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Short Note

Catch! Dolphin (*Tursiops truncatus*) Ball Tossing to Humans Is Affected by Human Perspective

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Although attention cannot be directly observed, its presence can be reasonably inferred by a variety of behavioral, verbal, and physical cues. For example, a referential signaler should be sensitive to the orientation of a receiver's "forward-directed" sensory systems (Corkum & Moore, 1998). Previous investigations have assessed the extent to which animals behave differently if humans are forward-facing vs facing away. For example, Call & Tomasello (1994) tested the effect of a receiver's orientation on the pointing behavior of two orangutans (*Pongo pygmaeus*) that had been explicitly trained to point. An experimenter placed two glasses of juice just beyond the ape's reach. The experimenter then faced toward the orangutan with eyes open, faced toward subject with eyes closed, faced away, or left the room. Both orangutans pointed significantly more often when the experimenter faced forward with eyes open than away or not present. However, one of the subjects consistently pointed when the human faced forward but with his eyes closed. Therefore, in this case, it is unclear what part of the attentional cue the subjects were using to infer a human's attentional state. Moreover, it is possible that the orangutans did not infer anything about the human's attentional state but, instead, were responding to situational cues (e.g., human face in view).

Flombaum & Santos (2005) presented free-ranging rhesus monkeys (*Mucaca mulatta*) with various situations in which they could "steal" a grape from one of two human competitors. Monkeys approached a human who was facing away from the grape significantly more often than a human who was facing toward the grape. The monkeys also were more likely to approach a human competitor whose eyes were facing 45° to the side than a human whose eyes were facing forward, and to approach a human competitor who was holding a small barrier horizontally in front of his eyes more often than a human who was holding a small barrier horizontally in front of his mouth. These results suggest that rhesus monkeys use information from the human gaze to provide information concerning the human's attentional state; but as was the case with the orangutans, it is possible that the monkeys' responses reflected situational cues rather than a true awareness of human attentional states.

Species other than primates also have demonstrated an ability to use at least some cues that signal human attentional states. For example, dogs (*Canis lupus familiaris*) were tested on their sensitivity to behavioral cues signaling human attention during a ball-fetching game, fetching an object on command, and begging from their owners (Gácsi et al., 2004). Dogs were tested with humans facing forward or away and blindfolded or not blindfolded. Overall, the dogs were less adept at utilizing the proper cues during the play scenario, and used the head orientation cues more successfully than the blindfolded vs non-blindfolded cues. In a different study, dogs were much more likely to disobey a command when their human owner was not looking at them or engaged in a distracting activity than when the owner was looking at the dog (Schwab & Huber, 2006).

Penel & Delfour (2014) examined the ability of sea lions to use the attentional cues of human trainers during a choice task. Sea lions were more likely to approach a trainer who had her entire body and head facing toward them than a trainer who had her entire body and head facing away. Similarly, dolphins (*Tursiops* spp.) were able to use human point and human gaze to correctly solve object-choice tasks (Tschudin et al., 2001; Pack & Herman, 2007). Xitco and colleagues (2001) described how two captive bottlenose dolphins (*T. truncatus*) spontaneously performed pointing behaviors with their rostrum in order to indicate a desired object to a human trainer and later found that the dolphins would point at a baited jar more

often when the human trainer was facing toward the subject than when the human was facing away from the subject (Xitco et al., 2004).

In the present study, we examined whether dolphins' ball play interactions with a human were influenced by the attentional state of the human. While observing a group of bottlenose dolphins at MarineLife Oceanarium, we witnessed an interesting behavior that led us to suspect that the dolphins' behavior was affected by the visual attention of humans. Many of the dolphins at this facility played with miniature basketballs, either by themselves as a form of solitary play or by eliciting social play with humans. The ball tossing behavior was not trained but, rather, was a result of trial and error and social learning. Social ball play was typically initiated when a dolphin tossed a ball at a nearby human, who invariably responded by tossing the ball back to the dolphin. This sequence was often repeated for minutes at a time and ended when either the human or the dolphin seemed to tire of the game.

Researchers recording the behaviors of the dolphins (during previous projects) often stood on the docks near the dolphins but were instructed to ignore any ball-play elicitations by them. This appeared to frustrate the dolphins and sometimes resulted in a dolphin tossing a ball with more force than usual toward the nonresponding researcher. These types of tosses seemed to happen more often when the researcher had her back turned or was not looking in the direction of the dolphin. We decided to test whether the dolphins did in fact alter their ball-tossing behavior based on the attentional cues of the human. Specifically, the ball-tossing behavior of four dolphins was tested when a human was facing forward (attentive) or facing away (inattentive).

Four adult bottlenose dolphins (one male [A] and three females [B, C, and D]) that frequently tossed balls to humans were selected to participate in this study. There were 30 trials for each condition (facing forward and facing away) for each dolphin. The order of trials for each dolphin was randomly determined. A trial began when an observer noted that a dolphin had a ball and continued until either the dolphin tossed the ball to or at the human or until 2 min had elapsed. In trials when a ball was tossed, the human researcher did not react or throw the ball back to the dolphin. For each trial, the type of ball toss was categorized as a soft toss (lob with an arched trajectory) or a hard throw (a line drive) by two independent observers. In addition, observers noted the body part of the human toward which the throw (body vs head) was directed. Inter-rater reliability was 91% for soft vs hard tosses and 87% for body vs head. All trials took place over a 2-mo period.

Preliminary group-level analyses revealed no differences between conditions in terms of frequency of ball tosses. Subsequent analyses focused on the responses of individual animals. Binomial tests revealed that two of the dolphins (B and C) tossed the ball more often to a human who was facing them than to a human who was facing away ($p < 0.05$). In fact, dolphin C never tossed the ball to an inattentive person (Figure 1). The other two dolphins (A and D) were equally as likely to toss the ball when a human was facing away as when a human was facing toward them.

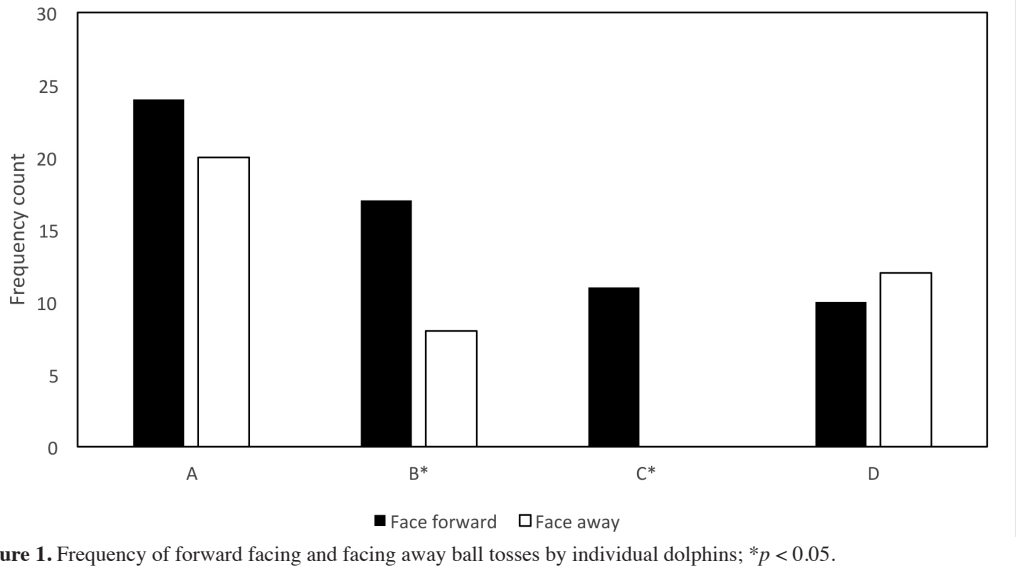

Figure 1. Frequency of forward facing and facing away ball tosses by individual dolphins; *$p < 0.05$.

Dolphins also differed in terms of the type of ball toss they used (soft toss vs hard throw; χ^2 [3, N =102] = 24.25, p = 0.001). The largest standardized residuals were for soft tosses for dolphin C; these differences depended in part on conditions (Figure 2). Dolphin A was equally likely to use a soft toss or a hard throw when the human was facing him, but he always threw the ball hard when the human was in the face-away condition (Figure 2B). Dolphin B was more likely to use a soft toss regardless of which direction the human was facing. Dolphin C was much more likely to use a soft toss than to throw the ball hard. She also only threw the ball when the human was facing toward her (Figure 2A). Finally, dolphin D was more likely to use a soft toss when the human was facing her (Figure 2A) but was also more likely to throw the ball harder when a human was facing away from her (Figure 2B).

The area of the human (body vs head) toward which the ball was tossed also varied across dolphins and conditions (χ^2 [3, N =102] = 17.28, p = 0.001; see Figure 3). Dolphins A and D were more likely to aim for the human's body in the face-forward condition (Figure 3A) and to aim for the human's head in the face-away condition (Figure 3B). Dolphin B was more likely to throw toward the human's body than toward the human's head in both conditions. Dolphin C always threw the ball toward the human's body.

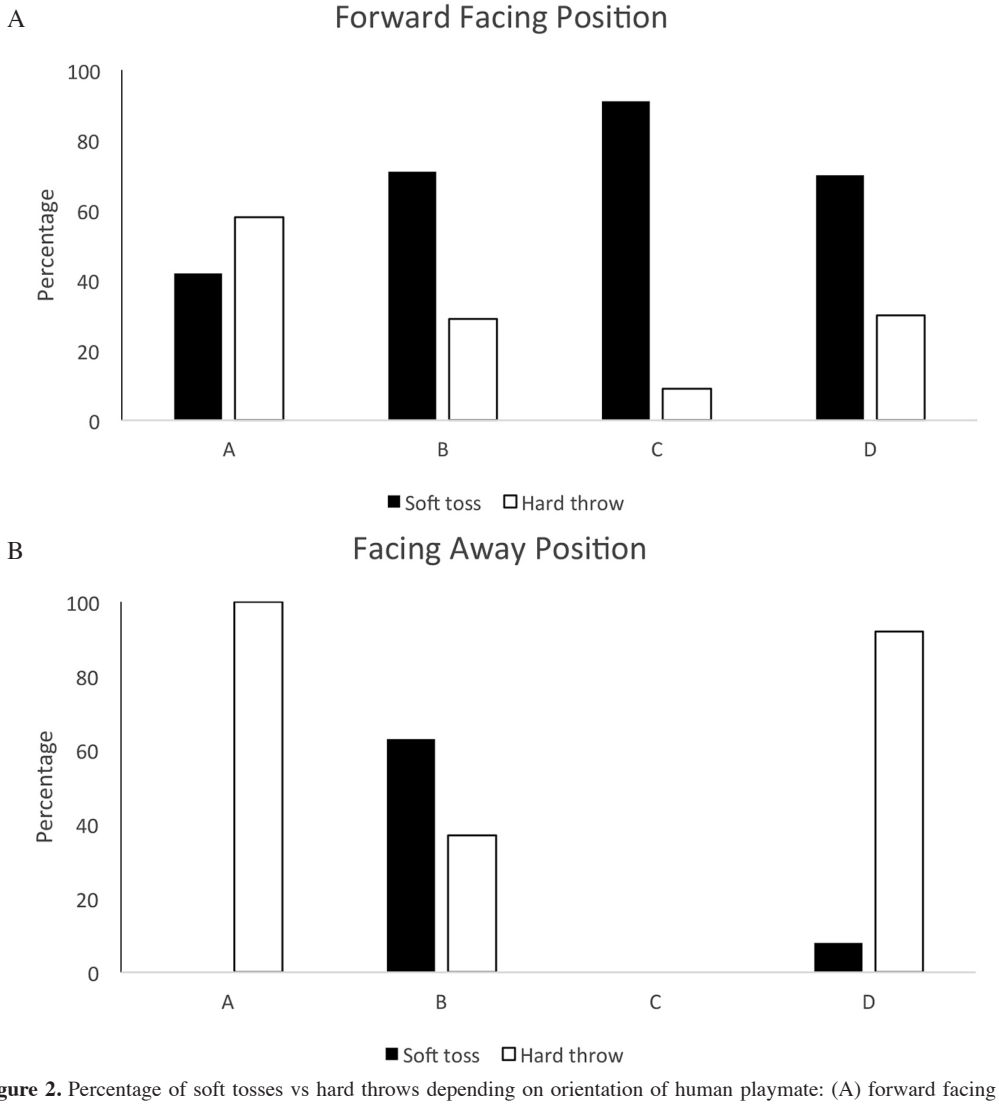

Figure 2. Percentage of soft tosses vs hard throws depending on orientation of human playmate: (A) forward facing and (B) facing away

The dolphins in this study modified their ball tossing behavior based on the body position of the human (facing forward or facing away), altering both the strength of their ball tosses and the part of the human body toward which they directed the tosses. These modifications varied across individuals but were consistent for individual dolphins. Dolphins B and C were more likely to toss a ball to a human facing them. When dolphins A and D tossed the ball to a facing away human, the tosses were more likely to be hard tosses that were aimed at the human's head. These results suggest that the dolphins were attending to human behavior and perhaps used behavioral cues to assess the attentional state of the humans. Our results are consistent with those observed in other species (e.g., orangutans: Call & Tomasello, 1994; dolphins: Xitco et al., 2004; rhesus monkeys: Flombaum & Santos, 2005; dogs: Schwab & Huber, 2006; and sea lions: Penel & Delfour, 2014), but, like these studies, our results do not make it possible to distinguish whether animals actually assessed human attentional states or had learned to respond to situational cues that reflect varying attentional states.

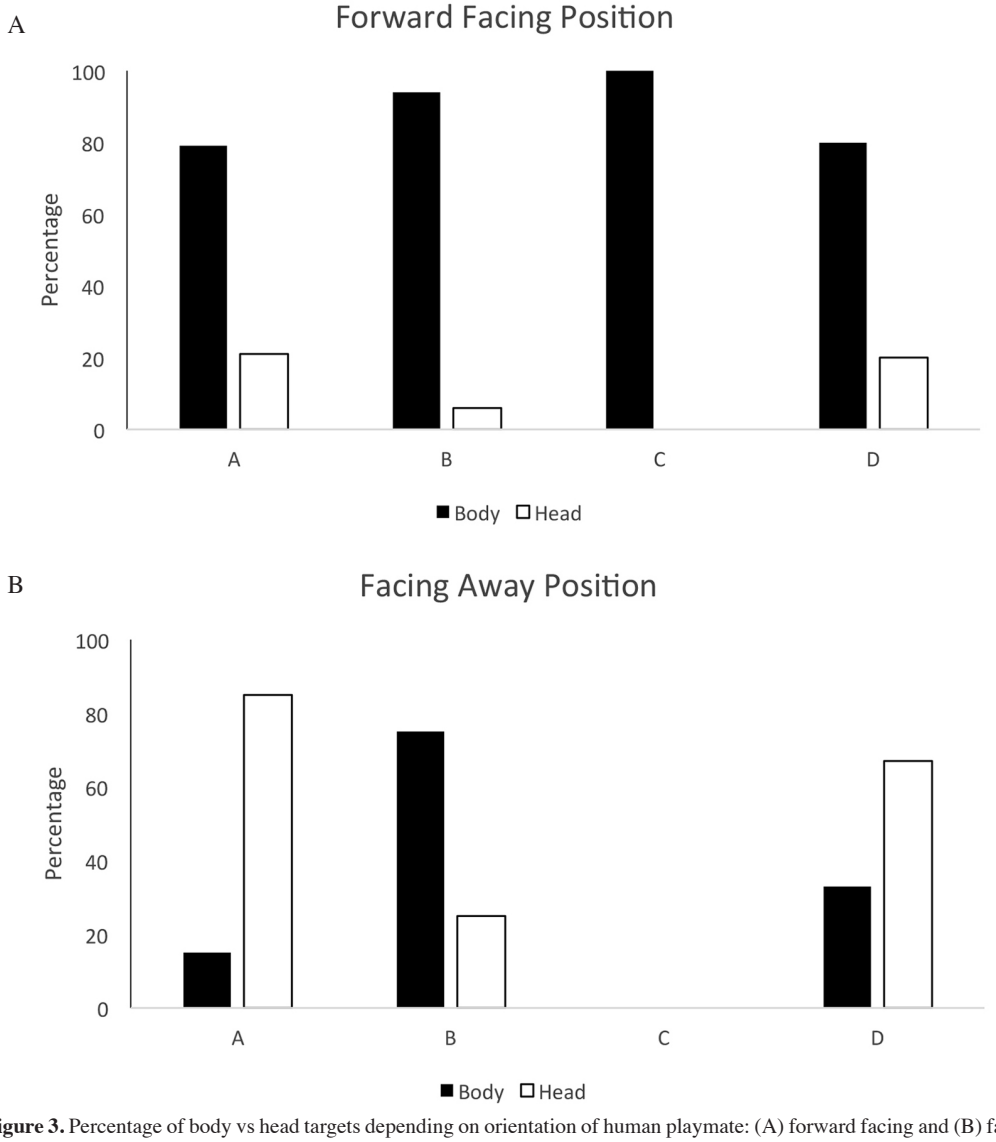

Figure 3. Percentage of body vs head targets depending on orientation of human playmate: (A) forward facing and (B) facing away

The dolphins tended to toss the ball more often to the human facing forward than away; however, the subjects demonstrated individual differences in terms of how their behavior was influenced by the human's position. These differences might reflect individual variation in each dolphin's interaction style with humans as has been reported in studies of other dolphins (Kuczaj et al., 2012). It is also possible that the differences resulted from varied experiences with human playmates, some dolphins having been reinforced by the reactions produced by inattentive humans who were unexpectedly hit by a dolphin-tossed ball. We believe that the differences more likely reflect personality differences. All of the dolphins inhabited the same pool and, therefore, could observe the human reactions produced when another dolphin engaged in ball play with a human. Dolphins can learn play behaviors and other forms of behavior via observation (Kuczaj et al., 2006, 2012), and the fact that all of the dolphins in the pool did not manufacture human startle responses by tossing balls at unsuspecting humans suggests that the dolphins differed in their desire to take advantage of human inattention. Of course, these differences could reflect past experiences with humans outside of the ball play context, and distinguishing the effects of such experience from the effects of personality differences is a topic worthy of future research.

The dolphin's ability to use the attentional cues of humans may extend from their ability to use attentional cues from conspecifics. While we know of no studies that have examined the ability of dolphins to use the visual gaze of conspecifics, dolphins are capable of eavesdropping on the echoes produced by another dolphin's echolocation clicks; for example, a bottlenose dolphin was able to correctly choose the matching object in a match-to-sample task after listening to another dolphin view the sample object using echolocation (Xitco & Roitblat, 1996). Such eavesdropping has also been reported in wild dolphins (Götz et al., 2006; Gregg et al., 2007) and supports the notion that dolphins may be sensitive to the orientation of conspecifics. Determining the ways in which dolphin behavior is influenced by the attentional status of others will increase our understanding of dolphin theory of mind and the factors that govern dolphin social interactions.

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Literature Cited

Call, J., & Tomasello, M. (1994). Production and comprehension of referential pointing by orangutans (*Pongo pygmaeus*). *Journal of Comparative Psychology, 108*, 307-317. http://dx.doi.org/10.1037/0735-7036.108.4.307

Corkum, V., & Moore, C. (1998). The origins of joint visual attention in infants. *Developmental Psychology*, *34*, 28-38. http://dx.doi.org/10.1037/0012-1649.34.1.28

Flombaum, J. I., & Santos, L. R. (2005). Rhesus monkeys attribute perceptions to others. *Current Biology*, *15*, 447-452. http://dx.doi.org/10.1016/j.cub.2004.12.076

Gácsi, M., Miklosi, A., Varga, O., Topal, J., & Csanyi, V. (2004). Are readers of our face readers of our minds? Dogs (*Canis familiaris*) show situation-dependent recognition of humans' attention. *Animal Cognition*, *7*, 144-153. http://dx.doi.org/10.1007/s10071-003-0205-8

Götz, T., Verfuβ, U. K., & Schnitzler, H-U. (2006). Eavesdropping in wild rough-toothed dolphins (*Steno bredanensis*)? *Biology Letters*, *2*, 5-7. http://dx.doi.org/10.1098/rsbl.2005.0407

Gregg, J., Dudzinski, K., & Smith, H. (2007). Do dolphins eavesdrop on the echolocation signals of conspecifics? *International Journal of Comparative Psychology*, *20*, 65-88.

Kuczaj II, S. A., Highfill, L., & Byerly, H. (2012). The importance of considering context in the assessment of personality characteristics: Evidence from ratings of dolphin personality. *International Journal of Comparative Psychology*, *25*, 309-329.

Kuczaj II, S. A., Makecha, R. N., Trone, M., Paulos, R. D., & Ramos, J. A. (2006). The role of peers in cultural innovation and cultural transmission: Evidence from the play of dolphin calves. *International Journal of Comparative Psychology*, *10*, 223-240.

Pack, A., & Herman, L. (2007). The dolphin's (*Tursiops truncatus*) understanding of human gazing and pointing: Knowing *what* and *where*. *Journal of Comparative Psychology*, *121*, 34-45. http://dx.doi.org/10.1037/0735-7036.121.1.34

Penel, M., & Delfour, F. (2014). Are California sea lions (*Zalophus californianus*) sensitive to the attentional state of their caretakers? *Animal Behavior and Cognition*, *1*, 434-445. http://dx.doi.org/10.12966/abc.11.01.2014

Schwab, C., & Huber, L. (2006). Obey or not obey? Dogs (*Canis familiaris*) behave differently in response to attentional states of their owners. *Journal of Comparative Psychology*, *120*, 169-175. http://dx.doi.org/10.1037/0735-7036.120.3.169

Tschudin, A., Call, J., Dunbar, R., Harris, G., & van der Elst, C. (2001). Comprehension of signs by dolphins (*Tursiops truncatus*). *Journal of Comparative Psychology*, *115*, 100-105. http://dx.doi.org/10.1037/0735-7036.115.1.100

Xitco, M., & Roitblat, H. (1996). Object recognition through eavesdropping: Passive echolocation in bottlenose dolphins. *Animal Learning & Behavior*, *24*, 335-365. http://dx.doi.org/10.3758/BF03199007

Xitco, M., Gory, J., & Kuczaj II, S. A. (2001). Spontaneous pointing by bottlenose dolphins (*Tursiops truncatus*). *Animal Cognition*, *4*, 115-123. http://dx.doi.org/10.1007/s100710100107

Xitco, M., Gory, J., & Kuczaj II, S. A. (2004). Dolphin pointing is linked to the attentional behavior of a receiver. *Animal Cognition*, *7*, 231-238. http://dx.doi.org/10.1007/s10071-004-0217-z