3 Questions I Am Often Asked

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Inevitably, I am asked three questions whenever I mention that I am a psychologist to a fellow airline passenger, taxi cab driver, or new acquaintance at a cocktail party.[1] The first question is usually something like "I have a brother-in-law who howls at the moon, why does he do that?" I explain that, as an experimental psychologist, that is not really my area of expertise, although I always feel tempted to steal a line from *Ace Ventura* and simply say "I don't do humans." I then explain that I am a comparative psychologist and primarily spend my time trying to understand the cognitive abilities of animals—in short, I want to know about animal minds. When I mention that I work with great apes and monkeys, this usually draws a lot of interest even among people who spend little or no time around animals, indicating that our attraction and fascination with animals is as strong as it has ever been.

This year, we celebrate the 200th anniversary of Charles Darwin's birth. Throughout the world, Darwin is being remembered for his many scientific and cultural contributions, and most of you know his biggest contribution—the role of natural selection in the evolution of species. Darwin's theory linked all living things and produced a blueprint for biological continuity that has transformed our understanding of many areas of science including biology and medicine. However, not all of you may know that Darwin also promoted the idea of psychological continuity across species. Darwin wrote of the mental lives of animals in his book *Descent of Man*, including his statement that the difference in mind between man and the higher animals, great as it is, certainly is one of degree and not of kind. It is this notion that guides much of the work in comparative cognition today. However, research into animal minds has not followed the same trajectory as research in natural selection and evolution, despite Darwin's best efforts. Where the idea of biological continuity permeated all of 20th century biology and medicine, the idea of psychological continuity has traveled a rockier road in comparative psychology.

In the late 1800s and early 1900s, many comparative psychologists asked questions about the mental lives of animals. Some of this research was very good, but some was very bad, producing an ideal climate for the emergence of more restricted views of the existence of animal minds (and even human minds) and their relevance for study in psychology. Comparative psychology then was dominated by behaviorism with its emphasis on using only observable responses and knowledge of the external environment to explain behavior. Only in the past half century has there been a resurgence in questions about animal cognition, but that resurgence has been strong and has produced some of the best evidence of the psychological continuities that Darwin promoted, including abilities usually reserved for humans alone, such as language acquisition (e.g., Rumbaugh & Washburn, 2003).

People are fascinated by the kinds of things that animals do, particularly when those things relate so closely to what people see themselves doing. And this leads to question number two: "What do your animals do?" This is the fun question, because of course everyone likes to talk about their own interests, and scientists are no exception. Comparative psychologists today study nearly every conceivable aspect of behavior and cognition as it may occur in other species. There are a number of excellent overviews of these research areas (e.g., Maestripieri, 2003; Roberts 1998; Rogers & Kaplan, 2004; Tomasello & Call, 1997; Wasserman & Zentall, 2006), so I will focus on some questions that most interest me in the hopes of giving just a glimpse of the kinds of questions that are being asked about animal minds in the 21st century.

Primate Accountants

My longest running area of research concerns the numerical and quantitative abilities of nonhuman animals. Specifically, I am interested in whether animals show any skill for counting, estimating, and performing arithmetic kinds of operations. Initially, people in my laboratory were trying to determine if chimpanzees could learn to look at Arabic numerals and then "count out"

1 I spent my first year in college as an accounting major (and my 2nd and 3rd years as a political science major, but that is another story), and although I dropped the accounting major, I kept company with some of the friends who became accountants as I worked my way through graduate school. Accountants are great because they are prime examples of the kinds of inquisitive people who are likely to ask the questions that I am talking about being asked in this article. I suspect that is because they are so pragmatic in their daily work lives (leading to their ultimately asking question three) and because they are starved to hear about anything BUT accounting principles at their cocktail parties (thus, question two).

a number of items equal to that numeral. This was all done on a computer screen, and ultimately we showed that chimpanzees could perform well with numbers up to 7 in this kind of task (Beran & Rumbaugh, 2001; Rumbaugh, Hopkins, Washburn, & Savage-Rumbaugh, 1989; see Figure 1). But, they did not do this the way that adult humans could, by basically performing equally well for all numerals. Instead, their performance decreased as the numerals got larger, suggesting that rather than using the formal counting routines that we all take for granted in our daily lives, they instead had a fuzzier notion of what the numerals meant, and that fuzziness increased as the numerals got larger. I then turned my attention to more spontaneous responses by chimpanzees by using a comparison task. Here, I was drawn again to my earlier interests in accounting to ask whether chimpanzees might be capable of different kinds of mental accounting that could involve very simple arithmetic operations. The first task I used was simple: chimpanzees watched as people dropped candies, one at a time, into each of two opaque containers, and then the chimpanzees were allowed to choose one container and eat the candies inside. As you might imagine, candies hold the same level of appeal for chimpanzees as they do for most of the rest of us, so it can be assumed that they will try to get as many as they can. The chimpanzees were very good at this task even when different people added different amounts of candies to the two containers at different times (Beran, 2001). Later, we showed that chimpanzees could make other kinds of comparisons such as comparisons between sequentially presented sets and sets of items that were all visible at once (Beran, 2004). They even performed well in picking the largest set when foods were added to the containers over a period of 20 minutes (Beran & Beran, 2004). Chimpanzees are not the only primates to do this, as some monkeys also can do these kinds of tasks (e.g., Beran, Evans, Leighty, Harris, & Rice, 2008).

Most recently, we have been thinking about another interesting phenomenon we observed during some of these earlier tests. The chimpanzees usually would work with us each day for about 30 minutes and complete 25 to 40 trials in which they compared sets. Toward the end of these test sessions, something interesting sometimes started to happen. The chimpanzees would try to make responses before we had finished presenting everything. Specifically, we noticed that if the first container only had a small number of items placed into it, the chimpanzees would immediately start to point to the other container, even though we had not yet added anything to it. If the first container had a rather large number of items placed into it, they pointed at it in an attempt to choose it even before seeing the other set. This suggested that they had made a choice despite having incomplete information, and so we decided to see what formed the basis for this interesting behavior. It turns out that after a dozen trials or so in which they get to see both choice options, chimpanzees start to use something similar to the average number of items they had been receiving on

Figure 1.
The chimpanzee Lana working on her enumeration task. Lana must touch the Arabic numeral at the top right of the screen (here, it is a 7), and then touch dots at the bottom of the screen in succession using a joystick to control a cursor (the + on the screen). She must do this until she has collected exactly 7 dots, and then she must return the cursor to the Arabic numeral to indicate she is finished (Beran & Rumbaugh, 2001).

trials to guide choice behavior in the face of uncertainty (Beran, Evans, & Harris, 2009). This uncertainty happens when they only saw one set but not the other. Sometimes, they chose the set they saw, but often they chose the unknown set. What predicted that choice was not the absolute number of items in the visible set, but how close that number was to the average number of items received during earlier trials in the session. This suggests that chimpanzees (and perhaps other animals) spontaneously perform a kind of record-keeping in which they discern how well "paid" they are for a given task and can use that information when there is ambiguity or uncertainty in a choice situation. This too points to a commonality between animal and human behavior as humans also devote much mental energy to calculating how well they are compensated for all kinds of things that they do (we are now giving humans this test to see if they perform similarly in terms of when they choose the known option versus the unknown option).

Primate Self-Control

Another one of my research interests emerged indirectly from the topic of numerical cognition. A very fascinating phenomenon had been reported with chimpanzees (Boysen & Berntson, 1995). When presented with two piles of candies, chimpanzees had to learn to point to the pile they *did not* want to receive. The pile they pointed to was given to another chimpanzee, and they received whatever was in the unselected pile. Despite tremendous efforts to get the chimpanzees to learn to do this, they never did. They almost always pointed to the larger set, and thus always received the smaller one. There were some ways around this (such as by using symbols rather than food items), but whenever food items were used the chimpanzees failed. This was not unique to those chimpanzees, as we have given this test to our chimpanzees and they always fail too. What this suggested was that chimpanzees had a hard time inhibiting pointing to things they really wanted (such as bigger piles of candy). This sparked my interest in whether there were other situations in which chimpanzees might better show inhibition and self-control, and what this might teach us about behavioral inhibition and the role of the environment in such self-control. I borrowed heavily from some elegant designs used with human children (e.g., Mischel, Shoda, & Rodriguez, 1989; Toner & Smith, 1977). Again, the tests themselves are pretty simple, but I think they demonstrate interesting aspects of animal behavior and provide compelling comparative data. Chimpanzees see a container in which highly preferred food items are added one-at-a-time. We have done this in a number of ways, including through computerized presentation (e.g., Beran & Evans, 2006). A computer dispenses a candy that slides down a tube into a container in the chimpanzee's room. The more time that passes, the more candies are dropped, and the chimpanzee can pick up that container at any time and eat those candies (but, this ends the trial, and the chance to get any more candy that day).

Figure 2.

Chimpanzees delaying gratification.

A The chimpanzee Sherman leafs through a magazine during the delay interval while candies accumulate in the tube coming into his enclosure.

B Panzee brushes her teeth during the delay interval. Having access to toys and objects improved the self-control of these chimpanzees (Evans & Beran, 2007).

So in many ways, the test is similar to that faced by a person with cash in a retirement or savings account. The longer you wait, the more it grows, but the more it grows, the more tempting it is to take it and spend it. Chimpanzees are quite good at waiting, sometimes waiting for close to 20 minutes as these items accumulate right in front of them (see Figure 2).

What is interesting, though, is not simply to demonstrate that chimpanzees can wait, but to determine how they do it. We have done this by looking at whether they understand the relation of their own behavior to how long they can wait. To do this, we gave them a test in which they could distract themselves from the food items (Evans & Beran, 2007), a strategy that is very successful for humans but often difficult to implement (e.g., Mischel, Ebbeson, & Zeiss, 1972; Mischel & Mischel, 1983)[2]. For the chimpanzees, there were three different situations. Sometimes, they had the food container within their reach (and they could eat whenever they wanted) and nothing else to do. Sometimes, they had the food container within reach, and they also had toys that they could play with during the time that food accumulated. Sometimes, they had toys, and food accumulated, but it did so out of their reach. So, in the first two conditions, they needed self-control, but in the third they did not. What we found was that when they had to inhibit, chimpanzees waited longer when they had toys than when they did not (Evans & Beran, 2007). We also found that the more they played with the toys, the longer they waited. This clearly indicated that having something else to do helped the chimpanzees. However, these two conditions alone did not tell us exactly how this helped them. Maybe the toys were interesting, and so the chimpanzees played with them, and this necessarily kept them from eating the candies. This would not mean that chimpanzees knew that turning attention away from the candies would be useful in getting more candy, unlike the way that adult humans can explicitly indicate their understanding of such an arrangement. But, what we also found was that chimpanzees played more with toys when they had to show self-control (when candies were in reach) than when they did not (when candies were out of reach). This means that simply having toys available did not produce the high levels of interaction with them. It was having toys and *needing toys* as a distraction that prompted chimpanzees to play more with them. This suggests to us that chimpanzees may know something about how to control their own behavior in ways that helps them maximize their benefits. They did not learn to play with the toys, nor did they learn to enjoy the candies during this experiment. Both of those things were already in place. Rather, they combined old behaviors in new ways toward the end of obtaining a salient and motivating outcome—we call this an emergent behavior (e.g., Rumbaugh, King, Washburn, Beran, & Gould, 2007). There are additional questions that remain about just how strategic chimpanzees can be in these kinds of tests, but we believe that these data highlight commonalities between human and nonhuman minds just as Darwin suggested.

[2] For those of you trying hard to change some behavior in your life such as avoiding junk food, you know the best strategy is to not put yourself in a situation to be tempted. Staying out of the kitchen late at night, avoiding the dessert tray in restaurants, and going places where food is not available are all helpful strategies, and we know it (although many of us seem hard-pressed to put those good behaviors into practice).

Why Does It Matter?

Getting back to that cocktail party or plane flight, people usually listen intently, but eventually someone asks question number three: "That is really interesting, but why does it matter that animals can do these things?" This is the BIG question, the one that requires a much more thoughtful response than *Ace Ventura* might have offered. In part, I would argue that it again comes back to Darwin and to the idea of psychological continuity across species. If such continuity exists, it means that our behavior may be the result of the same kinds of psychological processes that operate in other animals, and so understanding their behavior can help us understand our own. This does not mean that similar-looking human behaviors and nonhuman animal behaviors are necessarily the result of the same psychological processes. Rather, as with biological continuity across species, the idea is that different cognitive capacities have changed through time as a result of unique selection pressures, but they still share some underlying commonalities. I can illustrate this by returning to the topic of numerical cognition. Humans show a level of numerical sophistication that exceeds anything we expect to see in other animals. We use arithmetic, geometry, and calculus as the basis for engineering and mathematical systems that are unique to us. As I mentioned, even our counting abilities exceed those of other animals. However, our mathematical advances as a species (and those we experience as individuals as we grow and mature) are built upon a more primitive system for approximate calculation and estimation, a system that we share with other animals (see Beran, 2008). We see this system in action in many nonhuman species (e.g., Beran, 2007; Brannon & Terrace, 2000), in young human children (e.g., Cantlon & Brannon, 2006; Jordan & Brannon, 2006) and in human adults when we prevent them from using more advanced counting routines (Beran, Taglialatela, Flemming, James, & Washburn, 2006; Cantlon & Brannon, 2007; Cordes, Gelman, Gallistel, & Whalen, 2001). We even see evidence of similar neurological processes underlying the numerical representations of monkeys and humans (e.g., Nieder & Merten, 2007; Roitman, Brannon, & Platt, 2007) indicating that human mathematics, unique as it is, is still supported by a more ancient system that has served animals well for millions of years in dealing with quantities around them.

In some cases animal behavior might offer even clearer insights into some aspects of our mental capacities than human behavior alone. To give one example, I return to the topic of self-control. Human beings suffer in many ways because they cannot restrain themselves when faced with temptation, and failures of self-control produce devastating effects (e.g., obesity due to lack of restraint in diet, drug addiction, alcohol abuse, and financial debt due to lack of control over spending). Without question, reducing impulsivity and improving self-control would offer one of the strongest positive outcomes for humans, but often self-control is associated with aspects of "moral character" and other difficult-to-measure individual characteristics that vary from individual to individual and across cultures. Here, animal studies offer greater levels of control and a model in which social norms and moral beliefs about self-control are minimized so that other factors affecting self-control can be isolated.

Survival for most species and throughout most of the evolutionary history of humans has placed a premium on getting things as quickly as possible—food now, sex now, shelter now. Efforts to wait for something better were rarely rewarded. However, there are exceptions to this rule. In some circumstances, the ability to delay gratification led to a better future outcome that increased the chances to survive and reproduce. This started most likely through memory of distant locations with better food or shelter opportunities, where foregoing current chances to feed or rest were required so that animals could move elsewhere. Other behaviors, such as tool use and eventually tool transport, also required giving up immediately available foods (such as fruit or vegetation) to work to procure more protein-rich foods such as nuts. Hunting behavior among omnivorous species, such as is seen in chimpanzees, also requires delay of gratification and a level of risk-taking for a reward that is uncertain and more distant in time than eating food available in the immediate surroundings. And then, in humans, these kinds of scenarios expanded to include food production, food storage for leaner times, and eventually economic practices whereby humans produced goods and offered services for compensation that was received only later. But throughout, that compulsion to act now and to obtain things now remained, and so animal models help us understand this natural compulsion and also see some of the precursors that led us to greater foresight and self-control by overcoming those impulsive and short-sighted behaviors.

Beyond these examples, I would also emphasize that experimental psychologists are interested in minds and behavior however they manifest. We recognize that they may manifest differently across individuals and groups (whether we are talking about species, ages, cultures, etc.). To have a full psychological theory, and a true understanding of minds and behavior, it is not sufficient to understand only one mind. If that understanding does not generalize to other minds of the same species, it is not complete. And if it cannot account for processes such as learning, remembering, communicating, planning, and decision-making that we see in other animals, it is not complete. It is only when our explanations of human mental activity also account for those truly shared capacities we see in other animals that we have succeeded in understanding cognition. It is this level of analysis, and this interest in cognition from a comparative perspective, that offers a fuller picture of our own behavior, and one that I think Darwin would have appreciated.

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