Wardle J, Cooke LJ, Gibson EL, Sapochnik M, Sheiman A, Lawson M (2003) Increasing children's acceptance of vegetables: a randomized trial of parent-led exposure. Appetite 40:155–162
Weiskrantz L, Cowey A (1963) The etiology of food reward. Anim Behav 11:225–234
Whiten A, Ham R (1992) On the nature and evolution of imitation in the animal kingdom: reappraisal of a century of research. Adv Stud Behav 21:239–283
Yamamoto ME, Lopes FA (2004) Effect of removal from the family group on feeding behavior by captive *Callithrix jacchus*. Int J Primatol 25:489–500

17
Tactical Deception and Understanding of Others in Chimpanzees

Satoshi Hirata

1 Primate Deception

Many primate species live in social groups and experience daily interactions with other group members throughout their lives. Various types of behaviors are included in these daily interactions: friendly behaviors such as grooming, kissing, and embracing; aggressive behaviors such as biting, hitting, and charging displays; and playing behaviors such as chasing and wrestling. These behaviors may convey honest, or, occasionally, deceptive signals. Whiten and Byrne (1988) focused on deceptive behaviors by primates to elucidate social intelligence.

Studying deception is difficult, as deception occurs rarely. That is, deceptive acts are recognized by others as such and ultimately fail in accomplishing their goals, as the story of the boy who cried "wolf" demonstrates. Byrne and Whiten (1990) employed a method that involved asking numerous researchers to collect as many episodes of deception as possible. The authors succeeded in gathering 253 episodes of tactical deception in primates and categorized them into 5 classes and 13 subclasses. The 5 classes included deception by concealment, distraction, creating an image, manipulation of target using social tool, and deflection of target to fall guy. They further identified 18 possible examples of intentional deception, that is, deception based on understanding the mental state of a target individual. These examples of intentional deception were found much more often among great apes (i.e., chimpanzees, bonobos, gorillas, and orangutans), suggesting that they are able to understand the mental states of others.

A landmark paper by Premack and Woodruff (1978) underlies the discussion of Whiten and Byrne (1988). Premack and Woodruff (1978) asked if a theory of mind can be applied to chimpanzees, that is, if a chimpanzee imputes mental states to himself and to others. The main purpose of Whiten and Byrne's (1988) approach to primate deception was therefore to examine the ability of primates to deceive others by recognizing the mental state of others. The present chapter describes deceptive episodes of chimpanzees and discusses their understanding of others' mental states.

Great Ape Research Institute, Hayashibara Biochemical Laboratories, 952-2 Nu, Tamano, Okayama, 706-0316 Japan

1.1 Deception by Misleading

Menzel (1971, 1974, 1975) conducted a series of studies on a group of chimpanzees living in a 1-acre outdoor enclosure. One of the most interesting tests was a naturalistic study of leadership and communication occurring in experimentally manipulated situations. First, the entire group of six chimpanzees (Shadow, Bandit, Belle, Libi, Bido, and Polly) was locked into a cage adjacent to the enclosure. Then, a human experimenter hid pieces of food, for example, under leaves or grass or behind a tree within the enclosure. One of the chimpanzees (Bandit or Belle) was taken from the group and went together with a human experimenter to the food. The chimpanzee was shown the food without being allowed to touch it, and then was returned to the group in the waiting cage. This individual was operationally called the "leader." About 2 min later, the entire group was released from the cage and allowed into the enclosure. At this time, the entire group headed straight for the food. Because the chimpanzees in this study were all young, about 3 years of age, they preferred to remain together. They often traveled together via "tandem walking" (with an arm of an individual around the waist of another individual) and by clinging (ventro-ventral contact). During testing, they also approached their food and ate it together. Thus, the leader that knew the location of hidden food successfully led its companions to the food. If individuals failed to follow, the leader then became very upset, going from one follower to the next, grimacing, tapping each on the shoulder, starting off tentatively, and then stopping to glance backward. In an extreme case, the leader screamed, grabbed a preferred companion, and dragged it in the direction of the food.

The result was different, however, if the most dominant chimpanzee Rock was present. As soon as Belle uncovered the food, Rock raced over, kicked or bit her, and took all the food. The following description by Menzel (1974) explains what happened between Belle and Rock: "Belle accordingly stopped uncovering the food if Rock was close. She sat on it until Rock left. Rock, however, soon learned this, and when she sat in one place for more than a few seconds, he came over, shoved her aside, searched her sitting place, and got the food. Belle next stopped going all the way. Rock, however, countered by steadily expanding the area of his search through the grass near where Belle had sat. Eventually Belle sat farther and farther away, waiting until Rock looked in the opposite direction before she moved toward the food at all—and Rock in turn seemed to look away until Belle started to move somewhere. On some occasions Rock started to wander off, only to wheel around suddenly precisely as Belle was about to uncover the food. Often Rock found even carefully hidden food that was 30 ft or more from Belle, and he oriented repeatedly at Belle and adjusted his place of search appropriately if she showed any signs of moving or orienting in a given direction. If Rock got very close to the food, Belle invariably gave the game away by a nervous increase in movement. However, on a few trials she actually started off a trial by leading the group in the opposite direction from the food, and then, while Rock was engaged in his search, she doubled back rapidly and got some food. In other trials when we hid an extra piece of food about 10 ft away from the large pile, Belle led Rock to the single piece, and while he took it she raced for the pile. When Rock started to ignore the single piece of food to keep his watch on Belle, Belle had temper 'tantrums'" (Menzel 1974).

Thus, there were tactics and countertactics developed during interactions between Belle and Rock. The case in which Belle led the group in a direction opposite to that of the food can be clearly considered an example of deception. From these cases, Menzel (1974) inferred that chimpanzees know what effect their own behavior is having on others.

1.2 Deception by Concealment

Matsuzawa (1991) conducted a similar study with four 4-year-old chimpanzees (Whiskey, Freida, Liza, and Opal) living in a 2,000-m^2 outdoor enclosure and in indoor areas at the University of Pennsylvania. First, the four chimpanzees were locked in an indoor area. A human experimenter went to the outdoor enclosure with one of the chimpanzees and hid a banana in view of the chimpanzee. The chimpanzee was not allowed to take the banana and was returned to the group in the indoor area. This chimpanzee was called the "witness." After several minutes, the group was released into the enclosure. On the 1st day, Opal was the witness. As soon as the group was released, Opal rushed to the banana. The remaining three chimpanzees did not seem to understand what had happened. On the 2nd day, Liza was the witness. She rushed to the banana, and the remaining three still did not understand the situation. On the 3rd day, Whiskey was the witness. He rushed to the banana, and once again the other three did not seem to comprehend the situation. Freida was too timid to be alone in the enclosure and did not take on the role of witness. On the 4th day, Opal was the witness again and she rushed to the banana, with similar results.

A change was observed on the 5th day. The banana was hidden in the northern part of the enclosure, and Liza was the witness. A short time after the group was released, Opal started to run east. Then Liza started to run north, retrieved the banana, and continued to run north. Opal noticed that Liza had the banana and chased Liza. Whiskey also began to run toward Liza and took a part of the skin of the banana from Liza. On the 6th day, the strongest individual, Whiskey, was the witness. He ran for the banana and continued running after obtaining it. The other three ran after Whiskey, but he quickly consumed the entire banana. On the 7th day, Liza was the witness. Liza headed for the banana, and Whiskey chased her. Whiskey caught up and stole the banana. On the 8th day, Whiskey was the witness. He headed for the banana, and then Liza chased him. However, Liza was weaker than Whiskey and was unable to steal the banana from him.

On the 9th day, Opal was the witness. The banana was hidden under a pole in the northwest part of the enclosure. Immediately after the group was released, Whiskey ran for an earthen pipe at the western part of the enclosure. A banana had been hidden there once before, and Whiskey searched this area carefully.

Liza followed Whiskey, and searched the same area. While the two chimpanzees were searching, Opal wandered around the exit door of the enclosure. She was performing solo play at the water tank. Freida was also playing alone. After a while, Whiskey and Liza moved to a fallen tree and Freida joined them. When the three chimpanzees went to the fallen tree, Opal slowly began to return to the exit door, then slowly headed in a westerly direction along the wall. She glanced at the three chimpanzees several times, and walked slowly toward the pole where the banana was hidden. When she was about 3 m away from the pole, she stared at the three chimpanzees. Suddenly she rushed to the pole, obtained the hidden banana, and ate it before the other three chimpanzees noticed. Clearly, this was an example of deception by concealment, that is, inhibition of attending.

1.3 Deception and Counterdeception

Hirata and Matsuzawa (2001) adopted basically the same procedure to study interactions between pairs of adult chimpanzees at the Primate Research Institute, Kyoto University. Five containers used to hide a banana were set up at the outdoor enclosure, which measured about 700 m^2. While a pair of female chimpanzees was kept inside, a human experimenter entered the outdoor enclosure and hid a banana in one of the five containers. There were two conditions: the role-divided condition and the control condition. Under the role-divided condition, one of the two chimpanzees (witness) could see where the experimenter hid the banana, while the other (witness-of-witness) could not see it directly but was allowed a view of the witness observing the outside. While the experimenter hid a banana, the witness remained in a waiting room adjacent to the enclosure and saw where the banana was hidden through a half-open door. The witness-of-witness stayed in a room adjacent to the waiting room. She could not see where the banana was hidden, but she could see the witness looking outside from a half-open door to the waiting room. Under the control condition, the two chimpanzees were brought to the waiting room and the door was closed during baiting; thus, neither could see where the banana was hidden. Under both conditions, the two chimpanzees were released into the enclosure after baiting.

The results for a pair of chimpanzees, Chloe and Pendesa, follow. Chloe served as the witness and Pendesa as the witness-of-witness for the first 8 days. Pendesa did not seek the banana for the first 3 days, except on the 2nd day when she happened to come across the banana in one of the containers after the experimenter inadvertently failed to hide the reward completely. After the 4th day, Pendesa began to search the containers by herself but did not display any action toward Chloe. Thus, the witness Chloe easily obtained the banana during this period. Role reversal was introduced on the 9th day; Pendesa served as the witness and Chloe as the witness-of-witness from the 9th to the 11th day. During this period, Pendesa headed straight to the banana and obtained it. Chloe wandered around but did not do anything in particular. Another role reversal was introduced. Chloe served as the witness and Pendesa as the witness-of-witness from the 12th

to the 14th day. Pendesa began to threaten Chloe from the 11th day. Threats were followed each time by Pendesa seeking the banana alone; she found it along the way before Chloe could on the 13th day. Pendesa was thus dominant over Chloe. Then, role reversal was introduced again, and Pendesa served as the witness and Chloe as the witness-of-witness from the 15th to the 17th day. When Pendesa was the witness, she always obtained the banana, and Chloe could do nothing to prevent it.

The fourth role reversal was introduced, and Chloe served as the witness and Pendesa as the witness-of-witness from the 18th to the 31st day. Pendesa obtained the banana on the 18th and 19th days, when she first threatened Chloe and then searched for the banana alone. From the 20th day, Pendesa began to adjust her direction of movement to that of Chloe's. More precisely, after entering the enclosure, Pendesa first attempted to seek the banana by herself, and then, after Chloe had emerged, Pendesa began to approach Chloe's route from some distance away. At the same time, Pendesa began to look at Chloe more and more frequently. These strategies did not allow Pendesa to obtain the banana, however, because Chloe always arrived at the baited container before Pendesa had a chance to catch up with her. Chloe obtained the banana during the 20th to 26th days. After the 24th day, Pendesa began to run ahead of Chloe, and Chloe's initial response was to mislead Pendesa by taking an indirect route.

On the 24th day, Pendesa first entered the enclosure, and went to the right (Fig. 1.1). Then Chloe entered the enclosure and went straight ahead toward the baited container (Fig. 1.2). Pendesa looked back in the direction of Chloe, changed her route, and began to run toward Chloe. Chloe looked to the right, saw Pendesa coming, and stopped there, at a distance of about 6 m from the

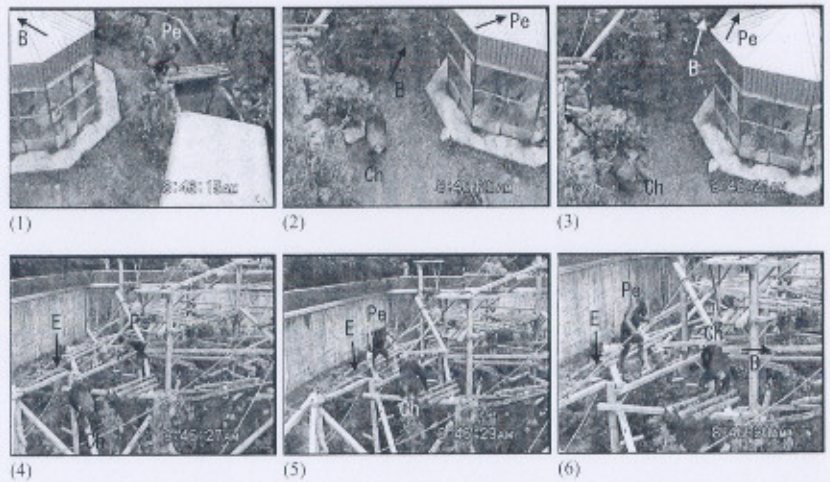

Fig. 1. Behavior sequence (*1–6*) of the two chimpanzees on the 24th day. *Ch*, Chloe; *Pe*, Pendesa; *B*, baited container; *E*, empty container

baited container. Chloe turned to the left, and went toward another empty container at the left side of the enclosure (Fig. 1.3). Pendesa caught up with Chloe about 2 m from the empty container for which Chloe was heading (Fig. 1.4). Pendesa looked at Chloe, jumped up in an overbearing fashion (Fig. 1.5), and Chloe retreated diagonally from Pendesa. Then Pendesa proceeded to the empty container where Chloe had been heading, while Chloe began to approach the baited container (Fig. 1.6). Pendesa looked into the empty container, and by this time Chloe had found the banana in the baited container. Chloe also succeeded in "deceiving" in a similar manner on the 25th, 27th, and 30th days, that is, Pendesa was misled to an empty container while following Chloe to a nontarget. While Pendesa was looking in the incorrect container, Chloe returned to the target and successfully obtained the reward on those days. However, Pendesa developed a counterdeception tactic and gained access to the reward on the 26th, 28th, 29th, and 31st days. That is, Pendesa remained close by and frequently adjusted her direction to that of Chloe.

On the 28th day, Pendesa entered the enclosure. She stopped about 2 m ahead of the door and stayed there. Then Chloe put her head out through the door. Pendesa looked back at Chloe, and swung her hand threateningly toward Chloe, whereupon Chloe pouted. Pendesa advanced, and Chloe entered the enclosure. Pendesa turned back at Chloe, stood up bipedally, and swung her arms threateningly toward Chloe. Two seconds later, Pendesa advanced for 2 s but then retreated again, changing her route to match the direction of Chloe's course (Fig. 2.1). Two seconds later, Pendesa faced Chloe and Chloe stood up. Pendesa stretched both her arms around Chloe and they embraced (Fig. 2.2). One second later, Pendesa began to turn forward and withdrew her arms from Chloe.

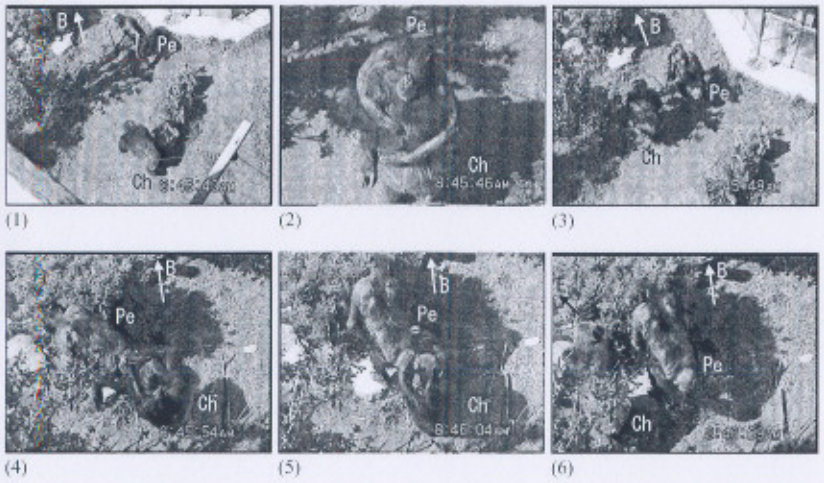

Fig. 2. Behavior sequence (*1*–*6*) of the two chimpanzees on the 28th day. *Ch*, Chloe; *Pe*, Pendesa; *B*, baited container; *E*, empty container

Pendesa and Chloe moved apart, headed in a forward direction, and Pendesa then went ahead of Chloe (Fig. 2.3). Three seconds later, Pendesa stopped, and Chloe came up just behind her. Pendesa then looked back at Chloe and oriented her posterior toward Chloe. Chloe embraced Pendesa from behind and inspected Pendesa's genital area with both hands (Fig. 2.4). After 11 s, Pendesa moved her body slightly forward. Chloe responded to this and touched Pendesa's waist, patting and stroking Pendesa's back rapidly with one hand and then the other (Fig. 2.5). Immediately after this, Chloe advanced toward one of the empty containers while looking at Pendesa twice, and they stared at each other (Fig. 2.6). Pendesa followed Chloe closely and appeared in front of Chloe, remaining there. Pendesa presented her rear to Chloe, who touched, stroked, and rubbed Pendesa's left instep. Nine seconds later, Chloe looked at Pendesa and moved toward the empty container. Pendesa went after Chloe and soon overtook her, about 2 m from the empty container. Then Chloe turned to the baited container while Pendesa looked into the empty container. Soon Pendesa turned back and followed Chloe, who looked back at Pendesa coming up just behind her. After 2 s, both Chloe and Pendesa arrived almost simultaneously at the baited container, and Pendesa, the witness-of-witness, obtained the banana.

From the 32nd to the 34th day of testing this pair, we introduced the control condition. Pendesa exhibited no actions but threatening once toward Chloe on the first day of the control condition. Pendesa went alone to seek the banana and obtained it on all 3 days. However, Chloe gradually lost her motivation to seek the banana toward the end of this experiment because she was repeatedly threatened and subsequently lost the reward. Chloe chose instead to stay in a neutral area of the compound during the final stage of the test, not paying any attention to Pendesa. Therefore, we decided to discontinue tests on this pair.

1.4 Implications for Understanding Others

Under these three test scenarios, there was a witness of a hidden reward. In the beginning, the situation was simple; the witness went to the hiding place that she already knew, and obtained the reward. After repeated trials, other ignorant chimpanzees or the witness-of-witness began trying to steal the reward. It was at this point that social maneuvering emerged as tactics. Rock in Menzel's (1974) study, Whiskey in Matsuzawa's (1991) study, and Pendesa in Hirata and Matsuzawa's (2001) study attempted to rob the hidden food by following and chasing the witness. The witness opposed this action by opting not to go to the hiding place in Menzel's (1974) and Matsuzawa's (1991) experiments, exhibiting deception by inhibition of attending. The witness succeeded in obtaining the reward during an unguarded moment of the ignorant chimpanzee. Furthermore, in Menzel's (1974) and Hirata and Matsuzawa's (2001) studies, the witness went in the opposite direction. After the ignorant chimpanzee or the witness-of-witness followed the witness and searched this empty area, the witness returned to the correct place and obtained the reward, exhibiting deception by

misleading. The witness-of-witness in Hirata and Matsuzawa (2001) again acted against this deception by remaining very close to the witness, that is, the two chimpanzees groomed and embraced during the course of interactions, exhibiting counterdeception. Deceptive episodes tend to be generally anecdotal, as discussed by Whiten and Byrne (1988), but these three cases show that chimpanzee deceptive ability emerges quite reliably under certain experimentally created situations.

In Hirata and Matsuzawa's (2001) study, a control condition was introduced at the end of the study in which neither chimpanzee witnessed the hiding. Under this condition the dominant chimpanzee seemed to care less about the other chimpanzee, suggesting that she changed her tactic depending on whether the other chimpanzee saw the hiding procedure or not. Although a systematic comparison between conditions was not possible because of the flawed nature of introducing the two conditions, the study indicated the possibility of chimpanzee understanding regarding what others have or have not seen.

2 Understanding of Others' Visual Perception

To investigate chimpanzees' understanding of what others are seeing, Tomasello, Call, Hare, and colleagues conducted a series of experiments, including confronting chimpanzees with competition over food (Hare et al. 2000, 2001; Call 2001; Call and Carpenter 2001; Hare 2001; Tomasello et al. 2003a,b). A pair of dominant and subordinate chimpanzees was brought into two rooms on opposite sides of a third room. For example, a dominant chimpanzee stayed in the left room and a subordinate individual stayed in the right room, both of them facing a third room in the middle.

In the first set of experiments, two pieces of food, along with an opaque or transparent barrier, were placed in the center of the third room. These two pieces of food were placed apart from one another. There were two conditions: the occluder condition and the transparent barrier condition. Under the occluder condition, an opaque barrier was placed on the dominant chimpanzee's side of one of the pieces of food. Viewed by the dominant chimpanzee, only one piece of food could be seen, because the second piece of food was behind the opaque barrier. The subordinate chimpanzee could see both pieces of food: one piece of food outside the barrier and the other piece of food in front of the barrier. Under the transparent barrier condition, a barrier was placed in a way similar to the occluder condition, but the barrier was transparent. Thus, the dominant chimpanzee could also see two pieces of food: one piece of food outside the barrier and the other piece of food behind the transparent barrier. The two chimpanzees were then released into the middle room, with the subordinate individual given a brief head start to allow her time to choose. A premise in this experiment was that subordinates avoid competition over food with dominant individuals. The result of the occluder condition was that the subordinate chimpanzees went to the food in front of the barrier much more often than the food outside the barrier. Under the transparent barrier condition, the subordinate chimpanzees did not show a preference for either piece of food. These results indicated that the subordinate chimpanzees knew what the dominant chimpanzees could and could not see.

In the second set of experiments, the basic procedure was the same except that there were two barriers and only one piece of food. Under the experimental condition, the subordinate chimpanzee saw a human experimenter place a piece of food inside one of the two barriers, on the subordinate individual's side. The dominant chimpanzee was not allowed to see the hiding process because the door was closed. Under the control condition, both the dominant and subordinate chimpanzees saw the hiding process. The result was that the subordinate chimpanzees went to the food more often under the experimental condition than the control condition. Therefore, the subordinate chimpanzees knew what the dominant individuals saw and did not see. The authors also introduced other conditions to rule out alternative interpretations, for example, that the subordinate chimpanzees preferred food next to the barrier or that they were intimidated when dominant individuals observed the hiding process. The results of these variations consistently support the idea that the chimpanzees know what others can and cannot see and also what others have and have not seen. The chimpanzees understand unobservable mental states of others, at least the visual perception of others.

Povinelli and colleagues criticized Tomasello et al. (2003a,b), however, and proposed the "behavioral abstraction hypothesis" (Povinelli et al. 2000; Povinelli and Giambrone 2001; Povinelli and Vonk 2003, 2004). In this hypothesis, the chimpanzees construct abstract categories of behavior, make predictions about future behaviors that follow from past behaviors, and adjust their own behavior accordingly. Povinelli and Vonk (2003, 2004) assert that humans engage in both behavioral abstraction and mental state attribution, but there is no evidence suggesting that chimpanzees engage in mental state attribution. If an experiment relies upon behavioral invariants such as looking or gazing, it cannot clarify whether chimpanzees engage in behavioral abstraction alone or behavioral abstraction plus mental state attribution, because the chimpanzees have the chance to formulate statistical regulations of the behavior of others and make predictions of future behavior from past experience. The subordinate chimpanzees can predict from their experience of observing others what dominant chimpanzees will do if they orient toward food; the dominant will go to the food and threaten the subordinate. The subordinate chimpanzees can predict from their past experience of observing others what the dominant individuals will do if they are not present when the food is placed; the dominant will neither go to the food nor threaten the subordinate.

Povinelli and Vonk (2003, 2004) proposed an experiment in which the cue toward the inference to the mental state is arbitrary, and the subject has no exposure to others behaving in association with that cue, to test if chimpanzees or other species are capable of mental state attribution. That is, a test should be conducted that requires subjects to make an extrapolation from their own

experience to the mental state of others. For example, "we let a chimpanzee interact with two buckets, one red, one blue. When the red one is placed over her head total darkness is experienced; when the blue one is similarly placed, she can still see. Now have her, for the first time, confront with others (in this case the experimenters) with these buckets over their heads. If she selectively gestures to the person wearing the blue bucket we could be highly confident that the nature of her coding was, in part, mentalistic—that is, that she represented the others as 'seeing' her" (Povinelli and Vonk 2003).

3 Naturalistic Observations and Experimental Tests

As Povinelli and colleagues discussed (Povinelli et al. 2000; Povinelli and Vonk 2003, 2004), it is true that naturalistic observations are insufficient to clarify whether behaviors result from mental attribution or behavior learning because it is almost impossible to record a complete history of an animal's interactions with others. Experimental tests are needed to address this issue, but experimental manipulations also face difficulties as irrelevant factors may influence test results.

I performed matching-to-sample tasks with two juvenile chimpanzees at the Hayashibara Great Ape Research Institute in Japan. Before my study, individuals had already learned to some extent how to solve a matching-to-sample task using a touch monitor. A sample stimulus, for example, a red circle, appeared at the bottom of a touch monitor. If the chimpanzee touched the sample stimulus, then two choice stimuli appeared at the upper part of the monitor, one of which was correct and identical to the sample stimulus, or red circle, and the other, which was incorrect and different from the sample stimulus, such as a green circle. If the chimpanzee touched the correct choice on the monitor, then a food reward was given. The two chimpanzees were able to solve the matching-to-sample task of color circles and several pictures using both colors and shapes as cues to accomplish the task.

A matching-to-sample task was then introduced in which a human–chimpanzee interactive situation was used. Two plates were placed in front of a chimpanzee, one on the left and the other on the right. Then I placed a red wooden circle in one of the plates and a green wooden circle in the other plate. I then gave a third wooden circle, red or green, to the chimpanzee, and asked it to put it into the plate having the same-colored wooden circle. If the chimpanzee succeeded, then a food reward was given. The two chimpanzees selected the correct plate at an above-chance level after 100 to 200 trials. Wooden yellow, blue, and gray circles were added, and the chimpanzees solved this matching-to-sample task after the first 20 trials. Thus, they seemed to grasp the objective of the task. When nine pairs of new objects with various shapes were introduced, the chimpanzees also solved this task after the first 20 trials. Subsequently, I used square boards on which either a black double circle or a black star was painted. The procedure was the same: a board with a double circle was placed on one of the plates and a board with a star on the other. I gave a third board with either a double circle or a star to the chimpanzee, and asked it to put it on the plate in which the board with the same mark had been placed. The two chimpanzees could not solve this task. After 3,000 trials, their performance was still at chance level.

Following this failure, the same matching-to-sample task was given using a touch monitor. A black double circle and a black star were used as stimuli, with the same size and shape as those painted on the boards. One of the two chimpanzees performed at above-chance levels after 50 trials, and the other performed above chance after 20 trials. Thus, they could solve the matching-to-sample task of a double circle and star using a touch monitor; however, when I reintroduced the task with plates and boards, the chimpanzees could not solve the task.

From the results of the touch monitor task, the chimpanzees could discriminate between a double circle and a star, although the same assertion cannot be made from the results of the plate task. The chimpanzees understood the rules of the matching-to-sample task using the plates and the touch monitor. The color, shape, and size of the double circle and the star were the same in the touch monitor task and the plate task. Although they could not pay attention to the difference in the patterns on the square boards, they could do so with the touch monitor. Thus, a change in the experimental procedure may generate different results, even if the basic structure of the task remains the same.

It is necessary to investigate chimpanzees' social cognition using rigorous experimental situations, such as a choice task with human experimenters using a red bucket and blue bucket. However, poor performance does not necessarily mean that chimpanzees lack the ability essential to successfully complete the task in ways that human investigators presume. Social cognition has evolved to solve problems that animals experience in group living. Thus, social cognition should appear in natural situations when animals interact with other group members. There is no guarantee, however, that same abilities are utilized when chimpanzees are faced with artificially created situations that are unrelated to their natural lives. Both naturalistic observations and rigorous experiments have advantages and disadvantages. The word "social" originally meant "allied" or "united." Naturalistic observations and rigorous experiments should be allied and united to further our understanding of the evolution of social cognition.

Acknowledgments

The studies were financially supported by the Japan Society for the Promotion of Science (JSPS) for Young Scientists (No. 2926) to S. Hirata, the Core-to-Core Program HOPE by JSPS, and Grants-in-Aid for Special Promotion Research (#12002009, #16002001) of the Ministry of Education, Culture, Sports, Science and Technology to T. Matsuzawa. I greatly acknowledge T. Matsuzawa for his generous guidance throughout the studies, M. Tomonaga and M. Tanaka for their support and suggestions, and all the collaborators for their assistance in data collection and analysis.

References

Byrne RW, Whiten A (1990) Tactical deception in primates: the 1990 database. Primate Rep 27:1–101
Call J (2001) Chimpanzee social cognition. Trends Cogn Sci 5:388–393
Call J, Carpenter M (2001) Do apes and children know what they have seen? Anim Cogn 4:207–220
Hare B (2001) Can competitive paradigms increase the validity of experiments on primate social cognition. Anim Cogn 4:269–280
Hare B, Call J, Agnetta B, Tomasello M (2000) Chimpanzees know what conspecifics do and do not see. Anim Behav 59:771–785
Hare B, Call J, Tomasello M (2001) Do chimpanzees know what conspecifics know? Animal Behav 61:139–151
Hirata S, Matsuzawa T (2001) Tactics to obtain a hidden food item in chimpanzee pairs (*Pan troglodytes*). Anim Cogn 4:285–295
Matsuzawa T (1991) Chimpanzee mind (in Japanese). Iwanami-Shoten, Tokyo
Menzel EW (1971) Communication about the environment in a group of young chimpanzees. Folia Primatol 15:220–232
Menzel EW (1974) A group of chimpanzees in a one-acre field. In: Shrier AM, Stollnitz, F (eds) Behavior of non-human primates, vol 5. Academic Press, San Diego, pp 83–153
Menzel EW (1975) Purposive behavior as a basis for objective communication between chimpanzees. Science 189:652–654
Povinelli DJ, Giambrone S (2001) Reasoning about beliefs: a human specialization? Child Dev 72:691–695
Povinelli DJ, Vonk J (2003) Chimpanzee minds: suspiciously human? Trends Cogn Sci 7:157–160
Povinelli DJ, Vonk J (2004) We don't need a microscope to explore the chimpanzee's mind. Mind Language 19:1–28
Povinelli DJ, Bering JM, Giambrone S (2000) Toward a science of other minds: escaping the argument by analogy. Cogn Sci 24:509–541
Premack D, Woodruff G (1978) Does the chimpanzee have a theory of mind? Behav Brain Sci 4:515–526
Tomasello M, Call J, Hare B (2003a) Chimpanzee understand psychological states: the question is which ones and to what extent. Trends Cogn Sci 7:153–156
Tomasello M, Call J, Hare B (2003b) Chimpanzee versus humans—it's not that simple. Trends Cogn Sci 7:239–240
Whiten A, Byrne RW (1988) Tactical deception in primates. Behav Brain Sci 11:233–273

Part 5
Conceptual Cognition