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The Role of Visual Perspective Taking in Great Ape Social Cognition : : A Philosophical and Empirical Analysis

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# The Role of Visual Perspective Taking in Great Ape Social Cognition: A Philosophical and Empirical Analysis

A dissertation submitted in partial satisfaction of the
Requirements for the degree Doctor of Philosophy

in

Philosophy (Science Studies)

by

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2013

The Dissertation of Marta Halina is approved, and it is acceptable in quality and form for publication on microfilm and electronically:

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TABLE OF CONTENTS

# LIST OF FIGURES

# LIST OF TABLES

## ACKNOWLEDGMENTS

One of the requirements for getting a degree in Philosophy and Science Studies is to do an internship in a scientific or technological field. It was in fulfilling this requirement that I first became interested in writing a dissertation on the topic of nonhuman primate cognition and communication. Thus, I would like to begin by thanking the UCSD Science Studies Program and its participants for making this project possible and for supporting the interdisciplinary work of graduate students.

The positions that I develop in this dissertation began to take shape during the year that I spent at the Max Planck Institute for Evolutionary Anthropology. It was there that I began to understand the enormous amount of work that goes into trying to understand the minds of apes and when I became concerned with how this work is interpreted. Thus, I would like to thank those who made that stage of my research possible: Bill Bechtel, Nancy Cartwright, and Cathy Gere for feedback on my initial writings in this area, letters of recommendations, and words of encouragement; Mike Tomasello, Josep Call, and Katja Liebal for welcoming me into their research groups and lab; Mike Tomasello, Katja Liebal, and Federico Rossano for patiently showing me the ropes of their field and providing feedback on my empirical work; and the Fulbright Program for funding my stay in Germany and for providing a network of social support.

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The study presented in chapter four was conducted in collaboration with Katja Liebal and Michael Tomasello, and has been submitted for publication. The dissertation author was the primary investigator of that study and the lead author of the submitted paper. The research presented in that chapter was supported by a German-American Fulbright Full Grant and conducted in association with the Evolutionary Roots of Human Social Interaction (ROSI) group. I thank Hagen Knofe, Claudia Menzel, and the staff of the Wolfgang Köhler Primate Research Center for their help in running the experiment. I also thank Sebastian Grüneisen and Sophia Alfano for their coding assistance.

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*Ecography*, 33, 565-577.

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# ABSTRACT OF THE DISSERTATION

# The Role of Visual Perspective Taking in Great Ape Social Cognition: A Philosophical and Empirical Analysis

by

Marta Halina

Doctor of Philosophy in Philosophy (Science Studies)

University of California, San Diego, 2013

Professor William Bechtel, Chair
Professor Nancy Cartwright, Co-Chair

Comparative psychologists have recently agreed that some nonhuman animals, such as chimpanzees, are capable of mindreading or reasoning about the cognitive states of other agents. This claim has been heavily criticized by a small group of psychologists and philosophers led by Daniel Povinelli. Povinelli and colleagues argue that the experimental approach used by comparative psychologists to test for

mindreading in animals is fundamentally flawed and propose a new experimental paradigm to take its place. In the first part of this dissertation, I argue that this criticism is mistaken. Focusing on visual-perspective-taking research in chimpanzees, I show how the experimental approach used by comparative psychologist provides evidence for mindreading, according to the critics' own definition of what counts as mindreading. I also show that the new experimental paradigm proposed by the critics fails, according to their own standards for success.

The fact that chimpanzees mindread has far-reaching implications. In the second part of this dissertation, I examine the potential impact of this finding on our understanding of ape pointing. Humans use pointing gestures in order to direct the attentional states of other agents. I examine whether there is evidence that apes point with similar aims. Surprisingly few studies have addressed this question and I attribute this lacuna to the imperative-declarative distinction currently guiding ape pointing research. I argue that the constraints imposed by this distinction are overly restrictive and propose an alternative framing. There are several ways in which one can test whether apes point in order to direct gaze. I introduce these and then present the results of one such study, which I conducted in collaboration with the comparative psychologists Katja Liebal and Michael Tomasello. The results of our study suggest that apes do not point with the sole aim of directing gaze. However, more studies need to be done in order to determine whether directing gaze is a component aim of ape pointing.

## Introduction

To have a theory of mind is to be able to reason about the cognitive states of other agents. Over thirty years ago, Premack and Woodruff (1978) posed the question, “Does the chimpanzee have a theory of mind?” Since then, psychologists have conducted numerous experimental and observational studies aimed at addressing this question. Recently, they have proposed an answer: chimpanzees do have a theory of mind with respect to some psychological states, such as goals, intentions, and perceptions (Call and Tomasello 2008). This finding has broad implications. Philosophers have argued that a theory of mind (or “mindreading”) is required for self-awareness and phenomenal consciousness, and that it is a defining feature of personhood (Carruthers 2000, 2009; Dennett 1978). The finding that chimpanzees are capable of mindreading could drastically change how we perceive and treat nonhuman primates.

This dissertation addresses two issues surrounding the claim that great apes are capable of mindreading. First, it responds to a criticism known as the “logical problem” or “Povinelli’s challenge” advanced by several psychologists and philosophers (most notably, Daniel Povinelli). According to this challenge, comparative psychologists are mistaken in their consensus position because there is an alternative hypothesis for why chimpanzees behave as they do. This alternative hypothesis holds that apes engage in complementary behavior reading (CBR) or draw on knowledge of observable regularities, rather than unobservable mental states, in order to predict the behavior of other agents. According to the critics, it is not until this alternative hypothesis is rejected that we have evidence for mindreading in apes.

Few attempts have been made to defend the position of comparative psychologists against this criticism. I develop such a defense in the first two chapters. A central claim advanced by the critics is that comparative psychologists must adopt a new experimental approach – one capable of rejecting the CBR hypothesis. In chapter one, I argue that the new experimental approach advanced by the critics does not meet their own standards for success. I do this by showing that those experiments that the critics take to be capable of rejecting the CBR hypothesis in fact fail to do so. I then suggest that the inability to reject this hypothesis is a version of what Carl Hempel identified as the "theoretician's dilemma." This dilemma holds that if the theoretical terms in a theory are successful at establishing regularities among observable entities, then they are unnecessary because one can always redescribe this regularity in terms of the observable entities alone. The mindreading equivalent of this dilemma is that if an individual uses mindreading to establish regularities among observable phenomena, then mindreading is unnecessary because the individual could be relying on a rule that relates the observable phenomena alone.

In chapter two, I explicate and defend the experimental approach currently used in comparative psychology. I show how this approach employs what John Stuart Mill identified as the "methods of difference and agreement" and how it provides evidence for mindreading. I then further develop the argument that Povinelli's challenge is a version of the theoretician's dilemma by showing that it is logically impossible to reject the hypothesis that mindreading tasks are solved on the basis of complementary behavioral rules. Two ideas motivate the critics' claim that the CBR hypothesis can be rejected. The first idea is that mindreading should perform "unique causal work" – work that cannot be accomplished by reasoning only about observable entities. The second idea is that some experiments reveal this unique causal work because they cannot be solved without mindreading. I argue that both of these ideas, as understood by the critics, are mistaken.

The finding that apes mindread will undoubtedly have an impact on many areas of primate research. One area that this finding could affect considerably is our understanding of ape pointing. The function of ape pointing is currently unknown. However, an important function of human pointing is to direct the gaze of another agent toward particular objects and locations. If apes understand perceptual states, then it is possible that they also employ pointing gestures with this aim. The last two chapters of this dissertation examine whether this is the case.

To date, there have been almost no studies examining the question of whether apes point to direct gaze (what I call, the "directing-gaze hypothesis"). This is surprising, as comparative psychologists have conducted many studies on the comprehension and production of pointing gestures in apes. Also, addressing this question would have important implications on our understanding of both ape gestural communication and human pointing. In chapter three, I examine why researchers have not investigated this hypothesis. I show that current research characterizes pointing gestures as either imperative or declarative and that the directing-gaze hypothesis does not fit neatly into either one of these two categories. I argue that researchers should refrain from framing ape pointing in this way until they have a better understanding of some of the basic properties of this gesture. I suggest that they instead frame their research in terms of investigating the goal of ape pointing while remaining agnostic with respect to how apes represent that goal.

In the remainder of chapter three, I determine whether there is any empirical evidence for the directing-gaze hypothesis. I do this by examining whether apes manipulate the gaze of other agents within or outside the context of pointing. There is evidence that apes manipulate the gaze of others in a dyadic manner – that is, in ways that involve directing a recipient's attention toward or away from the self. However, if ape's point to direct gaze, then this would be a triadic form of gaze manipulation or one that involves directing a recipient's gaze toward or away from a third object, agent, or location. There is currently little evidence that apes engage in triadic gaze manipulation and no evidence that they use pointing gestures to manipulate gaze in this way. However, it is possible that this lack of evidence is a product of the fact that pointing research is framed in terms of the imperative-declarative distinction. Thus, I propose two types of experiments that can be conducted to test the directing-gaze hypothesis within the context of ape pointing.

Chapter four presents the results of one of the experiments proposed in chapter three, which I conducted in collaboration with the comparative psychologists Katja Liebal and Michael Tomasello. Previous studies have shown that apes cease gesturing when the goal of their gesture has been achieved, and continuing gesturing when the goal of their gesture has not been achieved. Thus, if apes point with the aim of directing gaze, then they should stop pointing when the recipient of their gesture looks at the indicated object, and continue pointing when the recipient fails to look at the indicated object. Contrary to this prediction, we found that subjects spent more time pointing when the recipient of their gesture looked at the indicated object. Our results suggest that apes do not point with the sole goal of directing attention (as in "look there!"), but either point with the goal of soliciting a social action (such as "retrieve that food!") or with the dual goal of directing gaze and soliciting action.

Comparative psychologists have provided compelling evidence that apes mindread; Povinelli's challenge has been unsuccessful at undermining this claim. The fact that apes mindread will likely impact our understanding of primate cognition and behavior in many ways. Whether it will affect our understanding of ape pointing, however, is still an open question.

# Chapter One

## Animal Mindreading: Moving Beyond the Theoretician's Dilemma

### Abstract

Most contemporary comparative psychologists agree that chimpanzees are capable of level 1 visual perspective taking – the ability to infer what objects another agent can or cannot see, given that agent's point of view. Several philosophers and psychologists have recently criticized this consensus, however. They argue that visual-perspective-taking experiments are designed in such a way that there is an alternative "behavior-rules" hypothesis for why subjects behave as they do. According to the critics, one must reject this alternative hypothesis before making claims about visual perspective taking in apes. In this chapter, I argue that it is not empirically possible to reject the behavior-rules hypothesis by showing that even the critics' best attempts to do so have failed. I conclude that the critics' position is a form of the theoretician's dilemma or the idea that, in principle, observational terms can always replace theoretical ones. Comparative psychologists need not reject the behavior-rules hypothesis before maintaining that apes are capable of level 1 visual perspective taking.

## 1.1. Introduction

Humans are able to infer what objects another agent can or cannot see, given that other agent's point of view. Psychologists refer to this ability as level 1 visual perspective taking (VPT1). VPT1 is generally characterized as a form of mindreading because it requires that an individual reason about the perceptual states of another agent. Over the last decade, comparative psychologists have conducted many experiments aimed at testing whether chimpanzees have VPT1 abilities. The results of these experiments have been mainly positive, leading to a consensus among researchers that chimpanzees are capable of this form of mindreading (see Call and Tomasello 2008 for a review).

Recently, however, several psychologists and philosophers have criticized this consensus view (see Povinelli and Vonk 2003, 2006; Vonk and Povinelli 2006; Penn et al. 2008; Penn and Povinelli 2007, 2009, in press; Penn 2011; Lurz 2011; Lurz and Krachun 2011). They argue that the experiments that have been used to test whether nonhuman animals have VPT1 are flawed because they fail to reject the plausible alternative hypothesis that subjects reason on the basis of behavioral rules alone. These critics go on to propose an alternative research program; they urge that this new program is capable of rejecting the behavior-rules hypothesis and therefore should replace the experimental approach currently used by comparative psychologists.

In this chapter, I argue that the positive research program advanced by the critics is also unsuccessful at rejecting the behavior-rules hypothesis. I do this by showing that the most compelling examples of experiments capable of rejecting this hypothesis fail to do so. I then argue that our inability to reject the behavior-rules hypothesis is not a special problem facing mindreading research, but rather a version of what Carl Hempel identified as the 'theoretician's dilemma.' This dilemma maintains that if the unobservable, theoretical terms in a theory succeed in establishing a regularity in the world, then they are no longer required because we can always redefine that regularity in observable terms alone. Applied to chimpanzee mindreading research, the claim is that we can reinterpret any mindreading ability in terms of a chimpanzee's ability to recognize regularities among observable features. Hempel maintains that we should reject the theoretician's dilemma and instead evaluate hypotheses containing theoretical terms according to their epistemic virtues. I suggest that we do the same for the 'mindreader's dilemma.' I conclude that a serious shortcoming of the behavior-rules hypothesis is that it makes no novel predictions, but rather is dependent on the results of mindreading experiments for its content. The general aim of this paper is not to deny the possibility that nonhuman animals reason on the basis of behavioral rules, but rather to show that the current approach taken by the critics is misguided.

### 1.2. VPT1 Experiments and the Behavior-Rules Account

The main experimental strategy used to investigate whether chimpanzees are capable of VPT1 is to present a subject (A) with a social situation that involves interacting with another agent (B). Researchers then vary some property so as to affect what B can see. This may be a property of B (open versus closed eyelids, head turned toward versus away from some object) or a property of the environment (a transparent versus opaque barrier, a well-lit versus dark room). The question is whether A will recognize these changes and respond in the manner of someone who takes into account the perceptual states of others. For example, will A prefer to use begging gestures toward a recipient who can see those gestures, prefer to steal food from a competitor who cannot see the food or did not see where the food was recently hidden, etc.? If chimpanzees consistently behave in a wide variety of circumstances in the manner of individuals capable of VPT1, then comparative psychologists take this as evidence that they in fact have this ability.

As an example of this strategy, consider the experiment of Melis and colleagues (Melis et al. 2006). In this experiment, a chimpanzee subject competes with a human experimenter over two pieces of banana. The banana pieces are located inside a booth where the experimenter sits guarding them. The booth is completely occluded except for a small slit in the front through which the subject can observe the experimenter sitting between the two banana pieces.[1] The subject can also see through the slit that there is a tunnel leading from an opening on the left side of the booth to one piece of banana and a second tunnel leading from an opening on the right side of the booth to the second piece of banana. Lastly, the subject can observe that one of

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[1] The booth is occluded in this way so that when the subject is in the act of stealing a piece of banana, she does not have the option of modifying her behavior in response to the experimenter's behavior because she cannot see the experimenter.

these tunnels is opaque, while the other is transparent. The question is, when the subject tries to steal a piece of banana from the experimenter, through which tunnel will she reach? A subject that is sensitive to what other agents can see should reach through the opaque tunnel because it is more effective at concealing one's approach than the transparent tunnel. On the other hand, a subject that does not take into account the perceptual states of others should have no reason to prefer one tunnel to the other, as they are otherwise identical. I will refer to experiments such as these as 'mindreading tasks' and the ability to respond to the situation in the manner of a mindreader as 'solving' a mindreading task.

Critics of the above approach argue that the results obtained from such experiments are confounded by learned or evolved behavioral rules. The reason for this is that the observable properties that psychologists vary across experimental conditions are all properties that normally covary with an agent's ability to see or not see objects. Thus, one should also expect these observable properties to covary with seeing and not-seeing behaviors in a chimpanzee's natural environment. For example, the property of there being no opaque barrier between an agent's eyes and an object should regularly co-occur with that agent exhibiting behaviors consistent with seeing that object (such as approaching that object if it is desirable food, retreating from that object if it is a harmful predator, etc.). On the other hand, the property of there being an opaque barrier between an agent's eyes and an object should regularly co-occur with that agent exhibiting behaviors consistent with not seeing that object (such as not approaching it even if it is desirable food, not retreating from it even if it is a harmful predator, etc.). Given these co-occurrences, chimpanzees might have learned or evolved behavioral rules that link these observable properties with seeing and not-seeing behaviors. Though the regular co-occurrence of a particular observable property and a suite of behaviors may be caused by an underlying mental state, an individual adapted to this observable regularity need not reason about these mental states in order to successfully predict behavior.

According to the critics, an experiment cannot provide evidence for mindreading unless it precludes the possibility that subjects are solving the experimental task on the basis of complementary behavioral rules alone, where a complementary behavioral rule (CBR) is one that operates on precisely that observable regularity caused by an underlying mental state.[2] The advocates of this position (whom I will refer to as CBR theorists) do not take their argument as rendering mindreading empirically intractable. Their point is rather that comparative psychologists are not using the experimental approach necessary to provide evidence for or against mindreading abilities in nonhuman animals. Thus, though psychologists claim that they have evidence that chimpanzees are capable of VPT1, in fact, they have no such evidence. In order to produce such evidence, they must implement a new research program. The CBR theorists present such a program and argue that the real

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[2] The acronym "CBR" comes from Lurz (2011). The term is applied here in the same way that Lurz applies it; however, for Lurz, this acronym stands for "complementary behavior reading," whereas here it stands for "complementary behavioral rules." Behavior reading suggests that subjects are responding to behavioral cues, but comparative psychologists rule out this possibility through the implementation of experimental controls. In contrast, "behavioral rules" suggests that one can apply a rule in order to make a prediction about how another agent will behave on the basis of any set of observable circumstances, behavioral or otherwise. This is the sense in which the term is employed here.

question is whether chimpanzees can pass the mindreading tasks in this new experimental paradigm. If they can, then we finally have evidence of mindreading in apes. If they cannot, then this suggests that chimpanzees have in fact been applying behavioral rules all along.

In the following section, I present what CBR theorists take to be the two most compelling examples of experiments that test for perceptual state attribution in apes and reject the hypothesis that apes reason in terms of complementary behavioral rules alone.[3] For reasons that will be introduced below, both of these experiments are examples of what are known as 'experience-projection' experiments. I argue that these mindreading tasks can in fact be solved through the application of behavioral rules. Thus, they fail to satisfy the criteria imposed by their designers.

### 1.3. Experience-Projection Experiments

The general idea behind an experience-projection experiment is that a subject is given the opportunity to learn that some situation $S_1$ reliably leads him to experience the psychological $P_1$, while some other situation $S_2$ reliably leads him to experience the psychological state $P_2$. Once the subject learns to associate $S_1$ with $P_1$ and $S_2$ with

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[3] Penn and Povinelli (2007) present one additional experiment that they take as demonstrating how one should go about testing ape mindreading in a way that rejects the behavior-rules alternative. Their proposed experiment is a version of standard experiments used to test for knowledge, ignorance, and false-belief attribution in great apes (see, for example, Kaminski et al. 2008). However, success on these kinds of tests can also be explained through the application of behavioral rules. One need only apply a rule such as: In an object choice task, an agent will choose the container that had the preferred reward placed into it while that agent was present (see Appendix). See Lurz (2011, 149-157) for behavioral explanations of all positive results obtained on false-belief tasks with nonhuman animals.

$P_2$ in himself, the researcher then tests if the subject will reason that $S_1$ leads to $P_1$ and $S_2$ to $P_2$ in other agents. For CBR theorists, an experience-projection experiment seems like a promising way to prevent subjects from relying on complementary behavioral rules because experimenters can make $S_1$ and $S_2$ differ in some arbitrary way – that is, in a way that does not normally vary with the psychological states $P_1$ and $P_2$. Given this, subjects purportedly have no reason to infer that $S_1$ will lead to $P_1$-like behaviors in another agent, unless they reason that $S_1$ will lead to $P_1$ in that agent.

### 1.3.1. Original Proposal: Projecting Visual Experiences

Cecilia Heyes (1998) proposed one of the first experience-projection experiments, which has been cited as an exemplar of the CBR experimental approach (see Povinelli and Vonk 2006; Penn and Povinelli 2007). In Heyes's experiment, an ape subject is given the opportunity to interact with two pairs of goggles. The goggles are designed so that their external features are identical except that one pair has red trim and the other pair has blue trim. When the subject tries on these goggles, however, she discovers another important difference between them: she can see through the lenses of the blue-trimmed goggles, but not through the lenses of the red-trimmed goggles. By familiarizing herself with these goggles, the subject is expected to learn to associate the observable state of wearing blue-trimmed goggles with the psychological state of being able to see and the observable state of wearing the red-trimmed goggles with the psychological state of not being able to see. Once the subject learns these properties, the question is, will she expect agents wearing the blue-trimmed goggles to behave as if they can see and agents wearing the red-trimmed goggles to behave as if they cannot see? If so, CBR theorists hold, the subject must be capable of attributing perceptual states to others because there is no other reason to expect seeing and not-seeing behaviors from agents wearing blue-trimmed and red-trimmed goggles. The only way to come to this conclusion is by analogically inferring that when other agents wear these goggles, they are having the same perceptual experiences that I have when I wear them.

As commentators on this experiment have pointed out, however, this is not the only means of inferring that other agents will behave in ways consistent with seeing and not-seeing. For example, Kristin Andrews (2005) points out that subjects might experience themselves behaving like seeing agents while wearing the blue-trimmed goggles (walking around, manipulating objects, etc.) and experience themselves behaving like not-seeing agents while wearing the red-trimmed goggles (colliding with objects and agents, failing to perform familiar tasks, etc.). From these behavioral experiences, a subject might reason analogically that other agents will behave as I do when wearing blue- and red-trimmed goggles. To make this inference, the subject need not attribute to agents the psychological states of seeing and not-seeing. Robert Lurz (2011) also points out that even if subjects were not to attempt to move around or do anything while wearing the goggles, they could still recognize that wearing the red-trimmed goggles is like having an opaque barrier in front of one’s eyes, while wearing the blue-trimmed goggles is like not having an opaque barrier in front of one’s eyes. Given that the property of having an opaque barrier in front of one’s eyes normally covaries with an inability to see, and the property of not having an opaque barrier in front of one's eyes normally covaries with an ability to see, subjects could rely on the learned or innate behavioral rule: expect agents with an opaque barrier over their eyes to exhibit X behaviors (behaviors normally exhibited by not-seeing agents in this context) and expect agents with no opaque barrier over their eyes to exhibit Y behaviors (behaviors normally exhibited by seeing agents in this context).

The original experience-projection task, then, can be solved using complementary behavioral rules. Given this, CBR theorists such as Lurz have developed a new set of experience-projection tasks aimed at testing visual perspective taking abilities in nonhuman animals. The claim is that this new approach can reject the behavior-rules hypothesis and thus should be used to determine if nonhuman animals have mindreading abilities.

### 1.3.2. New Proposal: Projecting Visual Appearances

Lurz (2011) maintains that all experiments aimed at testing a nonhuman animal's ability to attribute perceptions of reality fail to reject the behavior-rules hypothesis. The reason for this is that normal visual experiences of real objects involve having a direct line of gaze to those objects, and normal visual experiences of not being able to see real objects involve not having a direct line of gaze to those objects (where a direct line of gaze to an object X is a spatial relationship between one's eyes and X, such that one can draw an imaginary line from one to the other ). Thus, the attribution of visual experiences of reality will always be confounded with the observable property of having or lacking a direct line of gaze (Lurz 2011, 82-83). Given this, Lurz argues that our best bet for empirically identifying whether apes can attribute visual perceptions to others is to determine whether they can attribute non-veridical perceptual experiences to others. To this end, Lurz develops an experimental approach for testing whether apes can attribute to others perceptual illusions that they have themselves experienced in a particular situation.

The theoretical motivation for maintaining that the act of attributing perceptual illusions to others cannot be achieved on the basis of behavioral rules alone runs as follows. Imagine that you are in the process of experiencing a perceptual illusion such that the situation that you perceive at time $t_1$ looks very different at time $t_2$. To use one of Lurz's examples, you watch as an insect becomes perfectly camouflaged as it lands on a leaf. According to Lurz, if you are an individual that reasons only in terms of observable properties, you will perceive the situation at $t_2$ as either a well-camouflaged insect on a leaf or a bare leaf. What you believe is in front of you depends on the biological and psychological constraints that shape your perception and understanding of the world, your previous experiences with such situations, etc. Crucially, however, you cannot simultaneously believe that there is an insect in front of you and that it looks like there is no insect in front of you. Given that you reason in terms of observable properties alone, there can be no two ways about one object. Let us say that your previous experience with these insects in this environment leads you to believe that there is an insect in front of you. Now a competitor comes onto the scene and directs his eyes at the camouflaged insect. You know from previous experience that your competitor generally eats insects that are in his direct line of gaze. What will you predict that the competitor will do? Given that you believe that there is an insect in front of you, you will predict that the competitor will attempt to eat the insect, regardless of whether the competitor was present while the insect was landing on the leaf.

Now imagine that you are in the same situation, but you reason in terms of both observable properties and mental states. Before the competitor arrives, you watch as the insect lands on the leaf and becomes perfectly camouflaged. Assuming that you also have the appropriate biological and psychological constraints, sufficient experience with these insects, etc., you too believe that there is an insect in front of you. However, in addition to this, you are able to recognize that the insect appears as if it is not there. The reason for this, according to Lurz, is that the ability to reason about mental states confers the ability to simultaneously cognize both what you believe to be the case and what you perceive to be the case.[4] What happens now when the competitor enters the scene, directing his gaze at the insect? Though you know that there is an insect on the leaf, you also know that it perceptually appears as if there is no insect on the leaf. Thus, using analogical reasoning and taking into account the fact that the competitor did not witness the insect landing on the leaf, you conclude that the competitor will not attempt to eat the insect because he sees only a leaf.

Lurz uses the above theoretical framework to design a set of experiments that test whether a subject can attribute to another agent the perception that an object

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[4] The argument that Lurz provides to support this claim is not critical to the discussion that follows, but involves the ability to introspect perceptual states directly (Lurz 2011, 86-96).

appears to be one way, when the subject knows that it is in reality another way. The particular example that I will focus on here is an experiment that relies on size-distorting lenses; however, my argument that this mindreading task can be solved using behavioral rules applies to Lurz's other experiments as well. In Lurz's size-distorting-lens experiment, a subordinate subject competes over food with a dominant conspecific in a room that contains strategically placed transparent barriers—some of which have size-distorting properties. Before the test begins, a subject is familiarized with the fact that the dominant competitor will take the larger of two rewards (let us say bananas) when given the opportunity. The subject is also familiarized with the effects that three types of transparent barriers have on objects that are located behind them. A blue-trimmed magnifying barrier makes objects appear larger, a red-trimmed minimizing barrier makes objects appear smaller, and a black-trimmed barrier has no distorting effect on the appearance of objects.[5]

After this pretraining phase, the subject and competitor are placed in separate rooms on opposite sides of an adjoining competition room (Figure 1). In the middle of the competition room are two barriers, each with one banana behind it. The bananas are located on the subject's side of the room, so that when the subject and competitor enter the room, the subject has visual access to both bananas, while the competitor is only able to view the bananas through the barriers. Imagine, as depicted in Figure 1,

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[5] When subjects are familiarized with these barriers, controls are put into place so that the subject does not learn that objects behind the blue-trimmed magnifying barrier are more likely to be approached or retrieved than objects behind the red-trimmed minimizing barrier. Also, the objects that the subject will be competing for during the experiment (in this case, bananas) are not used during the pretraining phase, so that the subject has no experience of preferring bananas located behind one type of barrier over another.

that the subject and competitor are competing over two same-sized bananas, one of which is located behind a blue-trimmed magnifying barrier and the other of which is located behind a red-trimmed minimizing barrier. When the subject and competitor enter the room, which banana will the subject expect the competitor to retrieve?

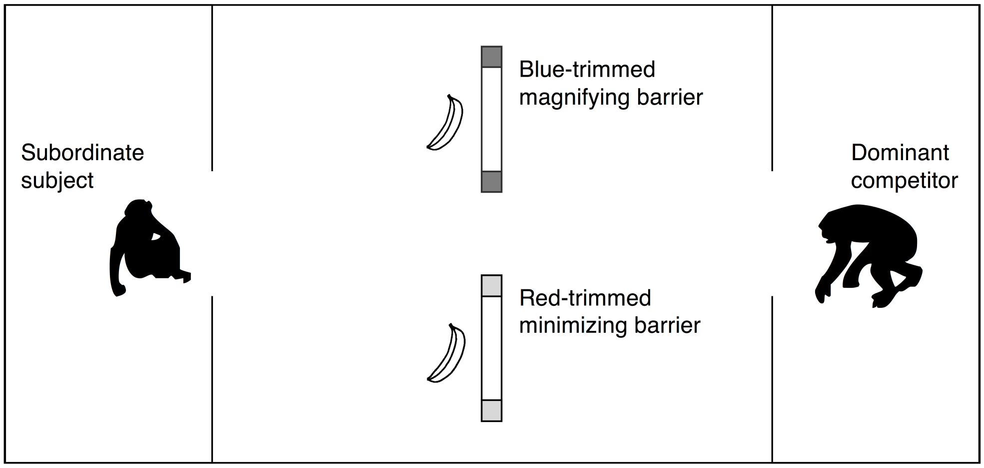

**Figure 1.1.** An experience-projection experiment that uses size-distorting transparent barriers. The subject anticipates which banana the competitor will attempt to retrieve.

According to Lurz, a subject that reasons about both observable properties and mental states will expect that the competitor will retrieve the banana behind the blue-trimmed magnifying barrier. Such a subject knows that both of the bananas are equal in size, but also knows that the banana behind the blue-trimmed magnifying barrier appears larger than the banana behind the red-trimmed minimizing barrier from the competitor's point of view. The subject can see that the competitor must view the bananas through the barriers and knows that the competitor has no experience with the distorting effects of the barriers.[6] Given this, the subject will predict that the competitor will retrieve the banana that appears to be the largest to him, which is the one behind the blue-trimmed barrier.

What will a subject that reasons only in terms of observable properties predict that the competitor will do in this situation? According to Lurz, there are two possibilities, neither of which is the same as the prediction made by a mindreading subject. The first possibility is that the subject views the competitor as having a direct line of gaze to both bananas. Under this scenario, the subject has learned that when it comes to the blue- and red-trimmed barriers, the reality of the situation is what lies behind the barriers and the reality is that two same-sized bananas lie behind these barriers. Thus, the subject will predict that the competitor will choose randomly between the two bananas because that is how agents generally behave when having a direct line of gaze to two identical food items. The second possibility is that the subject has learned that when objects are placed behind the blue- and red-trimmed barriers, images appear on the surfaces of these barriers. The reality of the situation for the subject in this case is that there are two same-sized bananas behind the blue- and red-trimmed barriers, but the competitor cannot establish a direct line of gaze to these bananas because the images on the barriers block the competitor's line of gaze to them. Given this, the subject will expect the competitor to retrieve neither banana – at

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[6] It is not clear from Lurz's description of the experiment how the subject is to know that the competitor is naïve to the distorting effects of the barriers. It seems possible that a subject would infer from the fact that she has had experience with these barriers that a competitor might have experience with them too. Let us assume that there is a way to control for this and that the subject knows that the competitor is ignorant of the effects that the blue- and red-trimmed barriers have on the objects behind them (because, for example, the subject has never observed the competitor interacting with these barriers).

least not until the competitor has the opportunity to walk around one of the barriers and establish a direct line of gaze to one of them.

If Lurz's analysis is correct, then it means that it is empirically possible to reject the hypothesis that apes reason on the basis of complementary behavioral rules alone. From this, CBR theorists can argue that until apes pass such a test, one cannot conclude that they attribute mental states to others. They can also argue that if apes fail this task, then that is all the more reason to doubt the positive results obtained by comparative psychologists thus far.[7] In the following section, I argue that Lurz's new experience-projection tasks do not in fact succeed in rejecting the behavior-rules hypothesis because supposing that chimpanzees could solve these tasks, we could still explain their behavior in terms of complementary behavioral rules. I show how this can be done and then argue that the problem of rejecting the behavior-rules hypothesis is not a special empirical problem facing mindreading research, but rather a general problem facing all explanations that contain theoretical terms.

## 1.4. The Mindreader's Dilemma

In introducing the new experience-projection tasks, Lurz does not consider all of the possible complementary behavioral rules that a subject might apply. The question then is whether there are such rules and whether subjects might have had the

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[7] This is under the assumption that a failure to pass this task is best attributed to a failure of mindreading as opposed to some other feature of the experiment (such as that noted in footnote 6).

opportunity to learn them during their lifetime or acquire them over evolutionary time. In this section, I show that, for the experiment described above, there is a chain of reasoning that a behavior-rules subject could apply that leads to the mindreading prediction that the competitor will attempt to retrieve the banana behind the blue-trimmed magnifying barrier. I then argue that the method that I use to reinterpret the results of this experiment can be applied to all of the new experience-projection tasks proposed by Lurz.

Before showing how the above experiment can be solved using complementary behavioral rules, it would be helpful to spell out the inferential steps that a mindreader must make in order to predict that the competitor will retrieve the banana behind the blue-trimmed magnifying barrier. Many of these steps were noted in the previous section. However, there was one inference that was not made explicit there. Recall that in this experiment, subjects have visual access only to the real bananas behind the barriers (**R**), not the apparent bananas or images on the barriers (**A**) (Figure 2).

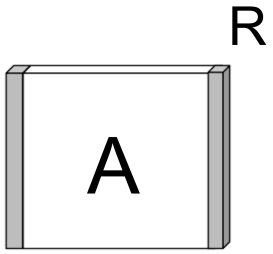

**Figure 1.2.** A transparent size-distorting barrier, where **R** is the object behind the barrier and **A** is the apparent object as seen through the barrier or the image of the object as it is projected onto the barrier.

Thus, in order to mindread, a subject must infer **A** on the basis of **R** and the color of the barrier. If the subject could not do this, then she would not know what the competitor can see. The only way to do this is to learn during the pretraining phase that there is a regular, predictable relationship between **R** and **A**. In this case, because the blue-trimmed barrier magnifies objects and the red-trimmed barrier minimizes objects, the subject must learn that the image on the blue-trimmed barrier ($\mathbf{A_b}$) is a larger version of the object behind it ($\mathbf{R_b}$) and the image on the red-trimmed barrier ($\mathbf{A_r}$) is a smaller version of the object behind it ($\mathbf{R_r}$). With this knowledge and that stated in the previous section, a mindreader can solve the experimental task by reasoning as follows:

1. For **R** = object behind barrier; **A** = apparent object or image on barrier:
    i. In the case of the blue-trimmed barrier, $\mathbf{A_b}$ = large $\mathbf{R_b}$
    ii. In the case of the red-trimmed barrier, $\mathbf{A_r}$ = small $\mathbf{R_r}$
2. $\mathbf{R_b} = \mathbf{R_r}$ (the two bananas are of equal size)
3. Given 1 and 2, $\mathbf{A_b}$ is larger than $\mathbf{A_r}$
4. An agent will see $\mathbf{R_b}$ as $\mathbf{A_b}$ (the banana behind the blue-trimmed barrier as large) and $\mathbf{R_r}$ as $\mathbf{A_r}$ (the banana behind the red-trimmed barrier as small) and will act on this perceptual knowledge when he
    i. can see $\mathbf{A_b}$ and $\mathbf{A_r}$, but not $\mathbf{R_b}$ and $\mathbf{R_r}$
    ii. is unfamiliar with the distorting effects of the blue- and red-trimmed barriers

5. The competitor
    i. can see $\mathbf{A_b}$ and $\mathbf{A_r}$, but not $\mathbf{R_b}$ and $\mathbf{R_r}$
    ii. is unfamiliar with the effects of the blue- and red-trimmed barriers
6. Given 4 and 5, the competitor will see $\mathbf{R_b}$ as $\mathbf{A_b}$ and $\mathbf{R_r}$ as $\mathbf{A_r}$ and will act on this perceptual knowledge
7. The competitor will attempt to retrieve the largest banana that he can see
8. Given 3, 6, and 7, the competitor will attempt to retrieve $\mathbf{R_b}$

A mindreader must make the above inferences in order to solve this experimental task. The key step in this line of reasoning is premise 4. Namely, it is this premise that allows the subject to infer that the competitor will be fooled by the distorting effects of the lenses. How does the subject know that, "an agent will see $\mathbf{R_b}$ as $\mathbf{A_b}$ and $\mathbf{R_r}$ as $\mathbf{A_r}$" when conditions 4.i and 4.ii are fulfilled? According to Lurz, the subject knows this from her own experience with the lenses during the pretraining phase. When chimpanzees first encounter size-distorting lenses, they are fooled by the effects of these lenses and treat the distorting glass as non-distorting transparent glass (Krachun et al. 2009). Given this, when a subject first encounters the red- and blue-trimmed barriers, it is expected that she will treat the apparent object **A** as if it were the real object **R** unless she has evidence to the contrary (such as the ability to walk around the barrier and see **R** directly). It is this experience that allows her to predict that an agent in the same situation (one lacking evidence to the contrary) will treat **A** as if it were **R**.

The question now is whether subjects can solve this experimental task on the basis of behavioral rules alone. We can see that they can by simply reformulating premise 4 in a way that does not appeal to seeing **R** as **A**. One way to do this is to maintain that when a subject first encounters the size-distorting lenses and takes them to be normal transparent barriers, she accesses all of the behavioral affordances that such a transparent barrier has. For example, such a subject could recognize that the way to retrieve **A** in this situation is to walk around the barrier toward **R**. This is how agents normally respond to transparent barriers. They do not treat them as opaque barriers (ignoring the objects behind them) nor as the absence of a barrier (trying to walk through them). Later, after becoming familiar with the effects of the blue- and red-trimmed barriers, the subject will revise her understanding of the situation, but this need not prevent her from recalling that when she first encountered the blue- and red-trimmed barriers she responded to them (or would have responded to them) as if they were normal transparent barriers. With this recollection, the subject can reason that the competitor will respond to the blue- and red-trimmed barriers as if they were normal transparent barriers, since the competitor is encountering them for the first time.

With this experience in hand, a subject can solve the proposed mindreading task on the basis of behavioral rules. Such a subject's chain of reasoning would run as follows:

1. For **R** = object behind barrier; **A** = apparent object or image on barrier:
    - i. In the case of the blue-trimmed barrier, $\mathbf{A_b}$ = large $\mathbf{R_b}$

   ii. In the case of the red-trimmed barrier, $\mathbf{A_r}$ = small $\mathbf{R_r}$

2. $\mathbf{R_b} = \mathbf{R_r}$ (the two bananas are of equal size)
3. Given 1 and 2, $\mathbf{A_b}$ is larger than $\mathbf{A_r}$
4. An agent will attempt to act on $\mathbf{A_b}$ by approaching $\mathbf{R_b}$ and $\mathbf{A_r}$ by approaching $\mathbf{R_r}$ when he
   i. has a direct line of gaze to $\mathbf{A_b}$ and $\mathbf{A_r}$, but not to $\mathbf{R_b}$ and $\mathbf{R_r}$
   ii. is unfamiliar with the distorting effects of the blue- and red-trimmed barriers
5. The competitor
   i. has a direct line of gaze to $\mathbf{A_b}$ and $\mathbf{A_r}$, but not to $\mathbf{R_b}$ and $\mathbf{R_r}$
   ii. is unfamiliar with the effects of the blue- and red-trimmed barriers
6. Given 4 and 5, the competitor will attempt to act on $\mathbf{A_b}$ by approaching $\mathbf{R_b}$ and $\mathbf{A_r}$ by approaching $\mathbf{R_r}$
7. The competitor will attempt to retrieve the largest banana to which he has a direct line of gaze
8. Given 3, 6, and 7, the competitor will approach $\mathbf{R_b}$

This series of steps is almost identical to what a mindreader would have to reason in order to solve the experimental task. The crucial difference is that we have replaced all of the steps involving mindreading with observable states. First, we have replaced the mental-state attribution of "seeing" with the observable-state attribution of "has a direct line of gaze." Second, instead of supposing that the subject learns during the pretraining phase that the blue- and red-trimmed barriers distort reality, we have supposed that the subject remembers that she would have treated these barriers as transparent when she first encountered them (premise 4). Lastly, rather than supposing that the subject attributes to the competitor the perceptual state of seeing **R** as **A**, we have presumed that the subject will expect the competitor to behave in the same way that the subject would have behaved when she first encountered the barriers (premise 6). In summary, a subject need not simultaneously believe that the competitor has a direct line of gaze to the real banana (**R**) and know that the competitor sees the apparent banana (**A**). Instead, the subject can reason that the competitor has a direct line of gaze to the apparent banana (**A**) and hold that for every action that the competitor is likely to perform on **A**, he will perform this action on **R** instead because this is how agents typically behave around transparent barriers.

The above technique can be applied to all of the new experience-projection tasks proposed by Lurz. This is because any subject with the observable information necessary for mindreading will also have the information necessary for behaving like a mindreader using behavioral rules. Specifically, if you give a subject the chance to experience that a situation has the effect of making **R** (some real object) appear as **A** (the illusory state), and also give the subject a chance to learn that **R** is not really **A**, then that subject will have also learned that when they were new to the situation, they treated (or would have treated, if given the opportunity) **R** as if it were **A**. Such a subject would then have the information needed to predict that other naïve agents (agents new to the situation) will respond to **R** as if it were **A**. This does not mean that the subject understands that the other agent perceives **R** (the observable state) *as* **A** (a mental state). Rather, the subject could simply reason that the agent will behave as naïve agents generally behave in this situation (as an agent responding to **A**).

If the above analysis is correct, then the new experience-projection tasks do not succeed in rejecting the behavior-rules hypothesis. This means that CBR theorists have been unable to show how one could go about rejecting this hypothesis. Indeed, at this point, it is difficult to imagine what such an experiment would look like. The idea that one can always take an explanation of mindreading and replace the unobservable mental states with observable features and regularities is analogous to what Hempel identified as the 'theoretician's dilemma.' Hempel described this dilemma as follows:

> …if the terms of and the general principles of a scientific theory serve their purpose, i.e., if they establish definite connections among observable phenomena, then they can be dispensed with since any chain of laws and interpretative statements establishing such a connection should then be replaceable by a law which directly links observational antecedents to observational consequents. (1958, 49)

Similarly, we can identify a mindreader's dilemma:

If an individual is capable of mindreading, i.e., if she establishes definite connections among observable phenomena, then her mindreading abilities can be dispensed with since any evolved or learned rule establishing such a connection should then be replaceable by a rule which directly links observational antecedents to observational consequents.

Several CBR theorists explicitly characterize their position as one that rejects the claim that nonhuman animals are capable of theorizing or reasoning about unobservable properties. As Penn and Povinelli characterize their own position, “we know of no evidence that non-human animals are capable of representing or reasoning about *unobservable* features, relations, causes or states of affairs or of construing information from the cognitive perspective of another agent” (emphasis original, 2007, 737). Given this characterization, it is no surprise that the CBR position maps on neatly to the theoretician’s dilemma.

Hempel rejects the theoretician’s dilemma, arguing that just because one can get rid of the theoretical terms in an explanation does not mean that one should. Instead, he maintains that researchers should take others things into account, such as whether the presence or absence of the theoretical terms leads to progress, given a set of epistemic goals. I suggest that we reject the mindreader’s dilemma on the same grounds. The fact that we can account for chimpanzee social behavior without positing mindreading abilities does not mean that we should. Instead, we must evaluate both the mindreading and behavior-rules hypotheses in light of their success relative to those epistemic goals valued by researchers.

Once we shift our attention to evaluating the mindreading and behavior-rules hypotheses with respect to particular epistemic virtues, we find that the behavior-rules hypothesis has a very serious shortcoming: it does not make any novel predictions. As Fletcher and Carruthers (in press) point out, “the behavior-rule account is only capable of ‘predicting’ new findings after they are discovered, postulating a novel behavior-rule for the purpose" (8). CBR theorists have yet to produce a positive account concerning what behavioral rules we might expect particular nonhuman animals to possess independently of their performance on mindreading tasks. Instead, the behavioral rules proposed are all and only those that can account for the current results of mindreading research.

As we have seen, CBR theorists do make positive empirical proposals. However, these proposals are not aimed at testing predictions made by the behavior-rules hypothesis. Instead, they are aimed at testing particular mindreading hypotheses (such as the hypothesis that chimpanzees are capable of attributing illusory perceptions to others). It is these mindreading hypotheses that guide the development and design of the experiments proposed by CBR theorists, not the behavior-rules hypothesis. Moreover, these mindreading hypotheses are entirely consistent with the research approach currently taken by comparative psychologists. Were CBR theorists to conduct these experiments, comparative psychologists would no doubt be eager to hear the results. However, unlike the CBR theorists, comparative psychologists would not take the results of these experiments as evidence for or against the behavior-rules hypothesis. Instead, they would take them as evidence for or against a particular mindreading hypothesis. Such an interpretation is entirely appropriate, however, given that this is what the experiments were designed to test.

In contrast to the behavior-rules hypothesis, the mindreading hypotheses currently advanced and tested by comparative psychologists make concrete predictions about how individuals should behave in particular situations. For example, the hypothesis that chimpanzees have level 1 visual perspective taking abilities predicts that chimpanzees will follow the gaze of other agents, use gestures appropriately depending on the attentional states of recipients (e.g., use visual gestures more when recipients can see them), modify their competitive strategies appropriately depending on the attentional states of their competitors (e.g., conceal their approach when stealing food), and more. If chimpanzee behavior consistently diverged from any of these predictions, then this would lead researchers to seriously question whether they have this mindreading ability. Indeed, it is on these grounds, that comparative psychologists currently maintain that chimpanzees do not understand the beliefs of other agents (Call and Tomasello 2008, Kaminski et al. 2008). It is only because chimpanzees consistently behave in a variety of circumstances in the manner predicted by the VPT1 hypothesis that researchers maintain that there is good evidence that they have this ability (Tomasello and Call 2006; Call and Tomasello 2008).

## 1.5. Conclusion

CBR theorists insist that the only way to empirically show that an individual is capable of attributing psychological states to others is to reject the alternative hypothesis that an individual solves mindreading tasks on the basis of behavioral rules alone. Because of this, they argue, the experimental approach currently taken by comparative psychologists should be rejected and a research program capable of falsifying the behavior-rules hypothesis should take its place. The experience-projection experiments are the most compelling examples of what such a research program should look like. However, as we have seen, these proposed experiments have not succeeded in rejecting the behavior-rules hypothesis. Indeed, it is difficult to imagine any experiment that could. If observable features and regularities can always be recruited to do the work of mental states in mindreading accounts, then any attempt to reject the behavior-rules hypothesis is bound to fail. Rather than attempting to solve the mindreader's dilemma, we should focus on assessing mindreading and behavior-rules hypotheses with respect to the epistemic goals of research. Currently, the behavior-rules hypothesis does not fare well under such an evaluation, as it lacks the ability to make predictions that go beyond the results obtained from mindreading experiments.

## 1.6. Appendix[8]

The second experiment that Penn and Povinelli (2007) take as an "existence proof" that there are experiments that can falsify the hypothesis that apes reason by behavioral-rules alone is a false-belief task modeled on the competition experiments of Hare and colleagues (Hare et al. 2000, 2001). The purpose of this experiment is to vary the epistemic state of a dominant competitor (altering the competitor's perceptual, knowledge, and belief states) by manipulating the competitor's visual

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[8] The analysis presented in this Appendix was originally included as part of the content of chapter one. However, after writing this section, I found that Lurz (2009) makes a very similar argument to the one that I present here – that is, we independently developed the same behavioral solution to Penn and Povinelli's false-belief task. Nevertheless, I include my analysis here because my approach and presentation differ from those used by Lurz.

access to events in the world. The question then is: will subjects respond differently to the competitor as a function of the competitor's epistemic state?

Penn and Povinelli present eight critical experimental conditions that they claim can together distinguish mindreading apes from their behavior-rules counterparts. Specifically, they maintain that

> In the context of the present protocol, i.e. randomly interspersed among the other conditions, there is no way for a subject to reliably pass these critical conditions without the ability to keep track of the counterfactual state of affairs from the dominant's cognitive perspective while simultaneously keeping track of the occurrent state of affairs from the subject's own perspective. (740)

As in the original studies of Hare and colleagues, in this experiment, a chimpanzee subject competes with a dominant conspecific over food. The experimental setup includes three rooms: a middle competition room and two adjoining waiting rooms – one for the subject and one for the dominant competitor. The doors leading from the waiting rooms to the competition room are sliding doors that can be partially opened so that the occupant of the waiting room can peak inside the competition room without having the ability to enter. In the competition room, there are five buckets evenly distributed along the middle of the room.

The experiment consists in an experimenter hiding two food items (one of which is more desirable than the other) into two separate buckets and then simultaneously releasing the dominant competitor and subordinate subject into the middle room, so that they can compete over the food items. Before the experiment is conducted, the subjects are trained to know that they can retrieve only one of the two baited food rewards. They are also tested to ensure that when given a choice between less- and more-desirable rewards, they choose the reward that is more desirable. Subjects are then paired with dominant competitors and tested to ensure that when in competition, the dominant competitor consistently retrieves the more desirable food item and the subordinate subject consistently retrieves the less desirable food item.

The experimental conditions vary along two dimensions. First, the experimenter's manipulation of the food items varies; namely, the order in which the two food items are hidden and whether or not one or both food items are moved into different buckets.[9] Second, the presence of the dominant competitor during the manipulation of food items varies. The dominant competitor is "present" when the sliding door to his waiting room is partially open so that he can witness what the experimenter is doing with the food items. The dominant is "not present" when his door is fully closed. In all conditions, the subject's waiting-room door is partially open, so that she can view not only where the experimenter is placing food items, but also precisely when the competitor is present.

As we saw above, Penn and Povinelli maintain that if subjects respond to the conditions of this experiment in the way that we expect a mindreading subject to respond, then we will have succeeded in rejecting the behavioral-rules hypothesis. However, when one takes a closer look at these experimental conditions, it is not too difficult to devise a few behavioral rules that can be used to reinterpret the responses

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[9] Penn and Povinelli (2007) describe some conditions in terms of moving the rewards into new buckets and other conditions in terms of moving the containers into new stalls. I will present the conditions in terms of shifting the rewards into new buckets. The behavioral rules that will be introduced, however, apply equally to both cases. In the case of shifting buckets, the subject must keep track of the status of the stalls, rather than the status of the buckets.

of a mindreading subject in terms of behavioral rules alone. Here are four rules that achieve this end:

1. If a competitor is present while a reward is placed into a container (C), this container acquires the status C* and the competitor will choose it if given the opportunity.
2. If the competitor has a choice between more than one C* container, he will choose the one that had the more desirable reward being placed into it while he was present.
3. A container remains C* until the competitor is present while a reward is removed from that container. When this occurs, the C* container loses its special status and becomes a C container again.
4. Avoid the container that the competitor will choose.

These four rules are all that we need to reinterpret the results of this experiment, were it performed by a mindreading subject.

Let me begin by illustrating how these rules apply in the context of two contrasting conditions: *removed informed* and *removed uniformed*. In the *removed informed* condition, the more desirable reward ($\alpha$) and the less desirable reward ($\beta$) are placed into two separate buckets while the dominant is present (Figure 3). When this occurs, the status of the buckets containing the rewards change from C (white colored) to C* (gray colored) according to our first behavioral rule. Next, an experimenter removes one of the two rewards while leaving the other reward as it is. In the example depicted in Figure 3, the less-desirable reward (β) is removed. As the name suggest, in the *removed informed* condition, the dominant is present as the experimenter removes β from its container. Given this, our third behavioral rule applies: the status of the container changes from C* (gray) back to C (white). Which bucket will the subject expect the dominant competitor to choose? According to our behavioral rules, he will choose the only C* container available, which is the bucket containing α.

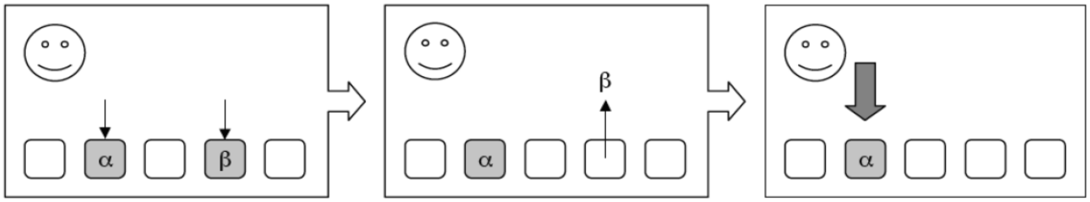

**Figure 1.3.** The *removed informed* condition in which the less desirable reward (β) is removed.[10]

The scenario is similar for the case in which the more desirable reward is removed instead of the less desirable reward (Figure 4). Here again, both rewards are placed into buckets while the dominant is present, changing the status of these containers from C to C*. Then, the more desirable reward (α) is removed in the

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[10] **Legend for Figures 1.3-1.7.** $\alpha$: the more desirable reward; $\beta$: the less desirable reward; *smiley face*: the dominant is present during the experimental phase represented by that frame; *white square*: a box with the status C; *gray square*: a box with the status C*; *narrow arrow*: indicates that a reward is being placed into or removed from a box; *wide arrow*: indicates the box that the subject expects the competitor to choose.

presence of the competitor, changing the status of its container from C* to C. Which of the containers will the competitor choose? Again, the competitor will choose the only C* available, which is the bucket containing β.

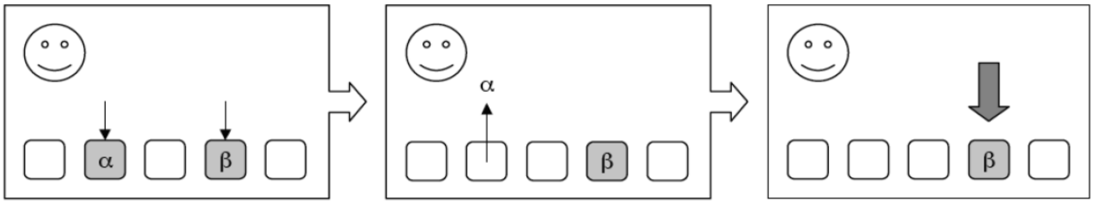

**Figure 1.4.** The *removed informed* condition in which the more desirable reward (α) is removed.

Now let us consider the *removed uniformed* condition. This condition is identical to the *removed informed* condition, except that the competitor is no longer present during the second phase when one of the rewards is removed. Consider the example depicted in Figure 5. As in the previous two examples, two containers are baited with rewards α and β while the competitor is present. When this occurs, the status of these two containers changes from C to C*. Then, the competitor's door is closed, so that only the subject is present while the experimenter removes the less desirable reward (β) from its container. Given that the competitor is not present during the process of removing β, the third behavioral rule no longer applies. The bucket that contained β retains its C* status. Given that both containers have retained their C* status, the subject will expect the competitor to choose the bucket containing α, as this is the container that had the more desirable reward placed into it while the competitor was present (in accordance with our second behavioral rule).

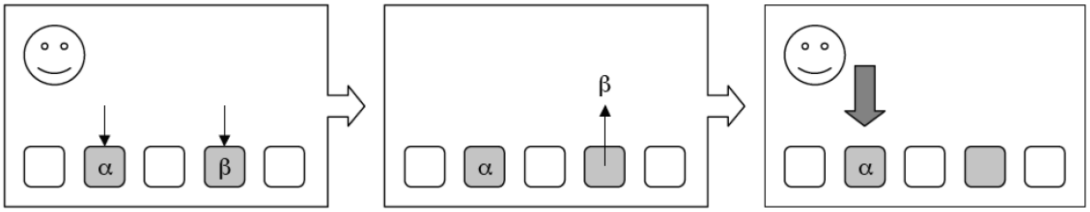

**Figure 1.5.** The *removed uninformed* condition in which the less desirable reward (β) is removed.

What happens when the more desirable reward is removed during the *removed uninformed* condition? This situation is depicted in Figure 6. Here again the subject watches as an experimenter baits one container with α and another container with β while the competitor is present. The competitor's door is then closed, and the subject watches as the experimenter removes α from its container. This container retains its C* status, given the absence of the competitor during the removal of α. Thus, the subject will again expect the competitor to choose the more desirable container out of the two C* containers available, which is the container that had contained α. The fact that this container no longer holds α is not relevant because its status as the more desirable C* container was established when it first achieved this status in the competitor's presence.

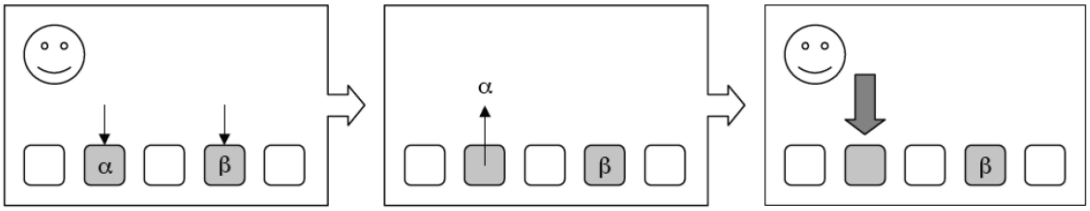

**Figure 1.6.** The *removed uninformed* condition in which the more desirable reward (α) is removed.

The previous example is one of the more interesting examples that we have considered thus far because it shows how a subject relying on our four behavioral rules makes the same prediction as a subject who knows when another agent has a false belief. If our subject were capable of attributing false beliefs to others, then she might reason that the competitor will choose the second container because the competitor believes that the second container holds α even though the subject herself knows that α is no longer in that container.

Let us consider one last example in order to demonstrate that our four behavioral rules produce the same predictions that we would expect of a mindreading subject, regardless of how many times we shuffle the rewards around. In the *misinformed* condition, both rewards are again placed into buckets under the competitor's gaze (Figure 7). Then the competitor's door is closed and the experimenter carries out the following three actions. First, one of the rewards gets moved into a randomly selected bucket X. Next, the item that was in bucket X (either a reward or nothing) is moved into a third bucket Y. Finally, the item that was in bucket Y (either a reward or nothing) is moved into the bucket that had originally contained the first reward that was moved.

Figure 7 depicts the specific situation in which, first, the reward α is moved from the second bucket into the (randomly selected) first bucket, which contains nothing. Then the contents of this first bucket (nothing) are placed in the (randomly selected) fourth bucket. This fourth bucket contains β, so β is then moved to the second bucket (the one that originally contained α). Though this seems like a complicated series of actions, the subject's reasoning concerning what the competitor will do need be no more complex than that of the last example. Namely, two buckets acquired the status of C* during the original baiting in the presence of the competitor. Thus, out of these two buckets, the competitor will choose the one that had the more desirable reward placed into it while he was present – in this case, the bucket that had contained α.

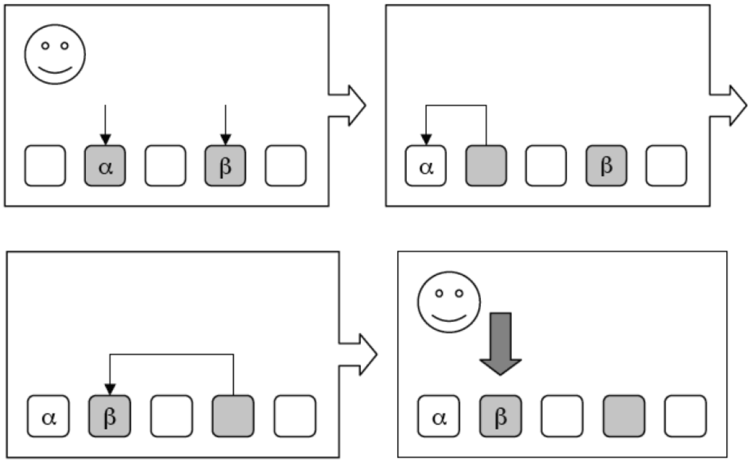

**Figure 1.7.** The *misinformed* condition

These examples show that the second experiment proposed by Penn and Povinelli (2007) can be reinterpreted according to complementary behavioral rules. The remaining conditions proposed by Penn and Povinelli can be reinterpreted in this way without the addition of any other behavioral rules or inferential steps. Thus, this experiment does not succeed in rejecting the behavioral-rules hypothesis as CBR theorists maintain.

# Chapter Two

# Is There a Special Problem of Mindreading in Nonhuman Animals?[11]

## Abstract

The CBR (complementary behavioral rules) theorists and comparative psychologists agree on the definition of mindreading, but disagree on how one should go about providing evidence for this cognitive ability. In this chapter, I show how the experimental approach taken by comparative psychologists provides evidence for mindreading, given the accepted definition. I then argue that, according to this same definition, it is theoretically impossible to reject the behavioral-rules hypothesis. Why do CBR theorists believe that one can reject the behavioral-rules hypothesis? I propose two reasons. First, they hold that the unique causal work performed by mindreading can be detected within a given experiment, rather than only across many experiments. Second, they believe that some mindreading tasks (such as the experience-projection tasks introduced in chapter one) cannot be solved on the basis of behavioral rules alone. My arguments in this chapter combined with those presented in chapter one show that these two claims are mistaken.

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[11] The title of this chapter is inspired by Callender and Cohen's paper, "There is no special problem about scientific representation" (2006). Callender and Cohen argue that the problems of scientific representation are just the problems of representation in general and thus that the proposed solutions for the latter can be applied to the former. Similarly, I believe that the problems involved in establishing the claim that nonhuman animals mindread are no different than the problems involved in establishing any theoretical claim in science. Thus, the proposed solutions to the latter can be applied to the former. This chapter does some of the preliminary work necessary for establishing this claim.

## 2.1. Introduction

In chapter one, I argued that the experiments proposed by CBR theorists fail to reject the behavior-rules hypothesis. I did this by showing how a subject could solve these mindreading tasks on the basis of complementary behavioral rules alone. In this chapter, I examine more closely the differences between what CBR theorists and comparative psychologists take as evidence for nonhuman animal mindreading.

For the purposes of this chapter, I focus on the work of Povinelli and colleagues, who are the main advocates of the CBR position. I begin in section 1 by showing that Povinelli and colleagues are in agreement with comparative psychologists concerning the definition of mindreading. According to both camps, to mindread is to be sensitive to the cognitive state of another agent in a way that goes beyond being sensitive to observable states of affairs. Namely, it is to treat disparate observable states as belonging to the same abstract equivalence class on the basis of the cognitive state that they have in common. I show how comparative psychologists employ what John Stuart Mill identified as the methods of agreement and difference in order to determine whether nonhuman animals have this ability.

In section 2, I briefly present why many comparative psychologists went from thinking that chimpanzees did not understand perceptual states (in the 1990s) to believing that they did (the current consensus). Povinelli and colleagues’ early opposition to chimpanzee mindreading was made on the basis that chimpanzees did not appear to categorize disparate behaviors as belonging to the same abstract equivalence class. Other comparative psychologists agreed with this position. However, this consensus shifted as the number of experiments testing for this ability increased and consistently found positive results.

Povinelli and colleagues do not distinguish their current opposition to animal mindreading from their earlier one. However, the basis for these two oppositional positions is very different. I show this in section 3 by introducing the current oppositional strategy advanced by Povinelli and colleagues and explaining how it departs from their earlier approach. Specifically, I show that while the earlier approach applied the mindreading criteria generally accepted by comparative psychologists, the new approach holds that meeting these criteria is not enough to demonstrate mindreading. Instead, it maintains that an experiment can provide evidence for mindreading only if it shows the unique causal work performed by a mindreader *within* a given experiment.

In section 4, I present my objection to this new oppositional approach. I argue that the standard that it sets for mindreading cannot be met according to Povinelli and colleagues' own definition of mindreading. I then consider why Povinelli and colleagues believe that any experiment could reveal the unique causal work performed by mindreading. I give two plausible reasons: first, that they assume that a property of a collection of experiments is also a property of each individual experiment; second, that they believe that some experimental tasks require mindreading abilities in order to be solved. I argue that both of these claims are mistaken. I conclude section 4 by briefly criticizing Povinelli and colleagues' characterization of CBR as a null hypothesis. I argue that CBR is not a null hypothesis, but rather just the claim that one must control for potential confounding variables when investigating mindreading experimentally.

I conclude this chapter by endorsing the mindreading criteria currently employed in comparative psychology. I also briefly note how the new oppositional strategy employed by Povinelli and colleagues has the features of a second-order behaviorism.

## 2.2. Identifying Mindreading Abilities in Nonhuman Animals

Penn and Povinelli (2007) present a bare-bones definition of mindreading that captures the core of the concept well. In their view, mindreading is the ability to produce and use *ms* variables, where an *ms* variable carries information about the cognitive state of another organism.[12] Since one organism cannot directly observe the cognitive state of another organism, mindreaders must produce *ms* variables on the basis of observable information. That is, they must implement some function that allows them to calculate *ms* variables on the basis of observable input. How do we determine whether an agent is producing an *ms* variable? Penn and Povinelli urge:

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[12] Penn and Povinelli do not state what the letters “ms” stand for. They could mean “mental state” (where a mental state is the mindreader’s account of another agent’s cognitive state) or “mindreading state.” I prefer the term “mindreading state” because it is not as easily conflated with the term “cognitive state.”

> let us agree that an *ms* variable carries information about some other cognitive state if the state of the *ms* variable covaries with the state of the other cognitive state in a generally reliable manner such that, *ceteris paribus*, variation in the *ms* variable can be used by the consuming cognitive system to infer corresponding variations in the cognitive state (733).

A mindreader, then, is an individual who produces and uses information that covaries with the cognitive state (*cs*) of another organism in a reliable manner (that is, $ms = f(cs)$). For ease of presentation, I will use the notation $cs \rightarrow ms$ ("*cs* leads to *ms*") to indicate that *ms* depends on *cs* in this way.

The above definition of mindreading concurs with the approach that comparative psychologists currently take to determine the mindreading abilities of nonhuman animals. Psychologists test for mindreading abilities by using what John Stuart Mill identified as the methods of agreement and difference (Mill 1872/2006, 388-396). Mill proposed these methods as ways of establishing a regularity or correlation between two phenomena (the antecedent and consequent).[13] For example, suppose that we would like to determine whether the presence of *x* regularly leads to the occurrence of *y*. The method of agreement does this by determining if *x* leads to *y* when the antecedent variables accompanying *x* vary. If the antecedent situations are such that they have nothing in common but *x*, then we have reason to believe that it was precisely the presence of *x* that led to the occurrence of *y*. In contrast, the method of difference determines if *x* leads to *y* by looking at two situations that are identical

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[13] Mill maintained that the method of agreement could only establish an invariable law between two phenomena, while the method of difference could further establish a causal law between phenomena (Mill 1872/2006, 394). Given our definition of mindreading above, however, we need not worry about establishing causal relationships, so I will discuss these methods only in terms of demonstrating that two phenomena correlate reliably.

except that one contains *x* and the other one does not. If the situation with *x* consistently leads to *y*, while the situation without *x* consistently does not, then we have reason to believe that the occurrence of *y* depends on *x*.

Comparative psychologists employ these methods in order to determine if nonhuman animals are sensitive to the perceptual states of other agents. As an example of how these methods are applied, consider the conditions depicted in Figure 1. In this experiment, chimpanzee subjects were presented with a situation that involved an experimenter that had access to food. The researchers manipulated the visual state (*cs*) of the experimenter in order to see if it had a reliable effect on the behavior of the subjects. In particular, they monitored when subjects would produce visual gestures (gesture that had to be seen to be effective) in order to request food from one of the experimenter. This measure served as a proxy for the *ms* variable representing a subject's understanding of perceptual states. An *ms* variable is an informational state instantiated in an organism and thus is not directly observable. Because of this, researchers monitor predetermined behaviors that are taken to be reliable indicators of *ms*. In this case, the reliable indicator was the production of visual gestures.

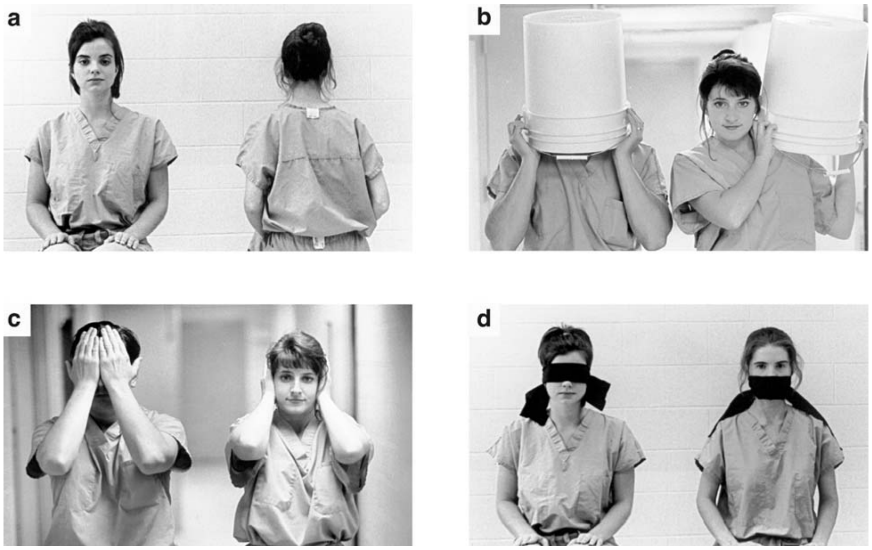

**Figure 2.1.** The use of Mill’s methods in comparative psychology. A chimpanzee subject is faced with two human experimenters that have access to food. The question is, in response to which experimenter will the subject produce a visual gesture? Within each condition (a-d), the presence and absence of the cognitive state *seeing* is presented while keeping other variables constant (method of difference). Across conditions, the situation is varied, while keeping the variables *seeing* and *not seeing* common to all (method of agreement). Images from Vonk and Povinelli, 2006.

Figure 1 illustrates the application of the methods of difference and agreement in this experimental context. For the method of difference, within each condition (a-d), there is one experimenter that can see the subject in front of her (*cs*) and another experimenter that cannot (~*cs*). The observable features of the experimenters are otherwise made to be as similar as possible (for example, a bucket over one’s head rather than a bucket next to one’s head) so that researchers can eliminate as many antecedent variables leading to the measured effect as possible. If *cs* → *ms*, then *ms* should occur in response *cs*, but not ~*cs*. That is, chimpanzee subjects should produce visual gestures in response to the experimenter that can see them, but not to the experimenter that cannot see them. If this occurs, then this provides some evidence that *cs* → *ms*, but this evidence is very limited because within each condition, there are clear antecedent variables or cues that accompany *cs* and ~*cs*. For example, in the bucket condition, *cs* is accompanied by the cue "has bucket next to head." It is possible that it is this observational state ($s_1$) that leads to *ms*, rather than *cs*. Comparative psychologists turn to the method of agreement to test this possibility.

Researchers apply the method of agreement in order to exclude those antecedent variables that tend to accompany *cs*, so as to provide stronger evidence that it is in fact the presence of *cs* that is leading to *ms*. They do this by varying the situations in which *cs* is manifested. For example, in Figure 1, *cs* occurs in four different situations (those in which the experimenter can see in a-d). While the experimenter has a bucket next to her head in one of these situations, this is not true for the other three. Thus, if all four of the situations lead to *ms*, then we have reason to believe that the occurrence of *ms* does not depend on $s_1$ ("has bucket next to head"). However, eliminating $s_1$ is only the first step. Psychologists iteratively apply the method of agreement in order to exclude other antecedent variables accompanying *cs*. For example, across the four conditions presented in Figure 1, all of the experimenters exhibiting *cs* also share the cue "facing the subject with open eyes" ($s_2$). In order to exclude the possibility that *ms* depends on $s_2$, another study is conducted, one that presents subjects with a situation that contains *cs*, but not $s_2$.

Over the last decade, comparative psychologists have conducted many experiments that examine how chimpanzees respond to states of *seeing* and *not seeing* in other agents (for reviews, see Tomasello and Call 2006, Call and Tomasello 2008). Each individual experiment is a test to determine if chimpanzees satisfy the criterion established by Mill's method of difference. Namely, it addresses the question, is there a relationship between *cs* and *ms* such that when *cs* occurs, *ms* occurs and when *cs* does not occur, *ms* does not occur? However, it is the experiments as a group that provide evidence that chimpanzees satisfy the criterion established by Mill's method of agreement. That is, they address the question, does *ms* occur in a wide range of experiments that have only *cs* in common? The application of these two methods, then, gives researchers the means for identifying mindreading according to the following two criteria:

Mindreading criteria

1. There is a relationship between *cs* and *ms*
2. The phenomenon *cs* is the only variable that is common to all situations that lead to *ms*

These two criteria pick out mindreading as defined by Penn and Povinelli above. They also pick out mindreading as characterized by Andrew Whiten (Whiten 1993, 1996, 1998). For Whiten, a mindreader is an individual that categorizes others in the same class on the basis of some unobservable state that they have in common (what Whiten refers to as an "intervening variable"). Under this view, a mindreader with respect to perceptual states should classify all *seeing* agents together (and *not* *seeing* agents together) even when these agents have no observable features in common. Penn and Povinelli take their definition of mindreading to be consistent with Whiten's account. They write that, "being able to recode perceptually disparate behavioural patterns resulting from the same underlying cognitive state as instances of the same abstract equivalence class is a bona fide example of postulating an *ms* variable in the sense defined hereinabove" (2007, 733). Mill's methods allow researchers to test whether an individual is grouping observable situations in precisely this way.

## 2.3. The Early Opposition to Animal Mindreading

Until the early 21st century, many comparative psychologists agreed that chimpanzees were not capable of attributing perceptual states. Early experiments by Povinelli and colleagues played an important role in establishing this consensus. Specifically, Povinelli and Eddy (1996) conducted a series of experiments that seemed to show that chimpanzees failed to meet the two criteria for mindreading specified above.[14] First, they found that subjects generally did not prefer to use visual gestures for an experimenter that could see them versus one that could not; thus, failing to meet the first criterion. Second, in those cases when subjects appeared to be sensitive to the presence and absence of *cs*, there was an observable cue that accompanied *cs*, and the pattern of performance exhibited by subjects suggested that they were responding to

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[14] Note that the conditions depicted in Figure 1 are from this experiment by Povinelli and Eddy.

this cue rather than to *cs*. Povinelli and Eddy draw two main conclusions from their studies. First, "appropriate experimental designs, coupled with sufficiently large sample sizes, can provide a very sensitive analysis of what nonhuman primates know about the mind" (140). Second, "collectively, our findings provide little evidence that young chimpanzees understand seeing as a mental state" (vi). Throughout the 1990s, many comparative psychologists agreed (Call et al. 1998, Tomasello et al. 1999).

This consensus, however, shifted at the turn of the century. It shifted because more and more mindreading experiments were conducted on chimpanzees and the findings of these experiments suggested that chimpanzees did in fact meet the two criteria of mindreading with respect to perceptual states (Tomasello and Call 2006, Call and Tomasello 2008). That is, chimpanzees consistently distinguished between *seeing* and *not seeing* agents and there were no observable variables common to all of the experiments in which they were successful. For example, subjects not only treated as *seeing* agents those individuals that faced forward with open eyes, but also those that directed their gaze at particular objects, that had looked at object in the past, and that could potentially be looking at an object (Hare et al. 2000, 2001, 2006; Kaminski et al. 2008; Melis et al. 2006). These situations had no one observable variable in common; indeed, the last one managed to exclude the observable variable "directs eyes at object now or in the past," which is no small feat when you are trying to test the effects of the mental state of seeing (a state that usually requires past or present looking behavior). A similar finding was found for the cognitive state of *not seeing*. Apes treated agents as *not seeing* a particular target object in those situations in which the agent was facing away from the target object, facing the target object with closed eyes, facing the target object with open eyes but with an opaque barrier between the agent and the object, etc. (Hare et al. 2000, 2001; Hostetter et al. 2001, 2007; Leavens et al. 2010).

In the context of these new experiments, the findings of Povinelli and Eddy seemed anomalous and researchers wondered whether some aspect of their experiment might have unintentionally impeded the performance of their subjects. Thus, Kaminski et al. (2004) conducted a study with conditions similar to those examined by Povinelli and Eddy, but with improved methods.[15] This new study found that chimpanzees were much more sensitive to states of *seeing* and *not seeing* than found by Povinelli and Eddy. Other experiments provided additional evidence that apes gestured in ways that were sensitive to the attentional state of other agents (Hostetter et al. 2001, 2007; Liebal et al. 2004; Leavens et al. 2004, 2010; Poss et al. 2006; Hopkins et al. 2007; Tempelmann et al. 2011; chapter four).

In this way, the majority of comparative psychologists have gone from thinking that apes do not understand perceptual states to thinking that they do. Whereas in the early stages of mindreading research, chimpanzees appeared to fail the criteria established by Mill's methods, this changed as an increasingly large number of studies showed that they were capable of making the appropriate discriminations in a

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[15] In Povinelli and Eddy's study, subjects were faced with the task of choosing to beg from one of two experimenters. This is not a predicament that chimpanzees are usually faced with and they had to be extensively trained (over hundreds of trials) to learn that they had to choose between the two experimenters. Thus, Kaminski et al. (2004) designed a study similar to that of Povinelli and Eddy's but with an important difference: the subjects were faced with only one experimenter at a time and their gesturing behavior was compared across trials. Using this approach, the researchers did not need to train the subjects to participate in the experiment.

wide range of contexts. Of course, as Tomasello and Call (2006) qualify, "science is open-ended, and the case is certainly not closed on the issue of whether chimpanzees understand seeing" (382). But for comparative psychologists the evidence currently favors the hypothesis that they do.

## 2.4. The New Oppositional Strategy

Povinelli and colleagues' early opposition to nonhuman animal mindreading fit within the traditional experimental methods and evidential criteria employed in comparative psychology. However, as we saw in chapter one, Povinelli and colleagues have advanced a criticism of the mindreading hypothesis that departs dramatically from this tradition. Indeed, the criticism maintains that the above experimental approach cannot provide evidence for or against a mindreading hypothesis even in principle (Penn & Povinelli, 2007, 731).[16] Let me present their argument again using the notation introduced in section 1 of this chapter. They argue that: An agent's perceptual state depends on various features of the observable environment (e.g., whether she has a bucket over her head, whether a particular barrier is opaque or transparent, etc.). We can denote the sum of these observable features in any given situation with the variable *s*. These observable features lead an agent to experience a

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[16] This is not the only strategy employed by Povinelli and colleagues in arguing against the claim that apes understand perceptions. Indeed, they employ many. For example, sometimes they argue that the behavior-rules hypothesis is supported by the fact that chimpanzees do not pass false-belief tasks – an argument that seems to presuppose a meta-representational account of mindreading (Penn and Povinelli 2009). However, in this chapter, I focus only on the strategy that leads Povinelli and colleagues to reject the experimental approach currently taken by comparative psychologists.

particular perceptual state (*cs*), which in turn leads the agent to produce certain behaviors (*b*). For example, having a bucket over one's head (*s*) leads to the experience of not being able to see outside of the bucket (*cs*), which in turn leads one to not respond to visual gestures (*b*). Psychological states, then, produce regularities between observable situations and behaviors ($s \rightarrow cs \rightarrow b$).

According to Ponvinelli and colleagues, an effective mindreading experiment is one that can show that a subject is responding to the regularity $s \rightarrow cs \rightarrow b$ and not just to the regularity $s \rightarrow b$. As Penn and Povinelli (2007) write, "in order to produce experimental evidence for an $f_{\mathrm{ToM}}$ [theory of mind function] one must first falsify the null hypothesis that the agents in question are simply using their normal, first-person cognitive state variables" (734). Currently, none of the experiments that claim to provide evidence for nonhuman animal mindreading succeed in falsifying this null hypothesis. This is because they do not ensure that subjects have knowledge of *cs* in addition to knowledge of $s \rightarrow b$. According to Povinelli and colleagues, the way to do this is to design an experiment in which a subject could not possibly establish s → b without knowledge of *cs*. That is, researchers must, "provide compelling evidence for the cognitive (i.e., causal) necessity of an $f_{\mathrm{ToM}}$ *in addition to* and *distinct from* the cognitive work that could have been performed without such a function" (734, emphasis original). In summary, one can outline the current oppositional strategy used by Povinelli and colleagues in the following way:

1. Identify those experiments that provide evidence that nonhuman animals understand perceptual states
2. For each experiment identified in 1, show that the regularity $s \rightarrow b$ can replace the regularity $s \rightarrow cs \rightarrow b$
3. On the basis of 2, maintain that subjects could have solved the experimental task on the basis of having knowledge of $s \rightarrow b$, rather than knowledge of $s \rightarrow cs \rightarrow b$
4. On the basis of 3, conclude that one cannot reject the null hypothesis that subjects solved the experimental task using their knowledge of $s \rightarrow b$
5. Conclude that there is no evidence that nonhuman animals understand perceptual states

Before presenting my critique of this strategy, there are three things that are important to note. First, in employing this strategy Povinelli and colleagues are not challenging that nonhuman animals meet the first mindreading criterion (that there is a relationship between *cs* and *ms*). Penn and Povinelli (2009) agree that nonhuman animals such as apes behave exactly as if they have knowledge of *cs*. In fact, they go so far as to state that with regard to the early competition studies of Hare and colleagues (Hare et al. 2000, 2001), "there has never been any dispute about the fact that chimpanzees act *as if* they understand that others can see things" (17, emphasis original).[17] However, when psychologists say that there is evidence that chimpanzees produce and employ an $ms$ variable, they mean nothing more than that there is behavioral evidence that this is the case. Thus, Povinelli and colleagues are not disputing that mindreading experiments are capable of establish a relationship between $cs$ and $ms$.

Second, Povinelli and colleagues are not challenging that nonhuman animals meet the second mindreading criterion (that $cs$ is the only variable common to all of the situations leading to $ms$). When showing how one can appeal to some regularity $s \rightarrow b$, they do not try to show that the $s$ in each experiment is the same. The antecedent variables can be various, and the regularities can be abstract and complex. Indeed, Povinelli and colleagues argue that given what we know about ape behavior in experimental and naturalistic settings, we have good reason to think that these regularities will be abstract and complex (Povinelli and Vonk 2004; Penn and Povinelli, in press).

Third, in employing the above strategy, Povinelli and colleagues do not attempt to show that it is phylogenetically or ontogenetically more plausible that subjects are employing $s \rightarrow b$ over $s \rightarrow cs \rightarrow b$. Indeed, they need not make such an argument. In order to interpret an experiment as providing evidence for mindreading, comparative psychologists must claim that subjects have knowledge of the regularity $s \rightarrow cs \rightarrow b$. However, if subjects have knowledge of this regularity, then they also have

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[17] This statement is at odds with Povinelli's earlier work. For example, Karin-D'Arcy and Povinelli (2000) fail to replicate one of the findings of Hare et al. (2000) and, on these grounds, offer an alternative interpretation of the results. Namely, they argue that in Hare's experiment, subjects were behaving as if they were taking the food that the competitor had left behind. (See Bräuer et al. 2007 for an experiment that tests this alternative interpretation.)

knowledge of the regularity $s \rightarrow b$. Thus, the claim that subjects have somehow acquired knowledge of $s \rightarrow b$ is never less plausible than the claim that they have somehow acquired knowledge of $s \rightarrow cs \rightarrow b$. If pressed on how a subject has obtained knowledge of $s \rightarrow b$, Povinelli and colleagues can appeal to whatever mechanism comparative psychologists believe is involved in the acquisition of $s \rightarrow cs \rightarrow b$. Heyes (1998) first makes this point when introducing the original experience-projection task presented in chapter one. She writes, “in the search for evidence of theory of mind in nonhumans… the crucial difference between mentalistic and nonmentalistic hypotheses lies in their claims about ‘what is known,’ not about whether or how knowledge is acquired” (109).[18]

When one first encounters this critique of contemporary mindreading research, one is struck by how it manages to undermine all of the positive evidence for nonhuman animal mindreading and seemingly put another account in its place – the hypothesis that animals reason about observable situations alone. However, in the next section, I argue that this new oppositional strategy is unsuccessful.

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[18] It is worth noting that Povinelli and colleagues provide an evolutionary account for why humans are capable of mindreading, while nonhuman animals are not. This is their “reinterpretation hypothesis,” which holds that the ability to reinterpret observable regularities in terms of unobservable cognitive states emerged in the human lineage after the evolutionary divergence of humans and great apes (Povinelli and Vonk 2003, Vonk and Povinelli 2006). However, this account is not aimed at rendering the behavioral-rules hypothesis evolutionarily plausible; instead, it is simply built on the assumption that the behavioral-rules hypothesis is true for nonhuman animals.

## 2.5. Why the New Strategy Does Not Work

My criticism of the argument advanced by Povinelli and colleagues is relatively straightforward. Povinelli and colleagues define mindreading as the ability to produce and employ an *ms* variable where $ms = f(cs)$. They also observe that every cognitive state is an outcome of some observable state of affairs. Let us designate the set of all observable variables that lead to the cognitive state *cs* with the variable $s_{cs}$. Lastly, they acknowledge that mindreading is not an act of telepathy; thus, any nonhuman animal capable of mindreading does so on the basis of inferring *cs* from some observable state of affairs. Moreover, an accurate mindreader will infer *cs* on the basis of those observable situations that actually lead to *cs*. Of course, one will not have knowledge of all the observable situations that lead to *cs*. Instead, a mindreader will only be able to infer *cs* on the basis of prior knowledge that some observable variables reliably lead to *cs*. That is, such an individual will infer *cs* on the basis of some subset of $s_{cs}$ (say, $s_{cs1}$), a subset that reflects the organism's evolutionary and developmental history. Thus, the *ms* of a nontelepathic organism is not a function of *cs* or even $s_{cs}$, but rather of $s_{cs1}$.

In order to provide evidence for mindreading, Povinelli and colleagues maintain that we must provide evidence that *ms* is a function of *cs* in a way that goes beyond it being a mere function of $s_{cs1}$. However, this is impossible because *ms* simply is a function of $s_{cs1}$. If this were not the case, then either 1) the organism would be inferring *cs* without any observable grounds for doing so or 2) the organism would be inferring *cs* directly (that is, telepathically). This point is another way of stating the mindreader's dilemma introduced in chapter one.[19]

If the above analysis is correct, why do Povinelli and colleagues believe that an individual experiment can demonstrate that subjects have knowledge of *cs* "*in addition to* and *distinct from*" knowledge of $s_{cs1}$? I think that there are two main reasons for this. First, the idea that a mindreader should be sensitive to *cs* in a way that goes beyond being sensitive to observable states of affairs is indeed correct. The problem is that Povinelli and colleagues believe that you can identify the unique effects of *cs* by examining an experiment in isolation. However, this is not possible. The only way to identify the effects of *cs* on a nontelepathic organism is to hold it constant while varying the observable states of affairs that normally accompany it. By doing so, one can show that *ms* is a function of not just this observable state or that observable state, but of a class of observable states that have only *cs* in common. Thus, when one considers a collection of experiments, knowledge of *cs* can do work beyond knowledge of $s_{cs1}$, but for any experiment considered in isolation, knowledge of *cs* simply is knowledge of $s_{cs1}$.

Second, certain experimental tasks have the appearance of requiring knowledge of *cs* in addition to knowledge of $s_{cs1}$ in order to be solved. Experience-projection tasks have this quality. In chapter one, I argued that when one examines the details of these experiments, one finds that they can be solved with knowledge of $s_{cs1}$

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[19] "If an individual is capable of mindreading, i.e., if she establishes definite connections among observable phenomena, then her mindreading abilities can be dispensed with since any evolved or learned rule establishing such a connection should then be replaceable by a rule which directly links observational antecedents to observational consequents."

alone. However, it would be helpful to construct a more general defense of this point here. To this end, consider an ideal experience-projection task. Imagine that in this task chimpanzees are given the opportunity to swallow red and blue pills, where red pills have the effect of making the subject go blind for 60 seconds, while blue pills have no effect. Later these subjects are monitored with respect to whether they use visual gestures to request food from an experimenter that has swallowed a red pill versus an experimenter that has swallowed a blue pill. Povinelli and colleagues would argue that surely someone who does not understand perceptual states could not solve this experimental task. The subjects in this experiment have only experienced the psychological effects of the pills themselves ($s \rightarrow cs$). And they have never seen the behavioral effects of such pills ($s \rightarrow b$). Thus, they must attribute their own psychological experience to the experimenter in order to infer that $s$ will lead to $b$ for that experimenter ($s \rightarrow cs \rightarrow b$).

This account of the experiment leaves out precisely those details that would show how a subject could derive $s \rightarrow b$ without attributing $cs$ to the experimenter. In order for a subject (mindreader or otherwise) to make a behavioral prediction in this situation, she must recognize that the experience caused by the red pill (temporary blindness) falls into a broader class of experiences. If she did not characterize her experience in this way (that is, if she found this experience utterly unique), then she would have no idea what to expect from an agent (herself or others) in this state. That is, she would lack the information necessary for establishing $cs \rightarrow b$. If this were the case, then this experience-projection task would not be a mindreading test. The subject could project her experience onto the correct experimenter, but this would give her no information about whether she should direct visual gestures toward that experimenter. Given this, we must assume that the subject classifies her experience of blindness in some way. Specifically, we must assume that she categorizes this experience with ones that are phenomenologically similar – that is, with other episodes of *not seeing* such as "being in a dark room" or "having my eyes closed". Only in this case would the subject draw the appropriate behavioral predictions from her experience and thus expect an experimenter in the same cognitive state (that of blindness) to behave in ways consistent with the assumptions of the experiment (such as by not responding to visual gestures).

This is the minimal assumption needed to get this experience-projection task off the ground. However, *cs* has already been rendered causally superfluous. The subject has the information necessary for establishing $s \rightarrow cs \rightarrow b$. That is, she knows that "consuming a red pill" will lead to "an experience that is like being in a dark room or having my eyes closed" and that this in turn will lead to "behaviors that agents typically exhibit when being in a dark room or having their eyes closed." Given this, she also knows that $s \rightarrow b$. Namely, that "consuming a red pill" will lead to "behaviors that agents typically exhibit when being in a dark room or having their eyes closed." Thus, the subject can predict how an agent that consumes the red pill will behave without attributing to that agent the perceptual state of blindness. The ideal experience-projection task does not require that a subject attribute perceptual states to others. It only requires that a subject recognize certain experiences as falling into the same class and identify the observable states associated with those experiences.

The oppositional strategy of Povinelli and colleagues does not work. It does not work because it is impossible to reject what they take to be the null hypothesis in mindreading experiments. It is also worth pointing out here another major feature of their approach that is problematic. This is the characterization of CBR as a null hypothesis. Null hypothesis significance testing is a technique commonly used in psychology. It tells one the probability of obtaining a set of data on the assumption that the null hypothesis is true. If this probability is very low (standardly, below 0.05), then one is generally warranted in rejecting the null hypothesis. Null hypotheses are often used to determine if there is a statistically significant difference between two phenomena or whether a particular treatment has an effect. In these cases, the null hypothesis is that there is no difference or effect. This is the way that null hypotheses are used in mindreading experiments. Namely, the mindreading hypothesis predicts that a mindreader will distinguish between a condition with *cs* and a condition with ~*cs* and the null hypothesis is that the subject will not discriminate between these two conditions (and thus will not produce a differential response). In this context, it does not make sense to think of CBR as a null hypothesis. To do so would be to claim that in order to accept the mindreading hypothesis, researchers must reject a null hypothesis that will produce exactly the same data predicted by the mindreading hypothesis.

To make sense of Povinelli and colleagues position, we have to interpret their claim that CBR is a null hypothesis in some other way. A more generous interpretation is that they mean that comparative psychologist must control for confounding variables. That is, that they must reject the possibility that the results of mindreading experiments are a product of some variable other than *cs*. If this is so, then CBR is not a hypothesis about animal cognition and behavior, but rather a suggestion on how best to study mindreading empirically. Unfortunately, as I have argued for in this chapter, the suggestion advance by Povinelli and colleagues is not very helpful. Applied to the level of an individual experiment, it renders mindreading empirically intractable. To control for such a variable would be to remove the observable basis on which a subject is expected to infer *cs*. Applied to the level of a collection of experiments, on the other hand, the position is no different than that already held by comparative psychologists.

## 2.6. Conclusion

Comparative psychologists test for mindreading in nonhuman animals by determining if they detect the presence and absence of particular cognitive states in a wide variety of circumstances. They eliminate potential confounding variables by ensuring that there is no one observable state that subjects might be responding to. In the 1990s, Povinelli and colleagues agreed with this methodological approach. Indeed, they advocated it. However, over the last decade, they have argued that animals might be solving mindreading tasks on the basis of observable states alone and that this undermines all of the mindreading experiments that have been conducted to date. I have argued that this new oppositional strategy is mistaken because a subject must have some observable grounds for inferring a particular cognitive state. If one treats the observable grounds for inferring *cs* within a given experiment as a confounding variable, then mindreading becomes an empirically intractable phenomenon.

Insofar as Povinelli and colleagues do not think mindreading is empirically intractable, they should accept the methods used by comparative psychologists for investigating it. These methods include an account of the unique work performed by mindreading (namely, categorizing behaviors into abstract equivalence classes) and accords with the definition of mindreading favored by Povinelli and colleagues. In accepting these methods, however, Povinelli and colleagues will also have to accept that there is currently positive evidence for mindreading in nonhuman animals.

Penn and Povinelli (in press) object that they are sometimes accused of “derived behaviorism” and that this accusation depends on a strawman of their account, one that casts them as holding that nonhuman animals have no representational abilities or are purely Pavlovian learners. I agree that this is not their position. However, the arguments that they advance may have more in common with behaviorism than they would like to admit. Skinner criticized the practice in psychology of positing unobservable variables as intervening between two observable entities in a causal chain. He argued that if there is a regular relationship between the observable and unobservable variables, then there is also a regular relationship between the observable variables alone, and thus the unobservable variable is causally superfluous (see Hempel, 1958, 49). As we have seen, Povinelli and colleagues make a similar claim with respect to nonhuman animal mindreaders. In this way, their position constitutes a sort of second-order behaviorism – behaviorism not with respect to the mental states of a nonhuman animal, but with respect to that animal's ability to know the mental states of others.

# Chapter Three

# The Goal of Great Ape Pointing Gestures

## Abstract

Humans use pointing gestures in order to direct the gaze of other agents. Great apes also use pointing gestures, but it is unclear whether they do so for the same reasons that humans do. Although many studies have been conducted on the comprehension and production of pointing in apes, almost none of these studies have examined whether apes point to direct gaze. In this chapter, I examine the source of this gap in empirical research and take steps toward bridging it. Psychologists currently categorize pointing gestures as either imperative or declarative. I argue that this leaves little room for addressing the question of whether apes point to direct gaze and propose an alternative framework for guiding research. I then examine what is known about apes' abilities to manipulate gaze. If apes point to direct gaze, then this would be a form of active-triadic gaze manipulation. Currently, there is no evidence that apes manipulate gaze in this way. Given the empirical gap in pointing research, however, I argue that more studies need to be done in order to determine if this absence of evidence is evidence of absence. I suggest two ways of doing so.

## 3.1. Introduction

Pointing is a gesture that is widely used among humans (Kita 2003). Over the last two decades, it has become well established that captive great apes also point to objects in a communicative manner (Leavens and Hopkins 1999, Leavens et al. 2009). The pointing behavior of great apes resembles that of humans in many important respects. It develops spontaneously and is used flexibly and referentially (Leavens et al. 2005). Given the similarities between human and ape pointing, an important question is whether great apes point with the same aims that humans do. Comparative psychologists have been attempting to address this question by systematically comparing the pointing abilities of the four great apes and human infants.[20]

Though research on the goal of ape and human-infant pointing is progressing, there is a conspicuous gap in the type of questions that are being addressed. In particular, few researchers have examined whether apes point with the goal of directing the gaze of another agent to the object indicated by the signaler's extended finger or hand. This is surprising, as answering this question is crucial to our understanding of how human and ape pointing compare. Preverbal human infants point with the aim of directing a recipient's gaze to the indicated object (Liszkowski et al. 2007) and this fact has played an important role in contemporary accounts of the cognitive abilities underlying human pointing (Tomasello et al. 2007). Thus, knowing

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[20] Comparative psychologists focus on human infants in their comparisons of human and nonhuman primates in order to avoid (as much as possible) the affects of language on cognitive-task performance (Tomasello 2006; Povinelli and deBlois 1992a, 1992b).

whether apes point to direct gaze will affect the similarities that we draw between human and ape cognition and communication. Determining whether apes point to direct gaze is also crucial for our understanding of primate gestural communication more generally. Currently, there is no evidence that apes use gestures to actively direct the gaze of other agents to specific locations or objects. Thus, it would be a major discovery if we found that this was an aim of ape pointing.

Why have few researchers investigated the question of whether apes point to direct the gaze of another agent? In the first section of this chapter, I propose an answer to this question. I suggest that one reason for this omission is that developmental and comparative psychologists tend to categorize pointing gestures into one of two groups (imperative versus declarative gestures) and pointing with the aim of directing gaze does not fit neatly into either one of these two categories. Thus, insofar as researchers continue to focus on determining whether apes point imperatively or declaratively, the question of whether they point to direct gaze will receive little attention. How does one determine if apes point with the aim of directing gaze? I address this question in the second section of this chapter by presenting the methods currently employed for investigating the goals of communicative gestures in nonverbal organisms. In the third section of this chapter, I review the evidence for and against the claim that apes point with the goal of directing gaze. I do this by first outlining the different ways in which one agent could manipulate the gaze of another and considering the evidence for each form of gaze manipulation in apes. If apes point to manipulate gaze, then this would be a form of what I call “active-triadic gaze manipulation." I show that there is currently no evidence that apes engage in this kind of gaze manipulation either within pointing research specifically or ape gestural research more generally. I conclude by suggesting two ways in which comparative psychologists can begin to fill this empirical gap and consider the implications of doing so.

## 3.2. The Present Framing of Ape Pointing Research

In this section, I propose that research on ape pointing is framed by a distinction between imperative and declarative gestures and that this distinction has led to a gap in empirical research. I argue that researchers should remain agnostic about whether the imperative-declarative distinction applies to ape pointing until they have a better understanding of the nature of this gestural phenomenon. By remaining agnostic in this way, one obtains the theoretical flexibility necessary for pursuing questions, such as, do apes point to direct gaze?

Following work in developmental psychology, comparative psychologists tend to classify pointing gestures into one of two categories: imperatives (or protoimperatives) and declaratives (or protodeclaratives). Although different authors characterize these categories in slightly different ways, many appeal to the following distinction:

### The imperative-declarative distinction (IDD)

- *Imperative gestures* are used with the aim of getting a recipient to produce a social action, where a social action is a sequence of behaviors performed on an object (such as retrieving a tool) or with the signaler (such as playing or grooming).
- *Declarative gestures* are used to either inform a recipient of the location of an object (“informative declaratives”) or get a recipient to attend to and have an attitude toward an object (“expressive declaratives"). To inform or direct the attention of another agent in these ways is to affect that agent’s psychological state.

Leavens (2012) traces the origins of IDD to psychological research conducted in the late 1970s and 80s on human infants and children with autism (e.g., Curcio 1978, Baron-Cohen 1989, Mundy et al. 1987, Mundy and Sigman 1989, see also Camaioni 1993). Studies in this area found that autistic children generally point imperatively, but not declaratively, while children without autism employ both forms of pointing. Autistic children were also found to be impaired in their ability to mindread or attribute mental states to others. These and other findings led to the hypothesis that mindreading and the ability to point declaratively depend on a common cognitive mechanism. Researchers like Baron-Cohen, for example, proposed that both of these abilities depend on the capacity to represent shared attention (Baron-Cohen 1997).

Imperative pointing, on the other hand, was thought not to require such a capacity (Baron-Cohen 1989).

It is important to emphasize that IDD makes two separate distinctions between imperative and declarative gestures. The first distinction is between the *goals* of the signaler. IDD maintains that imperative gestures are used to request various social actions, while declarative gestures are used to influences states of knowledge, attention, and affect. The second distinction that IDD makes is between how a signaler *represents* her goals in these two cases. IDD maintains that when a signaler gestures imperatively, she not only has the goal of eliciting a social action, but also represents this goal in terms of observable entities and actions. For example, if the signaler's goal were to get a recipient to retrieve food, then she would represent the recipient as a physical body who behaves in predictable ways in response to pointing gestures (walking toward the food, picking it up, walking toward the subject, and handing over the food). In contrast, when a signaler gestures declaratively, her goal includes representations of unobservable, psychological states. For example, if the signaler's goal were to provide a recipient with new information, then she would represent the recipient as one whose psychological state can be changed from ignorance to knowledge. Gómez (2007) refers to these two forms of representation as lean and rich (see also Tomasello et al. 2007). A signaler's goal is lean when it is represented in observable terms alone, while it is rich when it includes representations of psychological states.

IDD has framed recent studies aimed at determining the goal of ape pointing. For example, Zimmerman et al. (2009) look at the pointing abilities of orangutans and bonobos. They note that it is well documented that apes point to request things, but that it is unclear if they also use pointing gestures to inform other agents of an object's location (i.e., employ informative declaratives points). Their study aims to address this question by examining whether subjects point to the location of a hidden tool for a human experimenter that does not know the tool's location. Their results are indecisive; in particular, they state that it is unclear whether their subjects' pointing "was aimed at informing the human of the whereabouts of the fork (in the sense of making them *know* where the fork was)" or whether it was instead "some form of elaborate imperative where they are asking the human to retrieve the fork from its hiding and proceed to extract the food for them" (356, emphasis original).

In another study, Bullinger et al. (2011) examine the pointing abilities of chimpanzees compared to human children. Like Zimmerman et al. (2009), their study is aimed at determining whether apes use informative declaratives. To motivate their study, Bullinger and colleagues note that the results of one prior experiment (Tomasello and Call 1994) "might conceivably be interpreted in terms of an informative motive" (2). However, they find the results of that study inconclusive because "it is also possible to interpret this pointing as an imperative/directive gesture: something like 'Get the tool to get me food with it!" (2). They add that if this is the case, then "the ape is not informing the human by giving her needed information but rather directing her behaviorally to the tool and then to the food" (2). Bullinger and colleagues' experiment, then, is aimed at determining whether apes point to inform or only to direct behavior. The results of their study are negative. Namely, they found that chimpanzees did not point to a hidden tool when that tool was needed by an experimenter to extract food for the experimenter alone (they only pointed to the hidden tool when it could be used to extract food for the subjects themselves). The researchers conclude that chimpanzees point only with an "imperative-directive-requestive motive" not an "informative" or "sharing-declarative" (i.e., expressive declarative) motive.

The above studies provide a glimpse of how ape-pointing research is guided by IDD (see section 3 for additional examples). However, some researchers have challenged IDD by questioning the link that it forges between a gesture's goal and its representational form. For example, Moore and Corkum (1994) maintain that when a human infant uses an expressive-declarative point, "the infant may understand that the point will tend to lead to an adult head turn and an interesting subsequent response from the adult" (362; see also Moore 1996, Moore and D'Entremont 2001). This is a departure from IDD because it presents a lean account of declarative pointing. Similarly, Leavens et al. (2009) write:

> That human children will point in apparent bids to share attention with others is, in our view, not diagnostic of a precocious capacity in the infancy period for the representation of abstract, hidden, and causal mental states or processes, but is simply an instrumental act to elicit particular kinds of affective behaviors from their caregivers" (163-164).

The above authors do not reject the goals of declarative pointing as presented by IDD, but rather reject that these goals necessarily involve representations of psychological states. Instead, they suggest that young humans represent these goals in terms of observable entities and actions. The goal of an expressive declarative point, for example, might be to elicit a head turn and positive behaviors, such as smiling and the words “oh, wow!”

In addition to developing a lean account of declarative pointing, one could develop a rich account of imperative pointing. Such an account would hold that when a signaler points imperatively for a recipient (e.g., with the goal of getting that recipient to retrieve food), he represents the recipient as an agent with psychological states (such as the knowledge that the food is in a particular location). The idea that ape imperative pointing could be understood as representationally rich is not something that is explicitly argued for in the literature. However, I think that this is a position that is worth developing. Tomasello and colleagues sometimes seem to align themselves with such a view (Tomasello et al. 2007, Tomsello 2008). For example, Tomasello et al. (2007) write:

> Apes’ understanding of others’ goals and perceptions supports both the production and comprehension of some forms of imperative pointing, which presupposes an understanding of intentional agents who make things happen (718).

Tomasello and colleagues do not explain in more detail here why they believe that imperative pointing depends on understanding other agents as intentional. However, in his discussion of general ape gestural communication, Tomasello (2008) argues that because it has been shown that apes understand agents as having goals and perceptions in some experimental contexts, it is likely that they use their gestures in order to affect these states in recipients.[21] Regardless of whether this is a good argument, the claim that imperative pointing depends on representing other agents as having goals and perceptions is a move away from IDD.

To summarize, IDD categorizes pointing gestures as either 1) lean and imperative or 2) rich and declarative; however, one might also understand pointing as 3) lean and declarative or 4) rich and imperative. Which one of these accounts we should accept as a good account of ape pointing will depend on the known cognitive capacities of apes and the properties of their pointing behavior. Currently, the empirical research is framed in terms of determining if ape pointing fits the descriptions of accounts 1 and 2. However, I believe that this is premature. It is premature because it limits the kinds of hypotheses that are being addressed before researchers have had a chance to investigate some of the basic properties of ape pointing. One such neglected hypothesis is that apes point with the goal of directing the gaze of a recipient. I will call this the directing-gaze hypothesis.

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[21] It is worth noting that this argument is not convincing on its own. Namely, the fact that chimpanzees understand agents as having goals and perceptions in some contexts does not mean that they point in order to affect the goals and perceptions of others. In fact, Tomasello and colleagues have shown that chimpanzees understand states of ignorance and knowledge (Hare et al. 2001, Tomasello et al. 2003). However, they also maintain that apes do not point in order to provide ignorant individuals with new information (Tomasello 2006). They hold the latter on the basis that chimpanzees are not motivated to provide others with new information, so they point only in order to get agents to do things. One could make a similar move in the case of imperative pointing. That is, argue that although chimpanzees understand goals and perceptions, they lack the motivation to affect these states in others, and so point only in order to get agents to behave in certain ways.

> **The directing-gaze hypothesis**: Great apes point with the aim of directing a recipient's gaze from point A to point B.

This hypothesis has been studied in human infants with positive results (Liszkowski et al. 2007). However, as I will show in section 3, out of the many published empirical papers on the production and comprehension of pointing in apes, only one has addressed the question of whether apes point to direct gaze. If one uses IDD to frame ape pointing research, then this omission is unsurprising because the directing-gaze hypothesis does not fit into either one of the two accounts of pointing laid out by IDD.

Pointing to direct gaze is not a lean imperative gesture (account 1) because to direct gaze is not to solicit a social action. Traditionally understood, to perform a social action is to engage in an interaction with a partner. It is to do something with or for that partner (see, for example, Call 2011). Social actions include activities such as grooming, playing, displaying, mating, and nursing. They also include activities that are performed on objects, such as retrieving food or using a tool. In these latter cases, the actions are performed for the partner in the sense that this is the ultimate goal of the action (e.g., to bring the food to the partner or use a tool to get the food for the partner). Behaviors that do not engage a social partner in one of these two ways are not traditionally considered social actions. Thus, the behavior of turning one's head or eyes from one direction to another is not something that comparative psychologists would currently characterize as a social action.

Pointing to direct gaze is also not a rich declarative gesture (account 2). To see this, let us first consider the lean version of the pointing-gaze hypothesis and then the rich version. It is possible that apes have a lean representation of the goal of directing gaze. For example, a chimpanzee might have the goal of directing your gaze because he knows that when you turn your eyes toward a particular object, you are more likely to act on that object. Spelled out, a lean representation of the goal of directing gaze might take the following form:

**The directing-gaze hypothesis (lean version)**

1. The signaler knows that
    a. pointing gestures can be used to direct the eyes of an agent toward object *x*
    b. an agent tends to act on an object after her eyes have been oriented toward that object
2. The signaler wants an agent to act on object *x*, so he uses a pointing gesture to direct that agent's eyes at *x*

This version of the directing-gaze hypothesis is not a form of declarative pointing according to IDD because it is lean – that is, it does not include any representations of psychological states.[22] However, one could also have a rich representation of the goal of directing gaze. Such an account would take the following form:

**The directing-gaze hypothesis (rich version)**

1. The signaler knows that
    a. pointing gestures can be used to direct the eyes of an agent toward object *x*
    b. when an agent's eyes are directed at *x*, the agent sees *x*
    c. an agent is more likely to act on *x* if she can see *x*
2. The signaler wants an agent to act on object *x*, so he uses a pointing gesture to direct that agent's eyes at *x*

In this case, the signaler is aware of the fact that agents act on objects that they can see and uses the pointing gesture to bring an object to a recipient's attention. In other words, the signaler is not simply trying to initiate a series of behaviors, but understands something about the role that the psychological state of seeing plays in bringing about the desired outcome. However, this version of the directing-gaze hypothesis also does not fit the IDD category of a declarative gesture because it only posits that the signaler represents perceptual states. Recall that IDD characterizes declarative gestures as ones that are used either to affect the knowledge state of a

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[22] One might be tempted to try to characterize this version of the directing-gaze hypothesis as imperative pointing; however, as we saw above, this does not work because directing eyes is not an instance of soliciting social action.

recipient (informative declaratives) or the attentional and affective state of a recipient (expressive declaratives). Pointing to direct gaze is not an informative declarative because it does not include the attribution of states of knowledge and it is not an expressive declarative because it does not include the attribution of affective states. Instead, it is only a signaler's attempt to change a recipient's perceptual state.

The idea that apes point to direct gaze does not fit into the categories of pointing set out by IDD. Thus, insofar as researchers are primarily interested in determining whether apes point imperatively or declaratively as specified by IDD, they need not examine whether apes point to direct gaze. This is problematic. From the perspective of general research on ape gestural communication, the question of whether apes point to direct gaze is very important. In their natural communicative interactions with conspecifics, apes employ two types of gestures: action-soliciting and attention-getting (Tomasello 2008; see also chapter four). Action-soliciting gestures are used to request actions and objects such as food and sex, while attention-getting gestures are used to attract a recipient's attention. As an example of the latter, a chimpanzee might clap his hands or vocalize in order to get a recipient to look toward him (Leavens et al. 2010; see also section 3). If ape pointing were an action-soliciting gesture, then it would fall into a rare class of gestures that I call "triadic action-soliciting gestures." These are gestures that are aimed at getting a recipient to act on a third entity or object. It is possible that some apes use triadic action-soliciting gestures in their natural communicative interactions. For example, orangutans have been observed offering food to others (that is, requesting that a recipient take the food) and chimpanzees have been observed requesting that a recipient groom a specific area of their body (Liebal et al. 2006, Pika and Mitani 2006, 2009).[23] If ape pointing were an attention-getting gesture, on the other hand, then it would be the only known example of a "triadic attention-getting gesture" used by great apes. As we will see in section 3, the only examples of attention-getting gestures recorded thus far are dyadic ones that are aimed at attracting a recipient's attention to the signaler.

Thus, though the gaze-directing hypothesis is currently not considered relevant from the perspective of determining whether apes point imperatively or declaratively, it is highly relevant from the perspective of general ape gestural communication. Moreover, by investigating this hypothesis, we will learn properties of ape pointing that will in turn help us evaluate the imperative or declarative nature of this gesture. For example, if we find that ape pointing is a triadic action-soliciting gesture, then we have reason to reject the claim that apes point declaratively. Although directing gaze is not a sufficient component of declarative gestures as specified by IDD, it is a necessary one (one cannot inform or share attention with another agent without directing their gaze). However, at the present moment we need to loosen the theoretical constraints of IDD. I recommend that we do this by focusing on the goal of ape pointing, while remaining agnostic with respect to how a signaler represents that goal. Following this approach, we have two hypotheses to evaluate (the level 1 hypotheses of Figure 1). First, we have the hypothesis that apes point with the aim of directing gaze toward the indicated object (regardless of whether this action is

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[23] See the discussion of directed scratch in section 2 for a caveat concerning whether these gestures are in fact used triadically.

represented in a rich or lean way); second, we have the hypothesis that apes point with the aim of getting a recipient to perform a social action (regardless of whether this action is represented in a rich or lean way). Once we have decided between these two hypotheses, or found that they both apply (that is, that apes point with both aims), we can move on to evaluate various level 2 hypotheses.

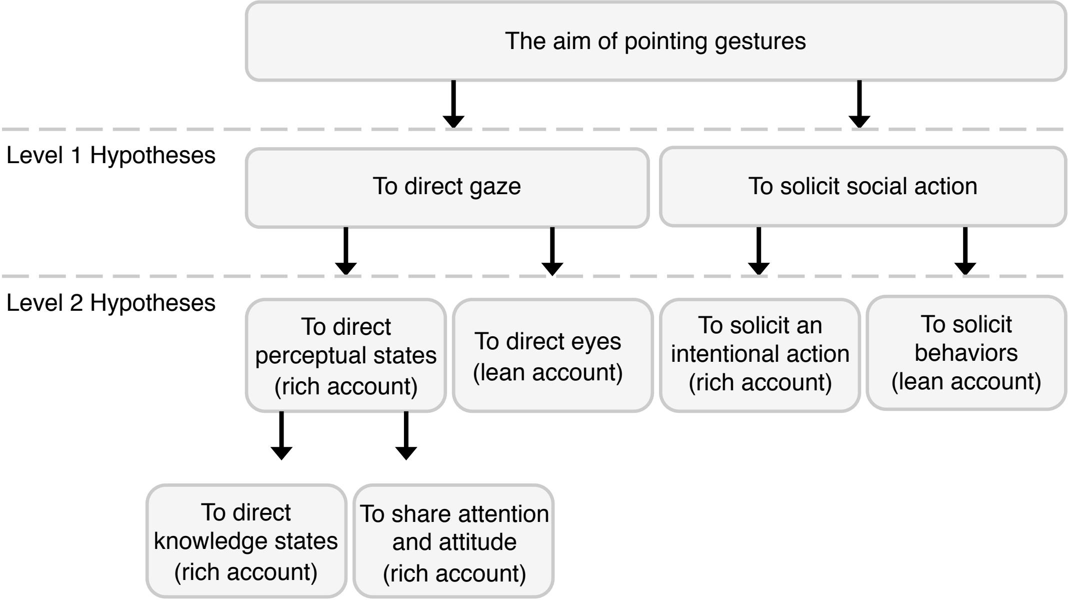

**Figure 3.1.** Different hypotheses concerning the aim of ape pointing. The level 1 hypotheses make a claim about the goal of ape pointing while remaining agnostic with respect to how this goal is represented by the signaler. The level 2 hypotheses make a claim about both the goal and representational format of ape pointing.

The directing-gaze hypothesis makes a claim about the goal of ape pointing. Thus, in the next section, I explain what comparative psychologists mean when they use the term goal and the methods that they use to determine communicative goals.

Then, in section 3, I review the evidence available for assessing the directing-gaze hypothesis and suggest avenues for future research.

### 3.3. Communicative Goals versus Outcomes

How does one determine whether apes point to direct gaze? More generally, how does one determine a nonhuman animal's goal for producing a communicative signal? In order to address this question, it is important to distinguish between a signaler's goal, on the one hand, and a signal's outcome, on the other (Seyfarth and Cheney 2003, Cartmill and Byrne 2010). The *outcome* of a signal is how a particular recipient responds to that signal. Different recipients might respond to a particular signal in different ways. Borrowing an example from Seyfarth and Cheney (2003), male Túngara frogs produce a "whine-chuck" courtship call. One of the common outcomes of this signal is that it leads nearby conspecific females to approach the signaling male for mating. However, this signal also leads predatory bats to approach the signaling frog in search of food. Both of these responses count as outcomes of the whine-chuck signal regardless of whether it is the signaler's goal to obtain these outcomes or whether the signaler has a goal for calling at all.

In contrast to the outcome of a communicative behavior, the signaler's *goal* in producing such a behavior is the outcome that the signaler intends to bring about. Attributing an intended outcome to the signaler means attributing a proximate psychological mechanism that is not directly observable. Thus, comparative psychologists draw on a set of observable criteria for determining the signaler's intended outcome (Tomasello et al. 1985, 1989; Cartmill and Byrne 2010). An ape signaler is taken to gesture with the aim of attaining a particular outcome when that signaler:

1. directs her signal at a recipient
2. alternates her gaze between the recipient and the object of the signaler's goal
3. shows signs of expecting the recipient to respond to the signal, such as waiting until the recipient produces a response
4. shows signs of satisfaction when the goal of the signal has been met, such as ceasing to gesture and engaging with the recipient in the social activity elicited by the signal
5. shows signs of dissatisfaction when the goal of the signal has not been met, such as persisting to gesture or using alternative means to obtain that goal

The first three criteria are meant to establish that the signaler is communicating with the aim of achieving some (yet unspecified by the researchers) goal. For example, if an infant chimpanzee gestures towards her mother and then pauses while maintaining eye contact with the mother, then this suggests that the infant is waiting for the mother to respond in some way. Exactly how the infant wants the mother to respond is determined by the fourth and fifth criteria. In order to apply these latter two criteria, researchers must first postulate a purported goal for the gesture under study on the basis of information independent of that specified by the criteria. For example, one might postulate a purported goal on the basis of the general physical and social context in which the gesture is produced (Cartmill and Byrne 2010). In the case of the infant and her mother, one might postulate that the infant is gesturing with the goal of obtaining food, if the infant typically uses this gesture when the mother has food that the infant lacks. Once a purported goal has been established, researchers can then test the goal's plausibility by determining whether it satisfies the fourth and fifth criteria. Does the infant appear satisfied when the mother hands over food (does she cease gesturing and begin consuming the food)? Does the infant appear dissatisfied when the mother fails to hand over food (does she continue gesturing, throw a tantrum, try to pry food from the mother's hand, etc.)? If the answer to both of these questions is yes in a large number of cases, then "requesting food" is taken to be a plausible goal of this gesture.[24]

It is important to distinguish between the outcome and goal of a signal because evidence for the former is not evidence for the latter. As in the case of the Túngara frog, the fact that a signal consistently has a particular outcome does not mean that it is the signaler's goal to elicit that outcome. I emphasize that here because the goal and outcome of a signal are sometimes conflated in the ape-gesture literature. For

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[24] It is worth noting that there may be other suitable criteria for identifying the goal of a communicative gesture in nonhuman animals. However, these are the criteria that are currently used in comparative psychology and thus will be the ones that I adopt here.

example, wild chimpanzees use the gesture “directed scratch” in the context of grooming (Pika and Mitani 2006, 2009). This gesture consists of a signaler loudly scratching an area of his own body in an exaggerated manner. Pika and Mitani (2006) argue that the goal of the directed-scratch gesture is to get a recipient to groom the specific area of the body being scratched. They write, “our observations suggest that the recipient of the [directed-scratch] signal has an understanding of the intended meaning of the gesture and that wild chimpanzees use gestures to specify an area of the body to be groomed and to depict a desired future action” (192). If Pika and Mitani are right, then directed scratch would be one of the first systematically documented triadic action-soliciting gestures used by chimpanzees in the wild. However, the only evidence that Pika and Mitani provide to support their claim is that the recipients of directed-scratch gestures tend to respond to this gesture by grooming the scratched area. This establishes that the outcome of directed-scratch is to groom a specific area of the body, but not that this is the goal or intended outcome of the signaler. In order to demonstrate the latter, one must further show that the signaler is satisfied when the recipient of this gesture grooms the indicated area and dissatisfied when the recipient grooms an area other than the one indicated.

The worry that we might conflate the outcome and goal of a gesture is especially pertinent in the case of ape pointing. Generally, apes only point for humans. Thus, it may be that humans are interpreting this gesture in a way that is consistent with our own goal when pointing, but that this interpretation does not match the actual goal of pointing apes. In other words, we cannot rely on our response to ape pointing alone in determining the goal of ape pointing. Instead, we must attribute a purported goal to pointing apes based on our general understanding of the context and manner in which this gesture is typically used. We then need to test the success of our purported goal at predicting when a pointing ape will be satisfied or dissatisfied with the outcome of his or her gesture.

## 3.4. Filling the Gap: Do Apes Point to Direct Gaze?

In this section, I consider the evidence available for evaluating the question of whether apes point to direct gaze. I do this by first reviewing the different ways in which apes are known to manipulate gaze. I then show that though there is evidence that apes manipulate gaze dyadically, there is little evidence that they manipulate gaze triadically. Though there are many studies that look at pointing comprehension and production in apes, only one has thus far published data on the role of gaze in ape pointing. I suggest two types of studies that could be done in order to help determine if apes point to direct gaze (one in the context of pointing production and one in the context of pointing comprehension).

### 3.4.1 Forms of Gaze Manipulation

As we saw in chapter two, chimpanzees infer the target of an agent’s gaze on the basis of a variety of features of the agent and its environment (for example, the orientation of the agent’s head and eyes, whether the agent’s eyes are opened or closed, the presence of opaque barriers in the environment, etc.). Out of the studies conducted on apes' understanding of gaze, the ones that are most relevant for evaluating the directing-gaze hypothesis are those that examine whether apes manipulate the gaze of other agents. Before reviewing these studies, I propose that we categorize the act of manipulating an agent's gaze along three dimensions.

The first dimension of gaze manipulation concerns whether one is affecting what another agent sees in a passive or active manner. To passively manipulate gaze would be to alter what falls in an agent's line of gaze without changing the direction of that agent's gaze itself. For example, if I want you to see me, one thing that I could do is to simply walk into your line of gaze. To actively manipulate gaze, on the other hand, would be to affect the direction in which an agent is looking. For example, if I want you to see me, I could also call out your name to get you to look my way. The second dimension of gaze manipulation concerns whether it involves a dyadic or triadic interaction. Gaze manipulation is dyadic if it involves only the self (the one doing the manipulating) and the recipient (the one being manipulated). It is triadic if there is a third object, agent, or location involved in the interaction in addition to the self and the recipient. Thus, when I call out your name to get you to look my way, I am initiating a dyadic interaction, whereas if I were to hold up an object and exclaim, "look at this!" I would be initiating a triadic interaction. The third aspect of gaze manipulation concerns whether I am bringing something to an agent's attention or removing it. For example, I could bring an object into your gaze by holding it up in front of your eyes or keep it away from your gaze by holding it behind my back. Table 1 summarizes these three dimensions of gaze manipulation.

**Table 3.1.** Different ways of manipulating gaze

| | Dyadic (self and recipient) | Triadic (self, recipient, and third entity) |
|---|---|---|
| Passive (I change what falls into your gaze) | Move self **into** recipient's gaze<br>Move self **out of** recipient's gaze | Move object **into** recipient's gaze<br>Move object **out of** recipient's gaze |
| Active (I change the direction of your gaze) | Direct recipient's gaze **toward** self<br>Direct recipient's gaze **away** from self | Direct recipient's gaze **toward** object<br>Direct recipient's gaze **away** from object |

With these different aspects of gaze manipulation in mind, we can assess what is currently known about gaze manipulation in apes and how this relates to the directing-gaze hypothesis. Let us begin by stating where the directing-gaze hypothesis fits with respect to the different dimensions of gaze manipulation. Generally, pointing in order to direct an agent's gaze from point A to point B is an active, triadic form of gaze manipulation (the lower right quadrant of Table 1). It is active because it posits that a signaler points in order change an agent's direction of gaze and it is triadic because it involves directing an agent's gaze toward or away from a third object, agent or location. It is possible for a pointing gesture to be used dyadically; this would occur if a signaler were to point to his or her own body to indicate the self. However, there are currently no recorded cases of an ape spontaneously using a pointing gesture in this way.[25] Thus, I will focus here on the triadic version of the directing-gaze hypothesis.

In order to assess the directing-gaze hypothesis, then, we must determine if apes are capable of manipulating gaze in an active and triadic manner. Before we do this, however, it is worth noting whether apes manipulate gaze in any of the other three ways presented in Table 1.

### *Evidence for passive-dyadic gaze manipulation*

There is evidence that apes manipulate gaze in a passive-dyadic fashion. All great apes move into an agent's line of gaze before producing visual gestures (Liebal et al. 2004a). They will also avoid an agent's gaze (e.g., that of a competitor) by taking indirect routes to their destination, choosing those routes that are most effective at concealing their approach, and conducting activities (such as copulations) out of sight of those agents that are likely to interfere (Byrne and Whiten 1990, Hare et al. 2006, Melis et al. 2006).

### *Evidence for active-dyadic gaze manipulation*

There is also evidence suggesting that apes manipulate the gaze of other agents in an active, dyadic manner. Hostetter et al. (2001) found that chimpanzees are more likely to use a vocalization as their first communicative behavior when a human

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[25] By "self" here, I mean the whole agent. Pointing to a specific area of one's body (e.g., this patch of skin or this limb) would still count as a triadic gesture (where the third object or location is the body part or area being indicated).

Great apes taught to use American Sign Language use the signs "me" and their own name; however, it is not clear whether they use these signs as pronouns (Rivas 2005).

recipient is facing away, and more likely to produce a visual gesture (namely, a begging or pointing gesture) as their first communicative behavior when a human recipient is facing toward them. Similarly, Leavens et al. (2010) found that chimpanzees produce more attention-getting behaviors (such as clapping and throwing) when a human with food is oriented away from them, and more visual gestures when a human with food is oriented toward them. Hostetter et al. (2007) also found that chimpanzees produce more vocalizations for an experimenter that has his eyes closed compared to an experimenter with his eyes open (see also Tomasello et al. 1994, Leavens et al. 2004, Poss et al. 2006, Hopkins et al. 2007). These studies suggest that chimpanzees produce vocalizations and other attention-getting behaviors with the goal of actively attracting an agent's attention in a dyadic manner.

Currently, there are no studies showing that apes actively direct the gaze of agents *away* from themselves. However, it is important to note that this ability is quite different than that of attracting attention toward oneself. To accomplish the latter, one need only produce a vocalization or audible behavior and rely on the natural attention-getting property of sound to get others to look your way. However, one cannot use this method to direct attention away from oneself. To accomplish this, one would have to produce a vocalization that normally succeeds in directing the attention of an agent away from oneself (perhaps an alarm call would have this effect) or produce a sound at a location away from oneself (for example, by throwing a rock). There have been no observational or experimental studies demonstrating such strategies in apes.

### *Evidence for passive-triadic gaze manipulation*

Currently, there is little evidence that apes manipulate the gaze of others in a passive-triadic manner. To manipulate gaze in this way, one would have to either present an object to a recipient or hide an object from a recipient's view. The gestural repertoires of apes include the offering of objects to others. For example, Tomasello et al. (1989) observe juvenile chimpanzees offering a ball to others as an invitation for play and Liebal et al. (2006) describe orangutans offering food to others. However, in these cases, there is no evidence that the signalers are trying to get other agents to simply attend to the object on display or offer. Instead, it appears that these gestures are used in order to get recipients to perform a social action (such as play or take the food). As described above, to show that apes use these gestures with the specific goal of bringing an object to a recipient's attention, one would have to demonstrate that they are satisfied when this outcome is achieved and dissatisfied when this outcome is not achieved. Savage-Rumbaugh and McDonald (1988) describe Kanzi (a human-enculturated bonobo) engaging in behavior that is a stronger candidate for passive-triadic gaze manipulation. Kanzi is described presenting objects (such as forbidden mushrooms) to the gaze of his human caretakers. In the cases described, Kanzi does not appear to be inviting the recipient to perform a particular social action, but rather seems satisfied when the recipient merely attends to the object on display.

There are some observations of apes potentially hiding parts of their body from the gaze of others. For example, de Waal (1982) reports several cases of a captive male chimpanzee using his hands to cover his erect penis from the view of nearby dominant males. De Waal (1982) and Tanner and Byrne (1993) also describe captive apes (a chimpanzee and gorilla, respectively) using their hands to cover their facial expressions. Lastly, Savage-Rumbaugh and McDonald (1988) describe Kanzi engaging in various attempts to hide objects from his human caretakers. Thus, though there are some observations of passive-triadic gaze manipulation in captive apes and a human enculturated bonobo, these reports are extremely limited in number and only anecdotal in nature.[26]

In summary, there is evidence that apes manipulate gaze in a passive- and active-dyadic manner. A chimpanzee will position himself in the gaze of an agent, avoid the gaze of an agent, and actively attempt to direct an agent's gaze toward himself. However, there is little evidence that apes manipulate gaze in a passive-triadic manner – especially, if we focus on non-human-enculturated apes alone. Thus far, then, we have little reason to expect that apes point with the aim of directing gaze triadically. However, let us examine now whether there is any evidence for such an ability.

Outside of studies on ape pointing, there is no evidence of active-triadic gaze manipulation in apes. The best potential example of such an ability is the directed scratch gesture discussed in section 2. It is possible that when a chimpanzee employs directed scratch, he does so with the knowledge that the noise produced by his

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[26] It is worth noting that the primatologist Jane Goodall has stated that she has not observed this kind of hiding behavior in her 25 years of observing wild chimpanzees (Call and Tomasello 1997, 236).

scratching will succeed in attracting the attention of a recipient to a specific area of his body. However, it is also possible that chimpanzees employ this gesture with only the aim of getting a recipient to groom the scratched spot. To decide between these two purported goals, one must test which one of them satisfies the fourth and fifth criteria of section 2.

Turning now to studies on ape pointing, there are two areas of research that could provide evidence for or against the directing-gaze hypothesis. The first area looks at the properties of pointing gestures produced by apes, while the second examines how apes comprehend the pointing gestures of others. In the following two subsections, I briefly review these two areas of research and show that neither has thus far provided evidence that apes point to direct gaze. As we will see, however, the lack of evidence for the directing-gaze hypothesis does not stem from negative findings, but rather from the fact that the majority of studies in these areas have simply not examined whether apes point to direct gaze. Instead, they have focused on determining whether apes point imperatively or declaratively as characterized by IDD.

### 3.4.2. Studies on the Production of Ape Pointing

Early studies on the production of pointing in apes documented the fact that captive apes spontaneously use pointing gestures to indicate food that can only be obtained with the help of a human experimenter or caretaker (Woodruff and Premack 1979, Leavens and Hopkins 1998). Other studies showed that these points were not thwarted attempts to obtain out-of-reach food, but were used communicatively from the outset. In particular, researchers found that apes employed points only in the presence of a human recipient and alternated their gaze between the recipient and the indicated object (Call and Tomasello 1994, Leavens et al. 1996, Krause and Fouts 1997, Leavens and Hopkins 1999). Researchers also found that apes used pointing gestures flexibly – that is, not just to indicate food but also tools needed to retrieve food (Call and Tomasello 1994).

Later studies aimed to determine more specifically the goal of ape pointing. For example, Leavens et al. (2005) examined whether chimpanzees pointed referentially or with the aim of communicating “about” a particular object. To do this, they examined whether subjects showed signs of satisfaction when they received the object at which their pointing gesture was directed, and signs of dissatisfaction when they received only part of that object or some other object altogether. They found that chimpanzees did point referentially in this way. Since this study, there have been only two experiments that examine more closely the goal of ape pointing. These were presented in section 1 and were studies explicitly aimed at determining whether apes point imperatively or declaratively as characterized by IDD (Zimmerman et al. 2009, Bullinger et al. 2011). The main finding from these studies was that chimpanzees point to a hidden tool only when that tool can be used to retrieve food for themselves, which Bullinger and colleagues interpret as evidence that chimpanzees point only imperatively.

To date, the studies on the production of ape pointing have examined whether apes point spontaneously, communicatively, flexibly, referentially, imperatively, or declaratively. However, none of these studies have examined whether apes point with the aim of directing gaze. In order to test the directing-gaze hypothesis, one would need to examine whether the purported goal of directing gaze satisfies criteria four and five of section 2. Chapter four of this dissertation presents the first empirical study addressing this question in the context of the production of ape pointing.

### 3.4.3. Studies on Pointing Comprehension by Apes

In addition to examining the production of pointing in apes, comparative psychologists have looked at how apes interpret the pointing gestures of other agents. These studies are meant to shed light on the phenomenon of ape pointing by revealing what apes understand about the pointing gestures of others. For example, if chimpanzees consistently fail to interpret the pointing gestures of others as informative in a variety of situations, then this is taken as evidence that they do not understand pointing as informative and thus probably do not point informatively themselves.

Apes' comprehension of pointing gestures is usually tested in what is known as an object-choice-task paradigm. In this paradigm, an object is hidden in one of two or more hiding spots, such as underneath one of several inverted opaque containers (henceforth, I will refer to all such potential hiding spots simply as "containers"). The object is hidden by a human (the "hider") in such a way that the subject knows that it has been hidden in one of several containers, but does not know in which one (e.g., an opaque screen blocks the view of the containers from the subject, but the subject can see the hider go behind the screen with the object and emerge without it). After the hiding process, the subject has the opportunity to choose one of the containers, and if he chooses the container with the object, then he gets to keep the object (e.g., eat it, if it is food; or use it, if it is a tool). Lastly, in these studies, there is an "informant" whose main role in the experiment is to point to one of the containers before or while subjects are making their choice. In the most basic form of this experiment, the informant has witnessed where the object was hidden and is helping the subject by pointing to the location of the hidden object. In this situation, the question is whether subjects will use the pointing gesture of the informant to help them find the object.[27]

In the context of pointing comprehension, the directing-gaze hypothesis predicts that apes will follow the pointing gestures of other agents with their gaze to a particular target location or object.[28] Thus, in order to test the directing-gaze hypothesis, one needs to monitor the gaze of subjects in response to the pointing

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[27] Different variations of this experiment have been run in order to probe apes' understanding of pointing. For example, pointing gestures have been compared with other sources of information, such as placing a marker on the container with the hidden object or presenting a replica of this container (Tomasello et al. 1997). Also, how apes interpret the pointing gestures of knowledgeable informants (those who have witnessed the hiding process) have been compared to their interpretation of ignorant informants (those who have not witnessed the hiding process) (Povinelli et al. 1990); and knowledgeable cooperative informants (those who encourage the subjects to retrieve the object and do not try to retrieve it for themselves) have been compared to knowledgeable competitors (those who try to retrieve the hidden object for themselves) (Hare and Tomasello 2004). Other properties of the experimental setup have also been systematically varied, such as the nature of the informant (human versus conspecific), the position of the informant with respect to the subject and hiding places, the gaze of the informant, the form of the pointing gesture produced by the informant (e.g., straight versus bent at the elbow), the position of the subject, and more (see Miklósi and Soproni 2006 for a review). In some cases, the object is also not hidden, but the subject must choose one object among several that are out in the open (Kirchhofer et al. 2012).

[28] This holds under the assumption that an ape's interpretation of the pointing gestures of others reflects their own goals when pointing. This is a common assumption in the pointing literature, but may be problematic. For example, it could be that apes point with the aim of directing attention, but do not understand that other agents can act with this goal. For the purposes of this discussion, I will assume that how apes interpret the pointing gesture of others reflects their own goals when pointing.

gestures of others. Unfortunately, virtually none of the pointing comprehension studies conducted thus far have done this. Instead, these studies usually document only whether subjects choose the container indicated by the informant (Table 2). The reason for this is that the goal of most pointing comprehension studies has been to determine whether apes understand pointing as an imperative gesture or as an informative declarative gesture (as argued for in section 1). One way to do this is to test whether apes interpret the pointing gestures of knowledgeable, cooperative informants as referring to the location of the hidden object (and thus choose the container being indicated). If subjects do this, then this suggests that they interpret pointing gestures as informative (that is, as providing information that the subject lacks and that is relevant to the task at hand). Thus, most pointing comprehension studies record only whether subjects choose the container indicated by the informant.

**Table 3.2.** The responses recorded in pointing comprehension studies

| Studies on pointing comprehension | The recorded behavior of subjects used to indicate their comprehension of pointing gestures |
|---|---|
| Povinelli, Nelson, and Boyson 1990 | pulling a handle and displacing the target* |
| Povinelli, Nelson, and Boyson 1992 | pulling a handle and displacing the target |
| Call and Tomasello 1994 | pointing to the target |
| Tomasello, Call, and Gluckman 1997 | touching or flipping the target |
| Povinelli et al. 1997 | moving the lid of the target, looking at the target |
| Itakura et al. 1998 | displacing the target |
| Itakura et al. 1999 | touching the target |
| Call et al. 2000 | touching the target |
| Hare and Tomasello 2004 | touching the target |
| Barth, Reaux, and Povinelli 2005 | poking the target |
| Herrmann and Tomasello 2006 | approaching and opening the target |
| Mulcahy and Call 2009 | touching the target |
| Lyn, Russell, and Hopkins 2010 | grasping and pulling the target |
| Kirchhofer et al. 2012 | retrieving the target |

* The "target" refers to the hiding place or object indicated by the experimenter's pointing gesture.

To my knowledge, there is only one study that explicitly examines the attentional states of apes in response to pointing gestures. This is an early pointing study by Povinelli and colleagues on chimpanzees (Povinelli et al. 1997). In this experiment, food is hidden in one out of two boxes (Figure 2). A human informant points to the box containing the food, but these pointing gestures vary in terms of where the informant is located (equidistant between the two boxes, in front of the indicated box, or in front of the box not being indicated) and where the informant looks while pointing (at the subject, at the indicated box, or at the floor).

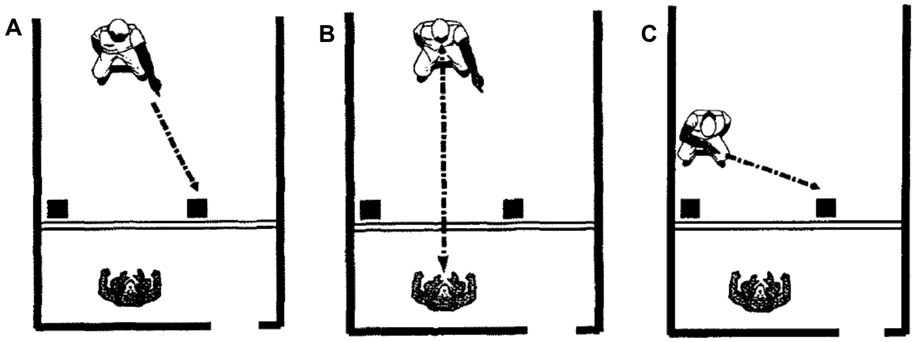

**Figure 3.2.** Three illustrative examples of the conditions implemented in Povinelli et al. 1997. **A**: Experimenter location equidistant; experimenter gaze directed at target. **B**: Experimenter location equidistant; experimenter gaze directed at subject. **C**: Experimenter located in front of other box; experimenter gaze directed at floor. Figure adapted from Povinelli et al. 1997.

Upon observing the informant's pointing gesture, subjects are allowed to choose one of the two boxes in search of the food. The main question of the study was whether chimpanzees chose boxes on the basis of interpreting the informant's point as referential or whether they instead relied on a learned rule, such as "choose the box that the experimenter is closest to." To address this question, the researchers examined under what conditions the subjects chose (or failed to choose) the container indicated by the informant's point. For example, did they succeed in choosing the indicated container no matter where the informant was positioned, or did they instead choose the container that the informant was sitting closest to regardless of the direction of his pointing gesture?

Examining the boxes chosen by subjects would be enough to address the main question of this study. However, in addition to this, the researchers were interested in whether subjects had an "implicit understanding" of the referential significance of pointing gestures “regardless of the subjects’ actual overt choice” (436). In order to investigate this possibility, Povinelli and colleagues examined whether subjects looked at the box indicated by the informant’s pointing gesture. It is here that we find some data on whether chimpanzees follow pointing gestures with their gaze. A summary of this data is presented in Table 3.

**Table 3.3.** Summary of chimpanzees’ gaze responses to pointing gestures (results from Povinelli et al. 1997)

| | Experimenter location | Experimenter gaze direction | Percentage of trials in which subject looked at indicated box first | Significance |
|---|---|---|---|---|
| Experiment 1 | Equidistant | Floor | 48.8 | ns (one-sample t-test) |
| | Equidistant | Target | 57.1 | ns (one-sample t-test) |
| | Equidistant | Subject | 65.5 | ns (one-sample t-test) |
| Experiment 2 | Equidistant | Floor | 53.8 | ns (binomial test) |
| | Equidistant | Target | 66.6 | .061 (binomial test) |
| | In front of target | Floor | 69.2 | .04 (binomial test) |
| | In front of other box | Floor | 28.6 | .02 (binomial test) |
| | In front of target | Target | 81.5 | .0008 (binomial test) |
| | In front of other box | Target | 56.0 | ns (binomial test) |

As we can see, the results are mixed. Subjects looked at the indicated box significantly above chance when the informant looked at the target or was located in front of the target. Subjects also seemed to prefer to look at the indicated box when the informant made eye contact with the subject while pointing; however, this result was not significant. Unfortunately, we cannot place much weight on the results of those conditions in which the informant did not look at the subject while pointing. In apes, making eye contact with a recipient is a crucial part of establishing a behavior as communicative (Gómez 1996). Thus, it is quite possible that a chimpanzee will not interpret an arm extension as a communicative gesture in those cases in which the signaler fails to make eye contact with the recipient.

It is worth noting here that chimpanzees have generally performed poorly in the above pointing comprehension studies. That is, they tend to not choose the container or object indicated by the pointing gesture of an informant above chance levels. This result has perplexed comparative psychologists because pointing is a relatively salient cue that other animals readily use to find objects in object-choice tasks (dogs: Bräuer et al. 2006, Virányi et al. 2008, Kirchhofer et al. 2012, dolphins: Herman et al. 1999, goats: Kaminski et al. 2005). Tomasello and colleagues interpret this finding as one that demonstrates that great apes have difficultly interpreting the helpful behavior of others (Tomasello et al. 2007, Tomasello 2008). Under this view, chimpanzees simply do not understand that an informant might be pointing *for them* (that is, in order to help them locate the hidden object). In support of this explanation, Hare and Tomasello (2004) show that chimpanzees have little difficulty interpreting the extended arm of a competitor as a cue for where food is hidden, when the competitor's goal for extending his arm is to retrieve food for himself (see also Herrmann and Tomasello 2006). This explanation may account for the fact that apes do not choose the container indicated by a knowledgeable, cooperative informant during an object-choice task. However, it does not help us evaluate the directing-gaze hypothesis. Great apes may interpret points as gaze-directing gestures, but not know why their gaze is being directed in the manner that it is. As Tomasello (2008) writes, they may follow a pointing gesture with their gaze, and then think, “OK. There’s the bucket. So what? Now where’s the food?” (39). I suggest that future studies on pointing comprehension in apes follow (but improve on) the 1997 study conducted by Povinelli and colleagues. In particular, apes should be presented with pointing gestures that are unambiguously communicative (that is, that include eye contact and perhaps gaze alternation by the signaler) and the subjects’ gaze responses to these gestures should be recorded.

The directing-gaze hypothesis posits that apes point with the goal of directing another agent’s gaze from point A to point B. This is an active-triadic form of gaze manipulation. Though there is currently evidence that apes manipulate the gaze of others dyadically (in both passive and active modes), there is very little evidence that apes manipulate the gaze of others triadically (in either passive or active modes). Thus, evidence in support of the directing-gaze hypothesis could significantly transform our understanding of great ape cognition and communication. I have suggested two approaches for testing whether apes point to direct gaze. First, one can examine whether apes show signs of satisfaction when their pointing gestures are successful at directing the gaze of a recipient and dissatisfaction when this outcome is not attained. Second, one can examine whether apes respond to the pointing gestures of others by directing their gaze to the indicated object or location. Chapter four of this dissertation presents an empirical study on chimpanzees and bonobos that follows the first of these two suggestions.

### 3.5. Conclusion

I have argued that the current theoretical framing of ape pointing research has led to a gap in the type of questions that are being asked by researchers. Namely, in attempting to determine whether apes point in a lean-imperative or rich-declarative manner, researchers have given little attention to those questions that cut across these two categories. One such question is whether apes point to direct gaze. Addressing this question is crucial for our understanding of how human and ape pointing compare, as well as how ape pointing relates to the general communicative abilities of nonhuman primates. If apes point to direct gaze, then this would, for the first time, establish that they manipulate the gaze of other agents in an active and triadic manner. If apes do not point to direct gaze, on the other hand, then this means that this gesture is likely aimed at getting a recipient to perform an action on an object. This finding would represent a major difference in the way that humans and apes employ pointing, one that would undoubtedly affect many areas of comparative and developmental psychology.

# Chapter Four

# Do Chimpanzees (*Pan troglodytes*) and Bonobos (*Pan paniscus*) Point in Order to Direct Attentional States?

## Abstract

Captive great apes regularly use pointing gestures in their interactions with humans. However, the precise function of ape pointing is unclear. There are two main possibilities: apes might point to order a recipient to perform an action (such as “retrieve that food!” or “use that tool!”), or they might point in order to direct the attention of a recipient to a target (as in “look there!”). If apes point to direct attentional states, then they should persist pointing when the recipient fails to attend and cease pointing when the recipient attends. Contrary to this prediction, in an experiment with chimpanzees and bonobos, we found that subjects spent more time pointing for a recipient that responded by looking at the indicated object than for a recipient that responded by failing to look at the indicated object. These surprising results suggest that subjects were not pointing with the sole aim of directing attention, but rather were either pointing with the sole aim of soliciting action or with the dual aim of directing attention and soliciting action

## 4.1. Introduction

Great apes use gestures regularly to communicate with conspecifics and with humans. Many of these gestures are employed in a flexible and goal-directed manner. Gestures are used flexibly in the sense that signalers use multiple gestures for a single communicative end and a single gesture for multiple communicative ends (Call and Tomasello 2007; Pollick and de Waal 2007). Signalers also modify their gestural strategies depending on the attentional state and response of the recipient (Leavens et al. 2004; Liebal et al. 2004a; Kaminski et al. 2004; Poss et al. 2006; Cartmill and Byrne 2007; Hostetter et al. 2007; Tempelmann et al. 2011). Gestures are used in a goal-directed manner in the sense that signalers wait for a response and persist in the face of failure (Liebal et al. 2004b; Cartmill and Byrne 2007; Cartmill and Byrne 2010; Hobaiter and Byrne 2011).

For the most part, apes use gestures in order to request that another agent perform a particular social action. These *action-soliciting* gestures include communicative attempts to get others to play, travel, groom, and nurse (see Pika et al. 2003; Pika et al. 2005; Liebal et al. 2006; Call and Tomasello 2007; Genty et al. 2009; Cartmill and Byrne 2010; Hobaiter and Byrne 2011). Some gestures, however, serve a different purpose. Apes use *attention-getting* gestures in order to attract the attention of other agents (Call and Tomasello 2007; Leavens et al. 2010).

The differential functions of action-soliciting and attention-getting gestures are reflected in their forms. Action-soliciting gestures generally take the form of truncated social actions or "intention-movements" because they are ritualized from social actions over ontogenetic or phylogenetic time. For example, the play gesture *arm raise* takes the abbreviated form of play hitting (for examples and discussions of ritualization, see Call and Tomasello 2007; Tomasello 2008; Halina et al. 2013). In contrast, attention-getting gestures generally take the form of actions that are functionally effective at attracting attention. For example, the gestures *poke*, *throw stuff*, and *hand-clap* attract the attention of other agents through their tactile and auditory effects. Although attention-getters are often functionally effective, apes use them communicatively as evidenced by the fact that signalers make eye contact with the recipient and wait for a response (Call and Tomasello 2007). Attention-getters are also used flexibly across different contexts. A chimpanzee, for example, might use *throw-stuff* in an attempt to initiate play (by drawing attention to his play face) or to initiate sex (by drawing attention to his erect penis).

Like action-soliciting gestures, attention-getters are used with the ultimate aim of getting a recipient to perform a social action (as in the examples above). Crucially, however, attention-getters take an indirect route to this aim. Whereas action-soliciting gestures are direct requests that a recipient "do X", attention-getters appear to function as requests that a recipient "look at Y". In the latter case, the signaler must rely on her knowledge that when a recipient sees Y, he will likely do X (Tomasello 2008). The idea that chimpanzees produce attention-getting gestures with the specific aim of attracting attention is supported by the fact that they use attention-getters more when a recipient is not attending (Hostetter et al. 2001; Leavens et al. 2004; Hostetter et al.

2007; Hopkins et al. 2007; Leavens et al. 2010). It is important to note, however, that only captive apes interacting with human recipients have been observed exhibiting this tendency. In their interactions with conspecifics, there is little evidence that apes use attention-getters more for non-attending than attending recipients (Liebal et al. 2004b; but see Tomasello et al. 1994), although they do use visual gestures more for attending than non-attending recipients (Call and Tomasello 2007). A plausible explanation for this differential use in attention-getters is that apes have greater mobility in their interactions with conspecifics and thus move into the recipient's visual field rather than attempt to attract the recipient's attention. Captive apes exhibit this strategy of moving into the recipient's visual field in their gestural interactions with humans when they have the opportunity to do so (Liebal et al. 2004a).

In addition to being aimed at soliciting action and directing attention, gestures can be either dyadic or triadic. Dyadic gestures involve only the signaler and the recipient, while triadic gestures involve a third object, agent, or location. Triadic gestures are "referential" in the sense that the signaler is requesting that a recipient act on or attend to a specific place or entity other than the self. The leading candidate for a triadic gesture in apes is their pointing gesture. When pointing, an ape typically extends his finger or hand toward an object, alternates his gaze between the object and the recipient of his gesture, waits for a response, and when the recipient acts on the indicated object, appears satisfied with the outcome (Leavens et al. 2004; Leavens et al. 2005). That some great apes, such as chimpanzees, use pointing gestures in a referential way is suggested by the fact that they persist pointing at a food item even when they receive another (non-indicated) food item (Leavens et al. 2005; see also Gómez 1990). Although non-captive apes generally do not use pointing gestures (but see Inoue-Nakamura and Matsuzawa 1997; Vea and Sabater-Pi 1998), captive apes acquire this ability spontaneously and employ it intentionally and flexibly (Leavens and Hopkins 1999; Leavens et al. 2005). Moreover, captive apes do not use pointing like a begging gesture with the sole aim of requesting an object because they will also point to objects (such as a hidden tool) that they themselves do not want, but that a human needs to fulfill a task (such as obtaining food that is desired by the signaler) (Call and Tomasello 1994; Zimmermann et al. 2009; Bullinger et al. 2010).

Although ape pointing is more than an object request, it is an open question whether apes point for the same reasons that humans do. By twelve months of age, human infants use pointing gestures with the aim of informing and sharing attention with others (Liszkowski et al. 2004, 2006, 2007). The fact that human infants point informatively and declaratively suggests that they point to direct attention because, in these cases, they seem to want nothing more than the recipient of their gesture to attend to a particular object. In contrast, apes generally do not point informatively or declaratively, but imperatively or with the ultimate aim of getting an agent to perform an action desired by the signaler (Gómez 2004; Tomasello and Carpenter 2005; Bullinger et al. 2010; but see Leavens 2004 and 2012). Thus, it is unclear if ape pointing is used as an attention-getter or as an action-soliciting gesture. If ape pointing were an attention-getter, then it would be similar to a chimpanzee directing the gesture *throw stuff* at an external object with the aim of getting a recipient to look at that object (as in “look there!”). If pointing were an action-soliciting gesture, on the other hand, then it would be more similar to a multi-purpose begging gesture used to request that a human recipient perform a desired action on the indicated object (as in “do [the desired action] with that!”).

In the current study, therefore, we tested if apes point in order to direct attentional states by presenting chimpanzees and bonobos with a situation that would lead them to spontaneously produce pointing gestures for a human experimenter (E). The situation was one in which food was visible (but not accessible) to the apes and not visible (but accessible) to E. We presented subjects with two experimental conditions. In one condition, E responded to the pointing gestures produced by subjects by looking at the indicated object (“successful look”); in the second condition, E responded to pointing gestures by looking at a location other than that indicated by the subject (“failed look”). As discussed above, apes persist gesturing when their goal has not been achieved. Thus, we predicted that if the goal of ape pointing is to direct attentional states, then subjects should spend more time pointing when they have not yet attained this goal (the failed-look condition) and less time pointing when they have already attained this goal (the successful-look condition). Furthermore, we predicted that if apes are not sensitive to how pointing gestures affect a recipient’s attentional state, then the time that subjects spend pointing should not differ across these two experimental conditions because the conditions only differ in E’s looking behavior.

## 4.2. Methods

### 4.2.1. Subjects

Five bonobos (two females and three males) and eighteen chimpanzees (twelve females and six males) participated in this experiment. All of the subjects were born in captivity and housed at the Wolfgang Köhler Primate Research Center in Leipzig, Germany. Subjects ranged in age from 2 to 34 years. Two of the bonobos were mother reared, while three were human reared. Out of the chimpanzees, twelve were mother reared and six were human reared. Throughout the study, the subjects remained on their normal dietary routine and had free access to water.

### 4.2.2. General Setup

Subjects were tested individually in a testing room. Those that were younger than five years of age could move between the testing room and an adjacent room occupied by their mother. The experimenter sat in an area adjoining the testing room and interacted with the subject through a wire-mesh experimental window that was approximately 66 cm wide and 48 cm high. Attached to the bottom edge of the experimenter's side of the window was a 58 × 66 cm table where the experimenter sat directly across from the experimental window and about 90 cm away from the window (Figure 1). For safety reasons, two clear Plexiglas walls and a clear Plexiglas ceiling enclosed the table. When giving a grape to the subject, the experimenter gently rolled it across the table to the experimental window, where the subject could pick it up through the mesh panel.

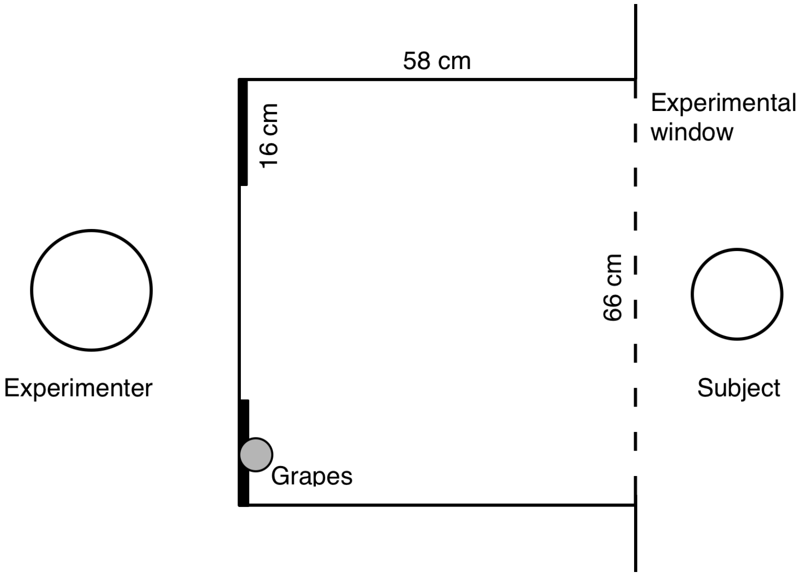

**Figure 4.1.** The general experimental setup for all conditions.

Two small (16 cm wide × 21 cm high) occluders were positioned between the experimenter and the experimental window—one to the right of the experimenter and one to the left. The occluders were located approximately 58 cm from the experimental window with their bottom edges 27 cm above the table and their inner edges 34 cm apart. Five grapes (attached to a vine) hung on the subject's side of one of the small occluders (with the location of the grapes counterbalanced across trials). In this way, the grapes were fully visible to the subject from the vantage point of the experimental window, but could not be seen by the experimenter unless she leaned forward and turned her head to the side. A large occluder was positioned between the experimental window and the two small occluders, blocking the experimental setup from the subject until a trial began (see main test below).

Two video cameras were located on each side of the experimenter and recorded the behavior of the subject at the experimental window during all conditions. A third video camera recorded the experimenter during the successful-look and failed-look conditions. All coding was based on the footage from these cameras (see coding procedures below).

### 4.2.3. Pretest

The purpose of the pretest was to identify those individuals that would spontaneously use pointing gestures to indicate or request the grapes in the above experimental setup. All subjects participated in this pretest, which consisted of twelve two-minute trials. In order to pass the pretest, a subject had to direct a pointing gesture at the grapes while making eye contact with the experimenter at least once during eight of the twelve trials. Three bonobos and ten chimpanzees met this requirement. Four of the subjects that participated (and passed) this pretest had previously participated in an experiment with a similar setup. However, this previous experiment involved no training; thus, all of the pointing gestures used by the subjects here were spontaneous in origin. During the pretest, the experimenter responded to the subject as in the motivational condition described below.

### 4.2.4. Main Test

Three bonobos and nine chimpanzees participated in the main test, all of which had passed the pretest (Table 1). One subject who passed the pretest did not participate in the main test for reasons unrelated to this study. Before a trial began, the experimenter sat at the table across from the experimental window. In the case of subjects younger than five years, the experimenter waited until the subject entered the testing room and called the subject, if necessary. Subjects had to be in the testing room for a trial to begin, but did not need to be positioned in front of the experimental window. A trial began when the experimenter removed the large occluder positioned between the experimental window and the experimental setup, and ended with the experimenter replacing the large occluder. Each trial lasted two minutes.

**Table 4.1.** Main test participant information

| Species | Name | Sex | Age (year.month) | Reared by |
|---|---|---|---|---|
| Chimpanzee | Kofi | Male | 5.1 | Mother |
| | Kara | Female | 5.2 | Mother |
| | Alex | Male | 9.6 | Human |
| | Pia | Female | 10.11 | Mother |
| | Alexandra | Female | 11.0 | Human |
| | Annet | Female | 11.0 | Human |
| | Sandra | Female | 17.2 | Mother |
| | Jahaga | Female | 17.8 | Mother |
| | Natasha | Female | 30.5 | Human |
| Bonobo | Fimi | Female | 2.1 | Mother |
| | Luiza | Female | 5.7 | Mother |
| | Limbuko | Male | 14.10 | Human |

The main test consisted of three conditions: one motivational and two experimental (successful-look and failed-look). In all three conditions, the experimenter acted in the following ways: First, she responded only to pointing gestures (as defined above); otherwise, she sat silently and causally watched the subject throughout the duration of the trial. Second, if the subject pointed to any location not occupied by the grapes, the experimenter followed the pointing gesture to the indicated location and alternated her gaze between the subject and that location. Third, if the subject pointed to the experimenter, the experimenter lifted her hands to show that she held nothing. The experimenter's behavior only differed across the three conditions in response to the situation in which the subject directed a pointing gesture at the grapes. In this case, the experimenter responded in one of three ways:

1. <u>Motivational condition</u>. The experimenter alternated her gaze between the subject and the grapes, picked one grape, and gave it to the subject.
2. <u>Successful-look condition</u>. The experimenter alternated her gaze between the subject and the grapes, but did not pick a grape and give it to the subject.
3. <u>Failed-look condition</u>. The experimenter alternated her gaze between the subject and a location not indicated by the subject (namely, the subject's side of the second small occluder rather than the occluder with the grapes) and did not pick a grape and give it to the subject.

All subjects participated in a total of two successful-look sessions, two failed-look sessions, and four motivational sessions, where a session consisted of two successive trials (Table 2). The order of conditions was counterbalanced across subjects. One experimenter ran all of the motivational trials, while two experimenters ran the successful-look and failed-look conditions (with the experimenter assigned to each experimental condition counterbalanced across subjects). Subjects received the three different conditions from three different experimenters, but had the same experimenter for all trials within a condition (Table 2). All subjects received one grape between trials (which was brought in from outside of the testing room) regardless of their performance during a trial.

**Table 4.2.** Main test design

| Day | Experimenter | Condition | Session | Number of trials |
|---|---|---|---|---|
| 1 | A | Motivational | 1 | 2 |
| | B | Failed-look | 1 | 2 |
| 2 | A | Motivational | 2 | 2 |
| | C | Successful-look | 1 | 2 |
| 3 | A | Motivational | 3 | 2 |
| | B | Failed-look | 2 | 2 |
| 4 | A | Motivational | 4 | 2 |
| | C | Successful-look | 2 | 2 |

### 4.2.5. Identifying Pointing Gestures in Real Time

In order to run this experiment, the experimenters had to identify pointing gestures in real time. For this purpose, we defined a *pointing gesture* as the mechanically ineffective act of extending a finger, hand, and/or arm through the wire-mesh experimental window and directing it at some point beyond this window, while making eye contact with the experimenter at least once during the process of extending, maintaining, or retracting the extended part.

Gestures that resembled pointing but included an upward-facing palm only counted as pointing if they were not directed at the experimenter; if they were directed at the experimenter, they were excluded as begging gestures. The extension of a finger or hand in close proximity to the table (that is, ≤ 8 cm above the table) also did not count as a pointing gesture, as this was the area through which subjects retrieved grapes, making it difficult to rule out the possibility of an attempted mechanically effective action (like attempting to retrieve a grape).

### 4.2.6. Coding Procedures

We coded the behavior of subjects by analyzing video taken during the experiment. Coders were blind to which condition was in effect during coding. We recorded all pointing gestures and coded their duration (in seconds) in order to determine if subjects spent more time pointing per trial during the failed-look condition compared to the successful-look condition. We defined a pointing gesture as beginning when the subject's finger, hand, or arm reached its final extended position (that is, the last position before retraction) and ending when the subject began retracting and/or changing the orientation of the extended part.

In addition to recording those pointing gestures produced while making eye contact with the experimenter, we recorded those behaviors that met our criteria of a pointing gesture except that the subject did not make eye contact with the experimenter. We called these latter events “points without eye contact” (as opposed to “points with eye contact”). We did this in order to confirm that the types of behaviors that we were identifying as pointing gestures were in fact generally used in a communicative manner, as indicated by the signaler establishing eye contact with the experimenter (Tomasello et al. 1985, Gómez 1996).

We classified all pointing gestures according to whether they were directed at the grapes or directed at a location other than that occupied by the grapes. We did this in order to determine whether subjects directed most of their pointing gestures at the grapes, as would be expected if they were using this gesture in a referential manner. We also recorded how long a subject spent away from the experimental window during a trial in order to determine if subjects decreased the time that they spent participating in the experiment over the course of the study. We expected that subjects might decrease the time that they spent participating in the successful- and failed-look conditions because their interactions with the experimenter in these conditions never resulted in the experimenter giving them a grape.

For the successful-look and failed-look conditions, we recorded the times at which the experimenter alternated his gaze during a trial—an action that was performed only in response to points with eye contact. The purpose of this was to confirm that the pointing gestures identified through video analysis matched those identified by the experimenter in real time. We confirmed this by comparing the times that pointing gestures occurred with the times at which the experimenter alternated his gaze. If the experimenter alternated his gaze during a point that was coded as “without eye contact” or ≤ 1 second after the occurrence of a point coded as “without eye contact,” then we counted it as a point “with eye contact,” as this is what the experimenter identified in real time.

The dissertation author coded the pointing gestures produced by the subjects (including their duration, orientation, and the presence or absence of eye contact) and the time at which the experimenters alternated their gaze. An assistant coded the time that subjects spent away from the experimental window. Inter-observer reliability was assessed in the following ways: For time spent away from the experimental window, the first author independently coded 20% of the successful- and failed-look trials. Agreement was high (Spearman correlation: $r_s = 0.988$, $N = 38$, $p < 0.001$) and there was no difference in the durations identified by the two coders (Wilcoxon signed ranks test: $p = 0.457$). For the direction and duration of pointing gestures, an assistant independently coded 10% of the 1,682 pointing gestures produced. Agreement was good on the orientation (left, right, center) of points (Cohen’s Kappa = 0.741) and the duration of points (Spearman correlation: $r_s = 0.858$, $N = 168$, $p < 0.001$) with no difference between the two coders in their assessment of pointing durations (Wilcoxon signed ranks test: $p = 0.733$). For experimenter gaze-alternation times, an assistant independently coded 13 out of the 96 experimental trials. The assistant identified 125 instances of experimenter gaze alternation occurring during these trials, while the original coder had identified 126. There was excellent agreement on the precise time (in seconds) that the gaze alternations occurred (Spearman correlation: $r_s = 0.999$, $N = 126$, $p < 0.001$.) with no difference between the times identified by the two coders (Wilcoxon signed ranks test: $p = 0.763$). For the presence and absence of eye contact made by subjects while pointing, an assistant independently coded 10% of the 1,682 pointing gestures produced. Eye contact agreement was moderate ($p_o = 85\%$, Cohen's kappa = 0.554) with high agreement on the presence of eye contact ($p_{pos} = 91\%$) and low agreement on its absence ($p_{neg} = 65\%$).

All analyses were done using nonparametric tests (Friedman tests for several comparisons and Wilcoxon tests for pairwise comparisons). Due to small sample sizes, we did not analyze species differences.

## 4.3. Results

### 4.3.1. Did subjects spend more time pointing per trial with eye contact than without eye contact?

If subjects used their pointing gestures in a communicative manner, then they should have spent more time employing points with eye contact than without eye contact, regardless of the condition. We found that this was the case (Wilcoxon signed ranks tests: motivational condition $Z = -2.98$, $p = 0.001$, successful-look condition $Z = -3.06$, $p < 0.001$, failed-look condition $Z = -3.06$, $p < 0.001$; Figure 2). For the motivational, successful-look, and failed-look conditions, subjects spent an average of

27, 25, and 18 seconds respectively pointing with eye contact per trial. In contrast, they spent an average of 2 to 3 seconds pointing without eye contact per trial. Given that our predictions concerned the use of communicative points, our remaining analyses focused on only those points made with eye contact.

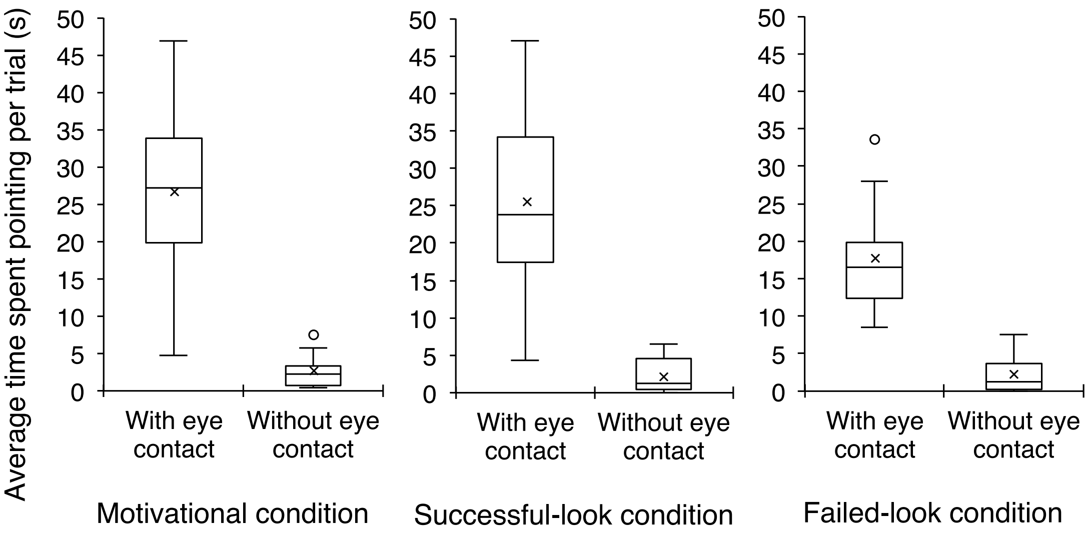

**Figure 4.2.** The average time spent pointing with eye contact was significantly longer than the time spent pointing without eye contact for all three conditions. Box plots represent the interquartile range, minimum, and maximum values; depicted also are the means (asterisks), medians (horizontal lines), and outliers (circles).

### 4.3.2. Did subjects spend more time pointing per trial in the failed-look than in the successful-look condition?

We predicted that subjects would spend more time pointing at the grapes in the failed-look condition compared to the successful-look condition because in the former the goal of directing attention has not yet been achieved. In contrast to our prediction, we found that the average time that subjects spent pointing at the grapes per trial was greater in the successful-look condition than in the failed-look condition (Wilcoxon signed ranks test: $Z = -2.35$, $p = 0.016$; Figure 3a). Subjects also spent more time pointing at the grapes in the first trial of the successful-look condition than in the first trial of the failed-look condition (Wilcoxon signed ranks test: $Z = -2.49$, $p = 0.009$; Figure 3b). Thus, subjects did not spend more time pointing at the grapes in an attempt to correct the experimenter that failed to look in the indicated direction. Instead, they spent more time pointing at the grapes for the experimenter that responded by successfully looking in the indicated direction.

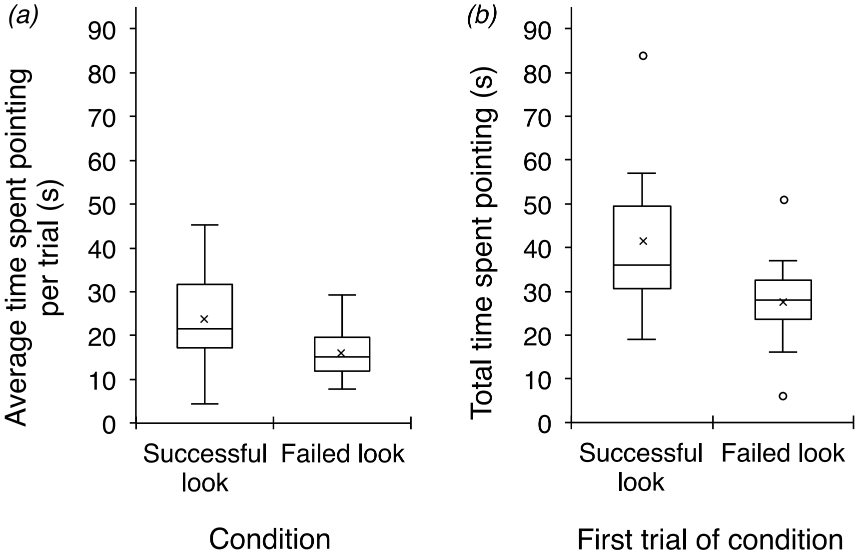

**Figure 4.3.** (*a*) On average, subjects spent more time pointing at the grapes per trial in the successful-look condition than in the failed-look condition ($p = 0.016$). (*b*) Subjects also spent more time pointing at the grapes in the first trial of the successful-look condition than in the first trial of the failed-look condition ($p = 0.009$). Box plots represent the interquartile range, minimum, and maximum values; depicted also are the means (asterisks), medians (horizontal lines), and outliers (circles).

### 4.3.3. Did subjects spend less time at the experimental window over the course of the successful-look and failed-look conditions?

During the successful- and failed-look conditions, subjects never received grapes from the experimenter. Given this, we expected that subjects might become less motivated over time to approach or interact with the experimenters during these two conditions. Comparing the two sessions of the successful-look condition revealed no significant difference in the time that subjects spent away from the experimental window (Wilcoxon signed ranks test: $Z = -1.41$, $p = 0.176$; Figure 4a). In contrast, for the failed-look condition, we found that subjects spent more time away from the experimental window in the second session than in the first session (Wilcoxon signed ranks test: $Z = -2.51$, $p = 0.009$; Figure 4b). Thus, over the course of the experiment, subjects became less motivated to interact with the experimenter that failed to look at the grapes, but continued to approach or interact with the experimenter that looked at the grapes.

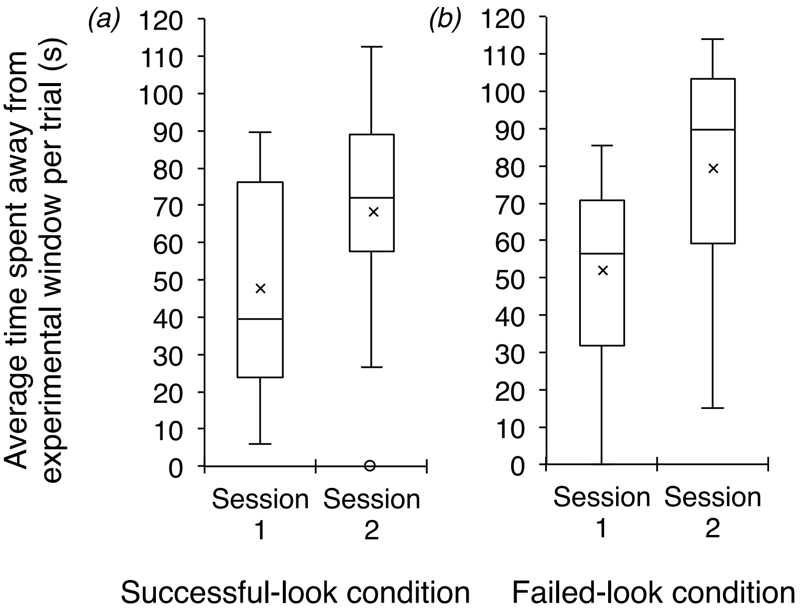

**Figure 4.4.** (*a*) We found no significant difference in the average time that subjects spent away from the experimental window per trial between the sessions of the successful-look condition ($p = 0.176$). (*b*) On average, subjects spent more time away from the experimental window per trial during the second session of the failed-look condition compared to the first session ($p = 0.009$). Box plots represent the interquartile range, minimum, and maximum values; depicted also are the means (asterisks), medians (horizontal lines), and outliers (circles).

### 4.3.4. Does the percentage of pointing gestures directed at the grapes vary across or within conditions?

We looked at the percentage of pointing gestures directed at the grapes relative to the total number of pointing gestures produced. If subjects were pointing referentially with the aim of getting the experimenter to attend to or act on the grapes, then they should direct the majority of their pointing gestures at the grapes. In all three conditions, the average percentage of pointing gestures directed at the grapes per trial was high (motivational 93.25%, successful-look 91.33%, and failed-look 89.5%) with no significant difference across the three conditions (Friedman test: $\chi^2 = 3.33$, $df = 2$, $p = 0.197$; Figure 5). In addition, we found no significant differences in the mean percentage of pointing gestures directed at the grapes across the trials within each condition: motivational (Friedman test: $\chi^2 = 3.54$, $df = 7$, $p = 0.831$), successful-look (Friedman test: $\chi^2 = 2.55$, $df = 3$, $p = 0.486$), failed-look (Friedman test: $\chi^2 = 4.26$, $df = 3$, $p = 0.243$). Overall then, subjects directed most of their pointing gestures at the grapes, and this did not change across conditions.

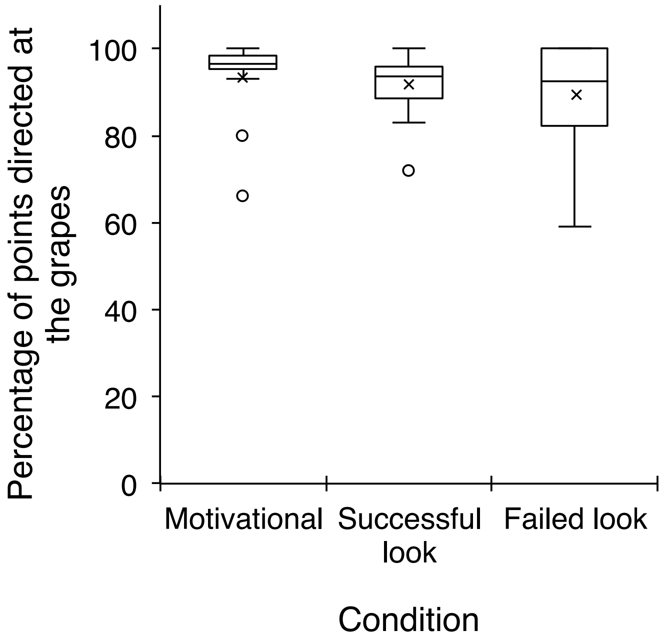

**Figure 4.5.** The average percentage of pointing gestures directed at the grapes per trial was high in all three conditions with no significant difference across conditions. Box plots represent the interquartile range, minimum, and maximum values; depicted also are the means (asterisks), medians (horizontal lines), and outliers (circles).

## 4.4. Discussion

The purpose of this study was to determine if apes point in order to direct attentional states. We predicted that if apes point to direct attention, then they should spend more time pointing for a recipient that does not look at the indicated object compared to a recipient that looks at the indicated object because in the former case the goal of the pointing gesture has not yet been met (thus, the signaler should persist gesturing), while in the latter case the goal of the pointing gesture has been met (thus, the signaler should stop gesturing). In addition, we expected that if apes point without at all taking into account the attentional state of the recipient, then the pointing behavior of signalers should not differ between the successful-look and failed-look conditions because these conditions differed only in the recipient's looking behavior.

We found that the pointing behavior of subjects did differ between the successful-look and failed-look conditions. This suggests that subjects were taking into account the looking behavior of recipients and modifying how long they spent pointing per trial in response. Surprisingly, however, subjects did not modify their pointing behavior in the manner that we predicted. Instead, they spent more time pointing when the recipient responded by looking at the grapes (successful-look) than when the recipient responded by looking elsewhere (failed-look), and they did this from the first trial. Thus, we are left with the question, why would subjects point more for a recipient that has already seen the indicated object than for a recipient that has not yet seen the indicated object?

One explanation is that apes do not point to direct attentional states, but rather draw on their level 1 visual perspective-taking abilities to assess an experimenter's ability to hand over food. Many studies have shown that apes know what objects other agents can and cannot see and use this information to determine what those agents will do (see Call and Tomasello 2008 for a review). For example, when competing over food, chimpanzees will approach food that a dominant competitor cannot see rather than food that the competitor can see (Hare et al. 2000; Bräuer et al. 2007). One might argue, then, that the subjects in this study pointed more for the recipient that looked at the indicated food because they knew that a human who sees a food item is more likely to hand it over than a human who does not see that food item. Making such a distinction would not require that apes point to direct attention. Instead, they could simply point at the food, observe the experimenter looking at the food, and become motivated to point more because the experimenter now sees the food without understanding that there is a connection between pointing and a recipient's change in attentional state.

A second explanation for the above result is that ape pointing does not have the sole purpose of directing attention ("Look!"), but rather has the dual purpose of both directing attention and requesting that an agent do something with that object ("Look! Give it to me!"). Under this view, a pointing gesture that succeeds in getting a recipient to look at the indicated object is only partially successful; thus, it makes sense to continue pointing because the intended goal of the gesture has not yet been fulfilled. Moreover, we might expect a signaler in this partially successful situation to be encouraged to point more because the recipient appears to be on the right track. In contrast, a signaler that is faced with a recipient who shows no signs of producing the right response might be led to abandon his completely ineffective communicative strategy. In this case, we would expect signalers to both spend less time pointing and be less motivated to interact with a recipient that fails to look a the indicated object, which is what we found here.

Further support for this second interpretation comes from the findings of Cartmill and Byrne (2007). Cartmill and Byrne examined how orangutans would respond when their gestural requests for food were met with partial understanding (the recipient of the gesture handed over half of the requested food) or complete misunderstanding (the recipient handed over a less desirable food item) (see also Leavens et al. 2005). They found that subjects tended to repeat gestures that led to partial understanding and avoid gestures that led to complete misunderstanding. Thus, it is plausible that the subjects in this study were employing a similar strategy—spending more time pointing for the recipient exhibiting partial understanding (looks at the food, but does not retrieve it) and less for the recipient exhibiting complete misunderstanding (neither looks at nor retrieves the food).

Great apes regularly infer what objects other agents can and cannot see (Call and Tomasello 2008). They also manipulate the attentional states of humans by using attention-getting behaviors (Hostetter et al. 2007; Hopkins et al. 2007) and sometimes even by concealing their actions (Hare et al. 2006; Melis et al. 2006). Whether apes are capable of manipulating the attentional states of agents with respect to entities other than themselves, however, is unknown. The current study represents a first investigative step in this direction. Our results suggest that apes do not point with the sole aim of directing attention. Further studies need to be done in order to determine if ape pointing has the dual function of directing attention and soliciting action or whether it instead functions only to solicit action.

### 4.5. Acknowledgments

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