is a very young animal. He showed a diversity of swimming patterns as well as 'jaw clapping' (normally associated with aggression) while swimming, that were possibly forms of play. In this dolphinarium, it is likely that if the animals had been presented with toys, as in dolphinarium A, their total time spent playing would have been higher.

The diurnal variation in the behaviour of the two studied groups was considerable. The most relevant differences were a much higher degree of alertness in dolphinarium A whereas the dolphins in dolphinarium B showed many more interactions. These alert behaviours (and the associated use of specific areas of the pools) in dolphinarium A commonly coincided with management routines, which suggests that those dolphins were very attached to the humans and thus very attentive to all situations that implied their contact with them. Also they seemed to engage in longer interaction periods and play behaviour when no staff were present.

By contrast, the group in dolphinarium B did not seem to be particularly dependent upon human contact, not even showing any anticipation prior to shows. If the alertness of these dolphins was linked to management routines, it would be expected that the proportion of time spent in this behaviour would increase at 0900h (before the arrival of the trainers) and at 1330h (before the first show of the day). The results show that these were not the times in which alertness occurred most. In fact, they were more alert in the interim period (1100h) and at 1930h (after a show). Apparently their alertness does not seem to be linked to any management routines, which makes sense considering the richness of social interactions and the fact that the animals are never left alone for long periods of time. Besides, these dolphins have permanent visual contact with people since the main pool has underwater panels with free access to the public.

The degree of association between Pinocchio and Missy (dolphinarium A) was very high. Despite the low frequency of direct interactions, these two dolphins spent the majority of their time in the same area and their synchrony of behaviour was high. At dolphinarium B, factors such as the patterns of diurnal diversity of behaviour or differential use of area, suggest the existence of well-defined association subgroups:

- Sam, spending his days quite isolated;
- Cher and Baby, with a very high degree of synchrony and, proportionally, not many interactions;
- Niko, Colby and Happy, showing various types of interactions and with partial synchronization.

Sam, the oldest dolphin of the group, tended to isolate himself from the other dolphins, which is common with old males in the wild, avoiding activities other than resting. Cher was the dominant female. Her maternal status, patterns of association with the other dolphins (except Baby) and the absence of aggression marks on the body were all factors that indicated her position within the group. Niko, Colby and Happy seemed to establish the higher degree of interactions but, proportionally, they did not synchronize their behaviour often. The context of some aggressive bouts initiated by Niko (qualitative observation),

seemed to be attempts at asserting dominance over Colby and Happy. Colby's interactive patterns agree with previous descriptions of social relationships of females without calves (Tavolga 1966; Caldwell & Caldwell 1972), that is, they tend to associate with subadult animals or with females with calves. It is interesting to note that Baby interacted as much with Colby (the female of the group without offspring) as with his mother (Cher). While some interactions seemed to be of a sexual nature (due to the observed penile erections in the males) it has been shown that apparent sexual behaviour may serve other social functions (Evans 1987).

Overall, the behaviour of dolphins in dolphinarium A was much more predictable than the behaviour of those in dolphinarium B. This included distribution of behaviour throughout the day, frequency of certain behaviour patterns, use of area and degree of synchrony. Many factors other than individuality must have been involved in these differences, such as the characteristics of the two social groups. In fact, there were many more social stimuli in dolphinarium B, since the presence of various animals of both sexes and different age classes, enriched the social environment. The intense activity of young animals and a moderate level of aggression by males may have provided stimuli which contributed to the avoidance of symptoms of boredom, or to excessive anticipation of interaction with humans. The observations strongly suggest that environmental stimulation in dolphinarium B (dolphins have visual contact with the public all day, they have almost permanent contact with trainers, the feeding sessions are more numerous and at less predictable times, etc) must also have contributed to the higher variability of the dolphins' behaviour.

In the future, it would be interesting to assess the specific influence of each of the mentioned variables on the dolphins' behaviour. This study has not been directed to events related to the shows, but it suggests that some aspects of such events deserve particular attention (eg frequency comparison between behaviour patterns performed in the shows and those occurring spontaneously; environmental features present immediately before and during the show times; etc) since they seem to influence the dolphins' welfare.

Animal welfare implications

A relevant implication of this study is the evidence that individual differences exist in captive dolphins as well as strong social bonds. Thus, both these aspects should always be borne in mind when assessing their welfare or when management decisions are taken (eg separation or mixing of certain individuals). This is particularly important now that exchanges within the EEP (from German: 'European Endangered Species Breeding Programme') are likely to occur in the near future.

Using these two groups of dolphins as models, a few behavioural variables are suggested that may be used as indicators of welfare:

- total amount of play behaviour and the context in which it occurs;
- variability of behaviour patterns and its relationship to the management routine;
- predictability of behaviour throughout the days;
- richness of social interactions.

Some of the factors that may account for a higher behavioural variability are:

- presence of toys in the pools (or any objects that could serve as such);
- permanent visual contact with people (without direct interference);
- numerous contacts with trainers throughout the day, at unpredictable times.

One physical contribution to the dolphins' welfare is the existence of holding pens that may be used as refuges in situations of aggression within the group or in extreme climatic conditions (eg during an extremely windy night all dolphins sought protection in one of the holding pens).

From a welfare point of view, the composition of the social group seems to be very important. As already mentioned, its complexity allows the performance of many natural social patterns of behaviour, which is certainly relevant for their integrity as individuals. Obviously, it is necessary to consider the area available in the pools. If there is not enough space, a very high social stress may arise, resulting in a higher level of aggression.

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