4. Behavior of dolphins *Tursiops truncatus* towards adults and children during swim-with-dolphin programs and towards children with disabilities during therapy sessions.

Abstract

In recent years dolphin-assisted therapy has become very popular and an increasing number of facilities offer therapy programs with dolphins worldwide. In contrast to other animal-assisted therapy programs, dolphins are not domestic animals; they are mostly caught in the wild and there are still no studies on their behavior during these therapies. However, there are some speculations that the behavior of dolphins toward human with mental and physical disabilities may play an important role in the success of the therapy. We observed 83 sessions with five untrained dolphins (*Tursiops truncatus)* at the "Dolphins Plus", a fenced area with ocean water in the Florida Keys. Our detailed observations of contact and distance behavior between dolphins and different groups of swimmers (adults, children, and children with mental and physical disabilities) show that in general dolphins prefer small humans to adults. One dolphin showed a clear preference toward children with mental and physical disabilities, and her behavior can be interpreted as assisting.

Introduction

Dolphin-assisted therapy has been employed for about 20 years to help mentally and physically disabled or terminally ill people. In contrast to the knowledge about swimming-programs with healthy humans (Frohoff & Packard 1993; Samuels & Spradlin, 1995; Kyngdon, D.J., E.O. Minot, K.J. Stafford. 2003), there are virtually no publications concerning the behavior of dolphins in swimming-programs with children with mental and physical disabilities or adult patients. Since 1982 there has been a small number of publications about dolphins-assisted therapy by several psychologists: The first piece of research was a case study in which dolphins were used to motivate an autistic child to communicate (Smith 1981). A further experiment indicated that children learned two to ten times faster and with greater retention when working with dolphins (Nathanson 1989). Also significant improvements in hierarchical cognitive responses occurred when interacting with dolphins in mentally disabled children (Nathanson & de Faria 1993). An improvement of the social situation in families with disabled children could also be observed (Voorhees 1995). Analysis of EEG showed that interaction with dolphins has a relaxing influence on humans (Cole 1996; Birch 1997). Effectiveness of short-term (Nathanson, de Castro & McMahon 1997) and long-term (Nathanson 1998) dolphin-assisted therapy for children with severe disabilities was presented. Based on a study with approximately 1500 patients, a positive influence on child's autonomic homeostasis and psychoemotional status could be observed (Lukina 1999). Furthermore, the presence of the dolphins seemed to alleviate the pain atopic dermatitis patients experienced while bathing in seawater. It could be shown that the skin condition improved dramatically, and immunologically, while serum IL-8 levels decreased (Iikura et al. 2001). A reduction of anxiety in organized tourists swimming groups in the wild was also observed (Webb and Drummond 2001). However, it is important to note that there also exists severe criticism that some of the studies used flawed data resulting in flawed conclusions (Marino and Lilienfeld 1998). Many common and uncommon effects of the DAT and also some future outlooks which represented the therapy in a very promising light have been discussed (McKinney, Dustin and Wolff 2001). Curtis points out that all publications were focused on humans but not on dolphins and possible disadvantage for these animals (Curtis 2000). Additionally, there is still an open discussion about the ethical and safety concerns of using wild animals (Iannuzzi

and Rowan 1991). Finally, Smith described the discovery and development of dolphin-assisted therapy based on her experience of more than 20 years as a scientist (Smith 2003).

However, to this date no studies exist about the behavior of dolphins during the dolphin-assisted therapy. In contrast to common assisted therapies with domestic animals, dolphins are not pets, they are predators and mostly captured from the sea. Nevertheless, people are willing to pay much more for dolphin programs than for other animal assisted therapy programs, mainly due to the greater publicity of dolphin therapy in the media. This resulted in a growth of this type of business over the last 10 years, and it is very likely that many oceanariums will follow the trend of offering this service.

One reason for the popularity of the dolphin-assisted therapy could be that humans have a very emotional attachment to these animals. We do not think that this is a sufficient explanation, because a high percentage of patients are very young or, for instance, autistic, and it is very unlikely that these patients could have developed this emotional attachment prior to the therapy. Moreover, we observed that many patients hesitated to interact with the dolphins in the first sessions because they were scared by these huge, unknown animals. The emotional attachment of humans is responsible for the great publicity of this kind of therapy. However, if there is any difference to other animal-assistant therapies, it may be due to other factors such as the excitement of being in the water or receiving all the unusual attention from other people.

Generally there are many reasons given for the success of animal-assisted therapies, most of which are based on the effects of socializing, such as increasing trust or responsibility (Levinson 1984; Blue 1986; Wilson 1987; Friedman & Thomas 1985; Veevers 1985; Fine, 2000).

Certainly, some of these mechanisms are valid for dolphins too. But trainers, therapists, and patients have reported that dolphins interact differently with patients than they do with healthy individuals, when they were not under the trainer's control. However, there could be several reasons for this behavior such as dolphins realizing that patients are not used to the water and need assistance or just because people and trainers treat people with mental and physical disabilities differently. We were able to confirm these anecdotal accounts in a pilot study in 1997. If dolphins indeed interact in a different way with patients than with healthy humans, this self-motivated

behavior and the water environment could account for the difference with other animal-assisted programs and a reason for a success of dolphin-assisted therapy. The aim of the study was to empirically test the hypothesis:

- Dolphins can distinguish between different groups of humans.

We observed the distribution and behavior of five **untrained** dolphins in interaction with different kinds of humans.

Material and Methods

Observations and Participants

The observations were part of a research project about communication among dolphins and interaction with humans that took place between April and December 1998 at the “Dolphins Plus“, Florida Keys, USA, a fenced area with ocean water. The largest pool we observed at "Dolphins Plus" was 20 X 30 m and depth of about 5 m. There was no refuge area where the dolphins were undisturbed and all dolphins were present in the pool during our observation period. The therapy is conducted by therapists of the "Island Dolphin Care, Inc." and is divided into three parts: (1) therapy in the classroom, where therapists use standard therapy techniques (2) therapy with trained dolphins, where therapists use trained dolphins to assist them, and (3) therapy with untrained dolphins, where therapists and patients interact spontaneously with dolphins in an unstructured manner. We included in our study only children with mental and physical disabilities younger than 12 years of age; all these children are further referred to as *patients*.

The patients had several mental and physical handicaps such as spasticity, apallic syndrome, epilepsy, ADDHD, autism, Louis- Bar-Syndrome and other disabilities. There were no special requirements necessary to take part in this therapy, except that patients had to have head control. The other swimmers were divided into two groups: adults and children younger than 12 years. This differentiation was used to analyze whether dolphins prefer small or large people.

The situations we observed included swim-with-the-dolphin programs with adults and children, therapy sessions with patients, and breaks in where the dolphins were undisturbed. Two different groups of dolphins were used in swim and therapy programs at the "Dolphins Plus". One group is trained and always under control of the trainers; correct behavior was rewarded with feeding of fish. The other group was untrained and interacts spontaneously with the swimmers with no control from the trainers. This group was fed three times a day independently of correct behavior. These dolphins were not used to being touched and all interactions with humans were initiated by the dolphins themselves.

As described in past research, trainers have a very high impact on the dolphins especially during the controlled programs (Frohoff & Packard 1993; Samuels &

Spradlin, 1995; Kyngdon, D.J., E.O. Minot, K.J. Stafford. 2003). It is therefore very unlikely that the trained dolphins in the controlled programs act in a self-motivated manner. For this reason we decided to only observe the behavior of the untrained dolphins, where the trainers do not reinforce the behavior of dolphins. There was a group of four adult females between 13 and 16 years which were caught in the Gulf of Mexico and one sub adult male of four years, born at the Dolphin Plus. These dolphins have the opportunity to interact with adults or with children in the public swim sessions. These swim sessions took place approximately 4 times a day with an average of five human swimmers regardless of adults, children or patients. In these sessions, however, the sex was normally distributed. The sessions did not take place if less than two or three people were present and not more than eight people were accepted in one session. In contrast to these swim sessions, the patients in the therapy sessions were assisted by a therapist. These dolphins have the choice of deciding if and for how long they want to interact with different swimmers. These conditions were similar to those in Birch's experiment. In our observations we concentrated on contact and distance behavior of *Tursiops truncatus*.

The dolphins were identified by natural marks (Würsig & Würsig 1977, 1979, Würsig 1978). To get representative data for the control condition with no interaction with humans, recordings were always made at the same time, in the morning after the swim sessions without humans close to the pool. The recording period was 30 minutes – the same duration as the swimming sessions and therapy programs. Altogether 83 sessions were recorded: 30 undisturbed with no humans in the water, 30 in swim-with-the-dolphin programs with tourists, and 23 in therapy programs.

Materials and Apparatus

The pool was monitored with two Sony cameras (CCD–107P) with a resolution of 752x582 pixels. One camera with a wide-angle lens captured the entire pool area and was mounted above the pool on a wooden construction on the side of the pool. The second camera recorded only a highly frequented area. This area was used to identify the dolphins. Both cameras were equipped with polarized lenses. Two VCRs (GV 690 S HiFi) were used to record the video streams synchronized by the rapid time code on tapes. This arrangement makes it possible to use the focal animal sampling technique (Martin and Bateson 1986) for each dolphin simultaneously. Therefore we were able to analyze the data for all five dolphins and all swimmers at

the same time. After identifying an individual in the highly frequented area, a special mouse-based computer program on the video screen (covering the entire pool), was used to identify the position of the dolphins and humans over time. To do so, the analogue video stream was digitized and presented on a computer screen. Every individual was followed manually by the experimenter with the computer cursor pointed on the head of humans or on the melon of dolphins, and the position of the cursor was recorded once every second. Furthermore, it was possible to add notes about each individual (dolphin or human) at any particular time, describing, for instance, depth of diving, or the color of swimming gear.

Unfortunately, it was not possible to map the cursor position directly onto the video view. All photo and video sources have a distortion of perspective, depending on the angle of the camera. This distortion must be taken into account in every case to calculate the exact positions. In this study, an exact formula complex was empirically developed for this purpose (Brensing et. al. 2001). This high precision of the position data allowed us to correlate the position from every swimmer or dolphin to each other at any given time. Based on known positions in a three dimensional coordinate system it is possible to calculate different parameters like distance, speed, frequency of contact, and duration of contact. Knowing speed and distance, we were able to calculate another essential parameter called speed-difference. This parameter is equal to adjusted behavior between individuals. All parameters were analyzed to describe the individual behavior as well as the group dynamics in the different situations. These situations were: (1) undisturbed (no humans were in the water or close to the pool), (2) adults (swimmers of an age over 12 years), (3) children (swimmers of an age under 12 years) and (4) patients (children with unspecific mental or physical handicap under 12 years of age). This distinction prevented misinterpretations, especially if dolphins showed a preference for small humans.

Calculation of parameters: The distances between two points in a two-dimensional coordinate system can be calculated according to formula 4.1.

$$D_{(C)} = \sqrt{a^2 + b^2} = \sqrt{|x_1 - x_2|^2 + |y_1 - y_2|^2}$$

Formula 4.1: Calculation of the distance (D) between two coordinates in two dimensions (x_1/y_1 and x_2/y_2)

The speed-difference was calculated from the difference of the speeds of the observed interaction-partners. For instance, if in a certain moment one individual has a speed of 3.2km/h and another individual has a speed of 2.4km/h the speed-difference is 0.8km/h. A small average of the mean value indicates that they swim at a similar speed (independently of whether they swim close together or far away). In this case the behavior must be adjusted because of the restricted area in the pool of "Dolphins Plus" (formula 4.2).

$$dV = |V_1 - V_2|$$

Formula 4.2: Calculation of the difference of speed. The speed for each interaction partner was calculated by the distance (D) per time (km/h).

The contact frequency was for the purpose of this study defined as a decrease in distance to less than two meters. Consequently, each event of entering into this area represents a contact. The contact-duration (close contact) was the time per occasion in which two individuals swim in a distance of less than two meters.

Statistics: The descriptive and the inferential statistics were calculated with SPSS version 8. The preferences for different kinds of people were calculated on basis of the reference behavior, were the dolphins were undisturbed by humans. The reference value was the average of the parameters (distance, speed-difference, contact-frequency and contact-duration) from every dolphin to all others. For example, the reference value distance of Sarah was calculated by the average of distance to Jessica, Samantha, Isla, and to Bob. A One-Way ANOVA was used to determine whether the differences in dolphins' behavior towards different kinds of humans were statistically significant. Before each analysis, a test of variance homogeneity was computed, in some cases the data had to be square root transformed. Another condition was that the data has to be independent from one other. However, position data of moving animals cannot be independent because a following position is always dependent on the previous position. The prerequisite of independent data is met if the correlation coefficient is smaller than 0,16 with an N of 100 (formula 4.3, Köhler, 1983).

$$t = \frac{|n|}{\sqrt{1 - r^2}} * \sqrt{n - 2}$$

Formula 4.3: Calculation of the correlation coefficient to prove the independence of the parameters distance (figure 4.1) and difference of speed (figure 4.2) (Köhler,1983).

To obtain the independence of the parameters distance and speed-difference, the average of 15 single values was calculated so that the correlation coefficient was below 0,15. The other parameters, contact-frequency and contact-duration, are independent. Significant results were further analyzed using Tukey post-hoc comparison. It is a common problem that there is an increase of the probability for Type I errors, if there are multiple tests. We tested this probability with the binominal distribution (Cross & Chaffin, 1982).

Results

Distance, speed difference, contact frequency and contact-duration were analyzed to describe the individual behavior of dolphins to different groups of humans. The behavior of dolphins without disturbance by humans, was the reference value.

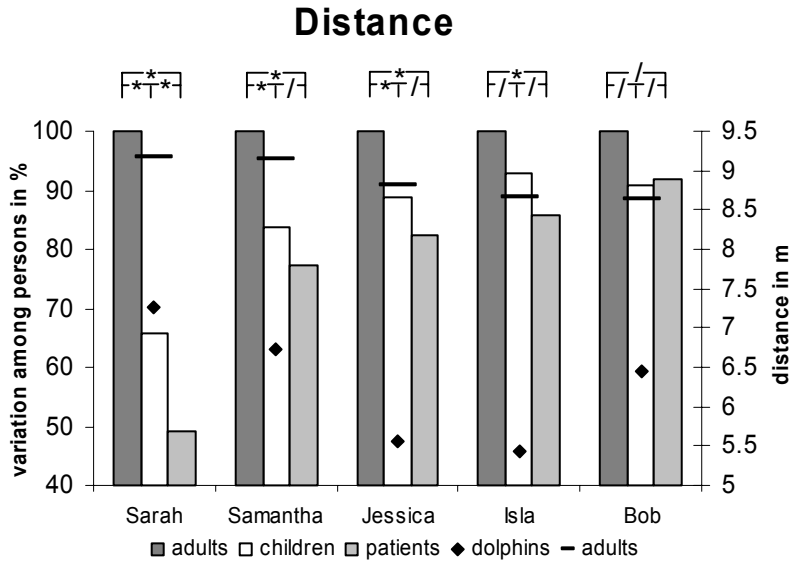

Figure 4.1: Distance between dolphins and humans. The right axis shows the average of the mean distance in metres between each dolphin and all other dolphins (◆) as well as between each dolphin and all adult humans (—). Based on the normalizing procedure, distances to children and patients were computed in percent. These relative values are presented on the left axis. In the upper part of the figure, the symbol (: ★ = significant and / = not significant) indicates if dolphins distinguish significantly between the groups of human (level of p=0.05).

Figure 4.1 shows the distance of each dolphin to adults, children and children with mental and physical disabilities. The illustration is normalized, i.e., the reference behavior value (where the Dolphins interacted with each other without disturbance by humans) is 0% and the behavior toward adults is 100%. For example, Sarah has an average distance to other dolphins of about 7.2m and 9.1m to adult humans, therefore the difference of 1.9m is set to 100%. This range was chosen to illustrate the different behavior towards humans and to simplify the interpretation. All dolphins were found to have a greater distance from humans than from the other dolphins. All animals maintained the greatest distance to adults (8.5 to 9.5m). The reference value between the dolphins, was about 5.5 to 7.5m. All dolphins showed significant differences in their behavior toward the humans, with the exception of Bob. Isla was found to

distinguish only between adults and patients. Samantha and Jessica distinguished between adults and children and between adults and patients, but not between children and children with mental and physical disabilities. They could differentiate small and large humans, as described in previous research (Samuels & Spradlin, 1995), even if the small humans were children or patients. However, Sarah could differentiate all three groups of humans, with a clear preference for patients.

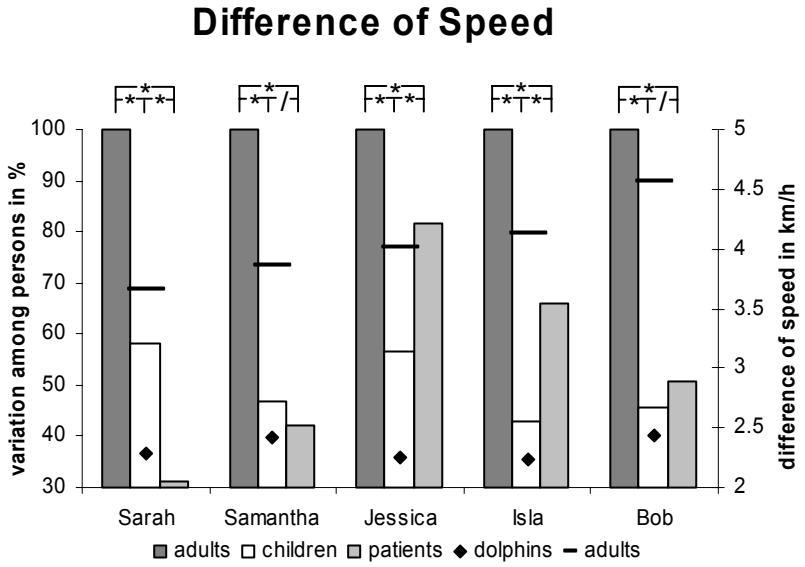

Figure 4.2: Difference of speed (DS) between dolphins and humans. The right axis shows the average of the mean DS in km/h between each dolphin and all other dolphins (◆) as well as each dolphin to all adult humans (—). Based on the normalizing procedure, DS to children and patients were computed in percent. These relative values are presented on the left axis. In the upper part of the figure, the symbol (┤*┬*┤ : ★= significant and /= not significant) indicates if dolphins distinguish significantly between the groups of humans (level of p=0.05).

The speed-difference (DS) among dolphins ranged from 2.2 to 2.4 kilometers per hour. As described above, the difference between the DS of dolphins and human adults was normalized, i.e., to 100%. For example, Sarah has an average DS to other dolphins of about 2.3km/h and of 3.7km/h to adult humans, therefore the difference of 1.4km/h is set to 100%. Similar to the parameter distance, the speed difference was always higher between dolphins and humans, and especially with adults, than to other dolphins (figure 4.2). Three dolphins distinguished between all groups of humans, but Bob and Samantha, did not distinguish between children and patients.

Contact was defined as an encounter with a distance of less than two metres. As shown in figure 4.3, dolphins had an average contact-frequency to each other of

between 1.5 and 1.9 contacts per minute. The average contact frequency of each dolphin was set to 100%, and 0 contacts are 0 percent. Most dolphins had 40% less contacts to humans than they had to dolphins. One exception was the behavior of Sarah, whose contact frequency was between 40 % and 50 %, but she did not distinguish between different groups of humans. All dolphins had more contact to small humans than to adults, with the exception of Bob, who had less contact to patients than to adults. Samantha and Isla distinguished between small and large humans, and Jessica between adults and patients. Similar to Sarah, Bob made no distinction between the different groups of humans.

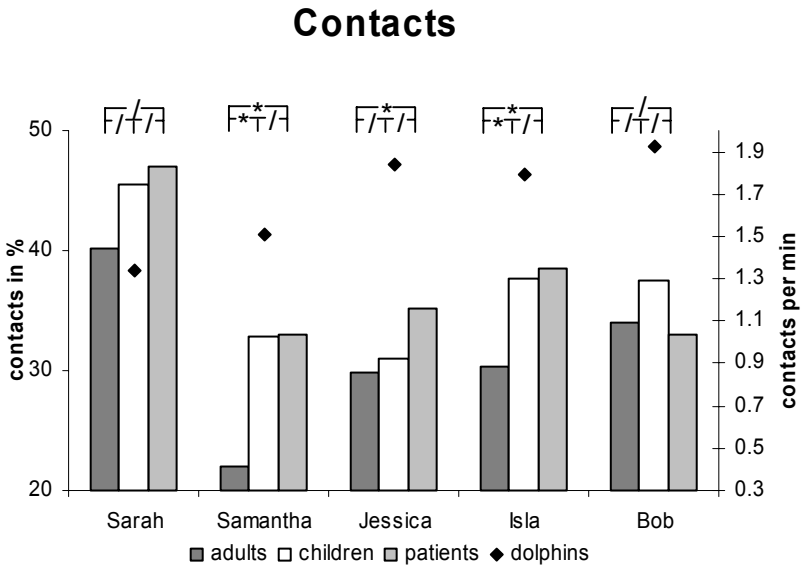

Figure 4.3: Frequency of contacts between dolphins and humans. The right axis shows the average of the mean contacts per minute between each dolphin and all other dolphins (◆). Based on the normalizing procedure, contacts to children and patients were computed in percent. These relative values are presented on the left axis. In the upper part of the figure, the symbol (: ★ = significant and / = not significant) indicates if dolphins distinguish significantly between the groups of humans (level of p=0.05).

The contact-duration between dolphins was variable from 5 to 10 seconds (figure 4.4). Similar to contact frequency, the average contact duration of each dolphin is set to 100 percent, and 0 seconds are 0 percent. None of the dolphins, with the exception of Sarah, could tell the difference between the groups of humans.

To estimate the probability, to make a Type I error, we compared the distribution between all our tests and the significant tests with the binominal distribution (Cross & Chaffin, 1982). We performed 60 tests and 29 were significant.

The probability to make a Type I error, was *P*: 6,88E-15 (exact binominal test two – tailed).

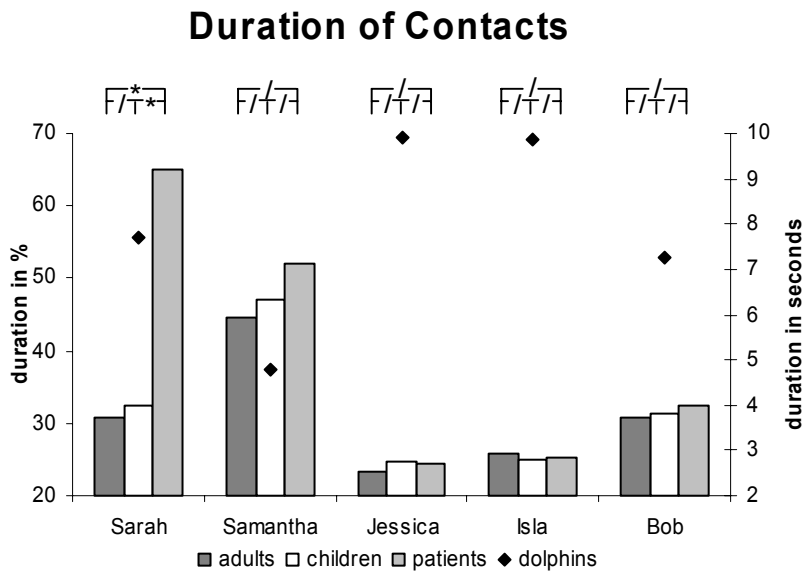

Figure 4.4: Duration of contacts between dolphins and humans. The right axis shows the average of the mean duration of contacts, between each dolphin and all other dolphins (◆) in seconds. Based on the normalizing procedure, the duration of contacts is presented on the left axis. In the upper part of the figure, the symbol (: ★ = significant and / = not significant) indicates if dolphins distinguish significantly between the groups of humans (level of p=0.05).

The behavior of Sarah was remarkable, because she especially preferred patients, whereby she did not distinguished between adults and children. Sarah was the only dolphin who established contacts with humans that lasted longer than a few seconds (in same cases >1 minute). Sarah's contact-duration to patients was equal to Samantha's contact-duration to the other dolphins. Samantha had a high percentage of contact-duration, compared to Jessica, Isla, and Bob, which was reasonable because of the low contact-duration to the other dolphins.

Sarah's long contacts invite a closer look. For nearly 50% of the contact-duration, Sarah's head was directed to the patients (figure 2.2). Usually the patients did not move much, so that Sarah had to remain in her position or swam around the patients. Sarah swam side by side with the patients for 22% of the time. She used this position to turn her belly towards the patients in 4% of the time, and several times this movement contacted the patients. In 25% of the time, Sarah swam in front of the

patients or the patients were close to her but behind her back fin. In both cases she was swimming very slowly so that the therapists with the patients could follow her.

Discussion

The results of this study show general behavior as well as individual differences among the animals.

All dolphins kept a larger distance to adults than to children and patients (figure 4.1). This demonstrates that dolphins can recognize small and large humans (Samuels & Spradlin, 1995), they prefer small ones. Perhaps small humans appear more attractive or less dangerous. The speed-difference, as a measure for adjusted behavior, shows how precisely dolphins hold a constant distance. Only two differences of the possible 15 combinations between the five dolphins and the humans are not significant (figure 4.2). This supports the hypothesis that most dolphins have the ability to recognize different kinds of humans and the behavior depends on these different groups. The speed difference compared to adults was the highest, so that we can say that the behavior to adults was less coordinated or less adjusted than that to the other groups of humans. Sarah and Samantha adjusted their behavior more towards patients. Jessica, Isla, and Bob appeared to prefer children. Dolphins approached humans with half the contact frequency that of their pool mates (figure 4.3). Most dolphins could distinguish between adults and patients/ children but not between children and patients. Similar to the distance, this finding shows that dolphins distinguish between small and large humans. The contact-duration, is an indicator of constant interest or maybe some kind of trust, contrary to the contact frequency. With the exception of Sarah, dolphins do not tend to increase the duration of contact to humans (figure 4.4). An average contact to humans took about two seconds. This is comparable to the average speed of just passing by the swimmers.

The hypothesis that dolphins can distinguish between different groups of humans cannot be accepted for the parameter tested. Three dolphins (Sarah, Jessica, Isla) distinguished, at least in one parameter, between all kinds of humans, but two animals (Samantha & Bob) did not differentiate between children and children with mental and physical disabilities. Our findings indicate that dolphins in general do not have a preference for patients but they prefer small humans to adults. However, two animals showed a different behavior, which warrants further discussion.

Bob, a 4 year old male did not distinguish between different groups of humans at all, but the speed difference and contact frequency were relatively high. This is a

common behavior for young dolphins because they are very interested and curious about humans in water in general (Pilleri, Gihr & Kraus 1980). Sarah, in contrast to the other dolphins, did not distinguish between adults and children but only focused on patients. Patients were always assisted by therapists, so Sarah could also be interested in the therapists. This could not be verified, but Sarah approached the group with a therapist and a patient more than 80% of the time from the direction of the patients, and tended to stay alongside the patients, rather than the therapists. All patients had to wear a life jacket, but it did not seem that dolphins were attracted by life jackets. It can be argued that Sarah was seeking out the patients and there are accounts of dolphins that helped and assisted each other and members of other species (Brown & Norris 1956; Norris & Prescott, 1961; Essapian, 1962; Gilmore, 1962; Caldwell, Brown & Caldwell 1963; Caldwell & Caldwell 1966; Norris, 1974; Felix, 1994). Dolphins are also known to assist helpless humans (Pilleri, 1984), but it is not known if dolphins react to special acoustic signals or to contexts of emergency (Norris & Dohl, 1988). Connor and Norris (1982) argued that dolphins supporting, care-giving and help-providing behavior towards other species is motivated by a broad concept of distress and some kind of emotional response to individuals of another species.

It can be argued that Sarah's behavior was assisting behavior, in which she also established body contact. In 25% of the contact time Sarah was swimming in front of the patient, as the leader, which is not typical for assisting behavior. The remainder of the time she was swimming around or behind the patients, and her head was orientated in their direction (figure 2.2). Usually the therapists were very close to the patients, but if they moved further away from the patients, Sarah tended to come closer to the patient. Her body turned slightly so that the belly was towards the patients. In these moments she was very close to the patients, and several times there was a body-contact, where she was trying to push the patient to the surface. This behavior is typical for dolphins if they assist with breathing (McBride & Hebb 1948; Norris & Prescott 1961). Certainly, this kind of approach could also be sexually motivated. But in this case, we wouldn't expect a different behavior to children and to patients, because they have many similarities (for instance, the same body size). Therefore we conclude that the most likely explanation for Sarah's behavior is a kind of assisting.

Experiments with children have shown that, parallel to the development of self-consciousness in the second year of life, children develop a conscience for the individuality of other children. This means that they are capable of showing empathy; for example, in the case of pain of another child (Bischhof-Köhler 1990). We as humans also develop empathy towards animals. If further observations can verify Sarah's case, it can be considered that dolphins have developed a kind of empathy to other species, too.

Conclusion

Dolphins prefer smaller humans to larger ones, and a single dolphin can be considered as assisting patients. But can the assisting behavior of Sarah explain a success of the therapy? We believe that this naturally motivated behavior can be easily reinforced, and that dolphins are therefore easy to motivate to assist the therapists and trainers, but this can not be an explanation for a success of the therapy. There are speculations that the ultrasound of dolphins can have a healing effect on patients (Cole 1996; Birch 1997). We could show that the duration of the necessary application in the observed interactions was not long enough to result a common effect of ultrasound (Brensing & Linke in press 2003). The exploration of interaction between dolphins and humans should be continued, where the neuropsychological response of humans such as EEG, EKG and EMG are continuously recorded and compared to several kinds of interactions with dolphins.

Dolphin-assisted therapy is a growth business all over the world, and expansion from pens to oceanariums is likely to occur. An interaction between dolphins and humans has a serious risk of infections and parasitism (Geraci & Ridgway 1991) for both interacting parties. To minimize this risk, oceanariums have to increase the concentration of chlorine which can results for example in irritation to eyes and skin. However, even if dolphins are shown to have a healing effect on humans, it does not necessarily mean that it would be ethical to keep them in unhealthy conditions. As described in 1991 by Iannuzzi & Rowan also today there is still no proof that dolphin-assisted therapy has more benefit then other animal-assisted therapies. Further research is required, to compare different kinds of animal-assisted therapy programs, and defining under which conditions dolphin-assisted therapy should take place.