Experimental investigation of social learning in domestic animals and non-human primates.

Submitted by Nicole R. Dorey to the University of Exeter as a thesis for the degree of Doctor of Philosophy in Animal Behaviour in the faculty of science, June 2008.

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Nicole R. Dorey
Abstract

Imitation is considered to be an efficient method of conveying information between individuals. It is believed to be among the least common and most complex forms of animal learning. After almost a century of studying social learning in animals, scientists still have not been able to give a clear answer to the question “Do animals imitate?”.

Although there have been some studies that have shown certain species under certain conditions unequivocally imitate (e.g. Zentall, et al., 1996), these studies have not been successfully replicated in a wide range of species. This thesis expands the social learning literature extending the range of settings and species in which it has been studied and by drawing links to the field of behaviour analysis.

Four of the current studies used versions of the two-action method to look for imitative learning in both non-human primates and domesticated animals. In this methodology an observer watches a demonstrator manipulate an apparatus with two different parts of their body. Using two different parts of the body and not two different manipulations lets researchers determine if the individual is learning by observation or just learning about changes in the state of the environment. This methodology is the only one that can distinguish local enhancement (learning only to attend to the location of the demonstrator), or stimulus enhancement (learning only to attend to the stimulus which the demonstrator interacts with) from “true” imitation (Campbell, Heyes, and Goldsmith, 1999).

One of the current studies used the “do as I do” methodology. In this method a subject is trained to match a few gestures of the demonstrator for reinforcement (i.e. the demonstrator raises her/his hand and the subject raises his/her hand) on the verbal command of “Do this” or “Do it”. After the subject reaches criterion on the trained
behaviours a novel behaviour is added that has not been trained to see if the subject will spontaneously imitate the behaviour. Successfully copying a novel demonstration is taken as evidence of understanding the rule needed for imitative performance. This methodology is popular because it not only can distinguish between imitation and the other forms of social learning, but it can also show the subjects’ ability to generalize this type of learning.

The overall results show very little imitative learning occurring in the various groups of animals studied. The low rate of imitation may not be surprising. For just over 100 years psychologists have been studying social learning and in that time only a handful of researchers have been able to show clear evidence of an animal’s ability to imitate the actions of a demonstrator. These results suggest that, though imitative learning may be important in the lives of a few species, or in the acquisition of particular behaviour, it is unlikely that it plays an essential role in the acquisition of behaviour in general, especially behaviour through which animals directly manipulate their environment.
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STATEMENT OF THE CANDIDATE’S CONTRIBUTION TO CO-AUTHORED PAPERS

There are five studies included in this thesis, all of which have been written up as manuscripts for publication. As detailed below, the substantial contribution to the co-authored papers presented in this thesis was made by the candidate. However, while the candidate is fully responsible for the work presented in this thesis, where the first person is used it is in the plural (i.e., ‘we’ rather than ‘I’) as in the original peer-reviewed articles to reflect the collaborative efforts guiding the research process. All chapters that have been written up as manuscripts are presented in the format requested by the respective journal; since each manuscript is meant to stand alone, some information may be redundant.

**Paper 1: Chapter 2**

Dorey, N.R., Melfi, V. and Lea, S.E.G. (in prep). *Evidence of social learning in Diana monkeys and Sulawesi black crested macaque*

The first manuscript, presented in this thesis as Chapter 2, was submitted as a paper to the *Journal of Applied Animal Behaviour Science*. The paper came back rejected, because it didn’t fit into the aim of the journal, but the reviewers gave great suggestions and thus the chapter was corrected. The chapter has been reformatted and is being sent to *Animal Cognition*. The data were collected and analysed by the candidate, with statistical advice from Prof. Stephen Lea. The paper was written with supervisory support from Prof. Stephen Lea and Dr. Vicky Melfi.
Paper 2: Chapter 3

Dorey, N.R., Melfi, V. and Lea, S.E.G. No evidence of imitative learning in a callitrichine, Goeldi’s monkey (*Callimico goeldii*)

The second manuscript, presented in Chapter 3, was sent to the *Journal of Comparative Psychology*. It came back rejected, because the methodologies did not match that of previously published work. However the reviewers gave fantastic feedback and thus the manuscript was changed accordingly. The candidate designed the methodology of data collection as well as collected and analysed the data. Prof. Stephen Lea contributed to the analysis of the data. The paper was written with supervisory support from Prof. Stephen Lea and Dr. Vicky Melfi.

Paper 3: Chapter 4

Dorey, N.R., Lea, S.E.G., & Melfi, V. (in prep.). Indication of imitative learning from conspecifics in a dog (*Canis familiaris*).

The third manuscript, presented in Chapter 4, was sent to Dr. Clive Wynne for review, who gave some very useful comments. The candidate designed the methodology of data collection as well as collected and analysed the data. Prof. Stephen Lea contributed to the analysis of the data. The paper was written with supervisory support from Prof. Stephen Lea and Dr. Vicky Melfi.

**STATEMENT OF THE SUPERVISORS’ CONTRIBUTION TO CO-AUTHORED PAPERS**
As outlined in the candidate’s statement above, the substantial contribution to the co-authored papers presented in this thesis was made by the candidate. This includes the review of the literature presented in each paper, study design, statistical analyses and interpretation of the data, together with the write-up for publication. The supervisors contributed to the papers by advising on statistical analyses and interpretational issues, relevant literature, and writing style. Moreover, the theoretical framing of the empirical work in this thesis and the arrangement of the papers is a product of a concerted discussion of the thesis content between the candidate and supervisors.

Prof. Stephen E.G. Lea (first supervisor)

Dr. Vicky Melfi (second supervisor)
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Toward the end of my time in Exeter Michael had to head back to the states because his visa would not allow him to stay any longer. When this happened I no longer felt safe living in the shared house we occupied and began looking for a place to live that would allow a dog. I looked for months but to no avail. It was Nicky Jago who came to my rescue and I am forever in her debt. Her hospitality and kindness was above and beyond and without it Zoë and I might have been living in a box by the sea. I would also like to thank Kate Jackson who allowed me to stay in her room whilst she was in Africa and for being a super cool flatmate when she came back. We all had many fun and interesting nights in the flat together. From the interesting neighbours to the mysterious wet spots it was always an adventure in the Merritt Flat. Thanks girls!

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CHAPTER I

Literature review
1.1 Social learning from Psychological and Biological perspectives.

Social learning is said to have occurred when an observer’s behaviour changes after viewing a demonstrator. It is considered to be “intrinsically fascinating often because of what it reveals about an animal’s cognitive abilities” (Caldwell and Whiten, 2004, p. 77). Biologists and psychologists differ in the way they approach the study of social learning. Biologists are interested in the adaptive value of behaviour, suggesting that imitation may fill an “important niche between species-typical, genetically predisposed behaviour and individual learning” (Zentall, 2006, p. 335). Biologists typically study social learning of natural behaviours such as bird song, and food preference (Zentall, 2006). Psychologists focus on the underlying mechanisms of behaviour and thus manipulate the environment to see under what conditions the behaviour occurs. Unlike psychologists, Biologists have discovered and can appreciate social learning in a variety of mammalian taxa which have a variety of living conditions and lifestyles (Box and Gibson, 1999). Biologists and psychologists also ask different questions in relation to social learning. Biologists study the “why”, whereas psychologists structure their research around the “how”. Biologists study the natural lifestyles and have found that socially mediated behaviours are part of the adaptive strategies that have evolved to increase the fitness of the individual (Box and Gibson, 1999). Because of this the two fields study different behaviours, have different methodologies and have different terminologies. This thesis will concentrate on social learning from a psychologist’s point of view, so that readers can understand where the definition for the social learning terms originated in the current research.

1.2 Distinguishing imitation from other forms of social learning.

The history of scientific study of imitative learning dates back to Darwin but it wasn’t until the publication of Romanes’ *Mental Evolution in Animals* (1883) that the first
description of imitation was published (Whiten and Ham, 1992; Zentall and Galef, 1988). Romanes and his followers soon “incorporated a diverse collection of phenomena under the heading of “imitation” (Whiten and Ham, 1992, p. 239). Thorndike (1898) was the first to characterize imitation formally: he defined it as “learning to do an act from seeing it done” (p. 50) and since then imitation has been defined in various ways (see Whiten and Ham, 1992 for a review).

To clarify this issue, Zentall and Galef (1988) attempted to distinguish imitation from other forms of social learning. However, others disagreed with the fundamental distinctions and have created their own (see Whiten and Ham, 1992). Zentall (2004) takes a different approach and defines imitation by describing what imitation is not. Thus, “imitation is a form of social learning that remains when one has ruled out or controlled for all of the alternative mechanisms (mimicking, observational learning, stimulus/local enhancement) that might contribute to the higher probability of a copied response” (Zentall, 2004, p. 18).

Whiten and Ham (1992) use the term mimetic processes as a broad term that encompasses non-social processes (mimicry, convergence, individual learning etc.), social influence (contagion, exposure, social support, etc) and social learning (imitation, goal emulation etc). Most researchers in the field agree with these definitions and categories (e.g. Zentall, 2006; Hoppitt, and Laland, 2008). However, some have used Tomasello’s definition of mimicking, which is defined as imitation where the observer may not understand the intentions of the model (Tomasello, 1996; Bugnyar, and Huber, 1997). For the purpose of this thesis, we will use Whiten and Ham’s (1992) definitions for mimicking for two reasons 1) even though it is an older paper, current papers within the animal cognition field still use their categories and definitions (e.g. Fredman and Whiten, 2008;
Mazur and Seher, 2008) 2) Tomasello’s definition requires one to accept that animals possess a theory of mind, which this author doesn’t fully accept (see section 1.3). For the remainder of this chapter and the thesis as a whole, we will focus on the social learning aspect of their taxonomy.

According to Whiten and Ham (1992) social learning is defined as occurring when animal “B may have learned from A the basis of a subsequent similarity between their actions” (p. 249). However, there are a number of ways (three according to Whiten and Ham) that the observer can learn from a demonstrator. The first is called local or stimulus enhancement and according to Whiten and Ham is the category that is “most often confused with imitation” (p. 249). Stimulus/local enhancement occurs when an observer learns from a demonstrator either which location or which stimulus to direct its behaviour towards. The second is called observational learning, which is similar to stimulus/local enhancement but instead of referring to appetitive actions, observational conditioning refers to avoidance reactions (Hall, 1963; Mineka and Cook, 1988; Whiten and Ham, 1992). Others however, have used this term more broadly and not always in the context of avoidance (Zentall, 1996). What there usages have in common, though, is, “that B initially shows an unconditioned mimetic response contingent on A’s reaction to the stimulus” (Whiten and Ham, p. 250). The third category is goal emulation which is defined as an observer learning from a demonstrator the final goal of the action watched. The final category is imitation which is defined as “B learning from A some part of the form of a behaviour” (Whiten and Ham, p. 247). Researchers in this area concentrate on the term learning when looking at imitation. If the behaviour is already part of the subject’s repertoire then the behaviour could have been not learned and therefore not imitative.
In a more recent article Fredman and Whiten (2008) add to this list the term canalization. Canalization is defined as occurring when an observer before watching a demonstrator produces a wide range of actions including that of a demonstrator, whereas after watching the demonstrator the behaviour chosen is mostly that of the demonstrator. Thus the observation of the demonstrator’s behaviour channels that of the observer, but only towards a higher rate of a behaviour that is already in the observer’s repertoire.

The trend in methodology within psychology has been to choose a novel behaviour and compare the behaviour of a group that watches a demonstrator perform this behaviour with that of a control group that doesn’t watch a demonstrator. However, “many studies of this type have suffered both theoretical and methodological problems” (Zentall, 1988, pg. 192). For example, observer rats who were given a reward for following a conspecific demonstrator in a T-maze were actually using the conspecific as a cue that elicited the behaviour rather than learning anything from them (Zentall, 1988).

But the biggest problem with this type of methodology is failing to control for other types of social learning. As psychologists in this area define imitation by distinguishing it from other forms of social learning, control procedures that allow this distinction to be made are critical. In the current thesis I will define imitation by exclusion following Zentall (2004). “imitation is a form of social learning that remains when one has ruled out or controlled for all of the alternative mechanisms” (Zentall, 2004 p. 18). I will also use behaviour that is novel. In this thesis novel behaviour will be defined as behaviour that might be in the animals’ repertoire, but not seen in the baseline with the stimulus used.

In the next section of this chapter we will discuss the evolution of methodologies within the imitation paradigm as used by psychologists.

1.3 Why imitation?
Some scientists in the field of animal psychology, research the area of animal consciousness (e.g. Woodruff and Premack, 1979; Povinelli, et al., 1993; Gallup, 1997). As Wynne (2001) states so eloquently “It seems positively foolhardy for an animal psychologist to rush in where even philosophers fear to tread” (pg. 15). However, some psychologists feel the need to understand how much one animal understands the actions of another. The term “theory of mind” or ToM for short, is at the heart of this research. ToM is defined as “the ability to predict and explain behaviour by attributing mental states” (Premack and Woodruff, 1979, pg 334). In other words how much does one animal understand the motivation and/or intention of another? Although I will not in this thesis be seeking to resolve the problems and criticism of the ToM concept, I think it is important to note here that the investigation of imitative learning has been used to address these types of questions because this behaviour is thought to involve the observer’s understanding of the demonstrator’s motivation for performing the behaviour.

Another reason for studying imitative learning is the belief that it is the “social glue with many beneficial social consequences” (Hurley and Carter, 2005, pg. 36) and thus important to the culture of humans and possibly the culture of animals. The most popular explanations as to why there are differences between the limited capacity for social learning in animals and human culture depend on the differences in adaptive advantages (Heyes and Galef, 1988). Assessing the adaptive advantages can be achieved by calculating the costs and benefits of the behaviour (Heyes and Galef, 1996). The cost of the individual may be reduced by learning how to perform the behaviour exactly as they have seen it performed rather than by costly trial and error. Fitness differences have been found between individual and social learning (Boyd and Richerson, 1998). The results show that
when the environment changes rapidly, individual learning is favoured and when the
environment is changing at an intermediate rate, social learning is favoured (Boyd and
Richerson, 1998). Thus studying which species learn by imitation could indicate the rate at
which their environment is changing.

1.4 Methodology

Thorndike, in 1898, was the first to develop a methodology to study imitation in an
attempt to confirm or refute the anecdotal evidence for its occurrence that was piling up at
the later part of the 19th Century (Zentall and Galef, 1988; Whiten and Ham, 1992). In his
procedure he compared the learning curves of cats who had been given the opportunity to
observe others escaping from a box with those who had never seen the puzzle box being
solved. He found no difference in the two groups’ rates of learning. Whiten and Ham
(1992) state that “this procedure represented an important advance in rigor and
imagination” (p. 242). Thus, even today, parts of Thorndike’s original procedure can be
seen in imitation research (Whiten and Ham, 1992). However there were limitations to
Thorndike’s design. First, he compared the speed and latency of escape between the
demonstrator and observer, which does not tell us whether the subjects were imitating the
behaviour of the demonstrator (it only tells us if the observer is faster at solving the puzzle,
which could occur for a number of reasons). Second, he took data on whether similar
actions were used, and although this would be sufficient to tell us if the behaviour was
learned socially, it wouldn’t give us enough information to conclude that the learning
involved true imitation. To overcome this problem, two other procedures are widely used in
the non-human imitation literature: two-action and the “do as I do” method. I will give a
review of both of these methodologies.
1.4.1 Two-Action Method

The two-action test procedure is an attempt to improve on the “Thorndike-like” procedures. This methodology is the only one that can distinguish local enhancement (learning only to attend to the location of the demonstrator), or stimulus enhancement (learning only to attend to the stimulus which the demonstrator interacts with) from “true” imitation (Campbell, Heyes, and Goldsmith, 1999). The first study to use the two action method was Dawson and Foss (1965). In this study a group of budgerigars were given a lid-removal task in which they had to learn a way to remove the lid. They found that the budgerigars removed the lid in one of three ways: pushing the lid off with the beak, twisting it off with the beak, or grasping it off with the foot. A second group of budgerigars were then exposed to watching birds from each of these groups to see how they would subsequently remove the lids. They concluded that observers who saw a demonstrator removed the lid significantly more in the same manner as the demonstrator they had observed.

Since this study there have been two methodologies that are called “two action”. The first is where two actions are done with the same part of the body on the same object, as in Dawson and Foss (1965) where the budgerigar either twisted off the lid or pulled off the lid with their beak. This procedure does not, however, rule out the possibility of stimulus enhancement and most researchers agree that “a tendency of observers to respond in the same direction as their demonstrator is not in itself conclusive evidence of imitation” (Fawcett et al., 2002 p. 548). However, investigators can control for this possible confound with the use of by ghost controls (see Denny, 1988; Fawcet et al., 2002).

The second variation of the two-action procedure, and the one that is used more often in imitation research, is the method where two actions are done with a different part
of the body on the same object. An example of this would be the budgerigars pulling the lid off with either their foot or beak. This methodology has been the most widely accepted among researchers. Fawcett, et al., (2002) states that this procedure significantly advanced the study of imitative behaviour.

Although this procedure rules out the possibility of stimulus enhancement, it cannot distinguish between response-reinforcer learning and stimulus-reinforcer learning (Whiten and Ham, 1992). Some scientists in the field (Premack and Woodruff, 1979; De Wall, 1992; Byrne, 1994) believe that animals have a Theory of Mind (ToM) and that imitation is evidence of this ToM. Following along with this theory, animals that imitate should “understand” the motivations and intentions of the demonstrator. If this is the case, being shown the consequence for the correct imitative behaviour should not be an important factor for the observer (Zentall, 2003), thus vicarious reinforcement should not be essential for imitation to occur. Even with improvements in the methodology, “psychologists have been unable to agree on the mechanisms required for true imitation” (Akins and Zentall, 1998, p. 694). None of the accepted methods for studying imitative learning control for the fact that the observer can watch the demonstrator receive food and some argue that because of this confound the animals are just learning the relationship between the response and the reinforcer, also called response-reinforcer learning (Zentall, 2003).

1.4.1.1 Bidirectional control

The first type of “two action” procedure is also called “bidirectional control”. It was first used by Heyes and Dawson (1990). In their experiment, two groups of rats observed demonstrators manipulating a joystick in different ways to obtain food. The first group observed demonstrators pushing the joystick to the left and the other group observed demonstrators pushing to the right. When the “observers” were given access to the joystick
they were found to push the joystick in the direction they observed (although they would have obtained the food by pushing the joystick in either direction). Hayes and Dawson conclude that rats showed “non-vocal imitation of response learning through observation”. Later research suggested, however, that these results may have been due to olfactory cues (Mitchell, Heyes, Gardner, & Dawson, 1999).

Another bidirectional control experiment was conducted with marmosets by Bugnyar and Huber (1997). In this experiment a subject was trained as a demonstrator to push or pull a pendulum door open. Seven observers were allowed to watch the demonstrator open the door to obtain food. In addition control studies were carried out with 10 subjects who were given access to the apparatus to see how they would open the door. The researchers found that the marmosets in the observer group explored less than the group that didn’t watch a demonstrator and they were more likely to match the behaviour of the demonstrator in the initial test phases.

Although bidirectional control procedures are not controlled enough to show if a behaviour is imitative or facilitated socially, the method can be improved by using a series of bidirectional actions that have to be conducted in a particular order. Whiten (1998) studied the imitative learning of four chimpanzees using an apparatus that he called an artificial fruit. The artificial fruit was an opaque box secured to a board that could be opened by one of two latching devices (bolt or barrel). The barrel latch incorporated two subcomponents that had to be released sequentially (pin and handle). Each of the latching devices could be manipulated in one of two ways to open the door. Thus the bolt could either be poked or twisted, the pin could either be turned or spun, and the handle could either be pulled or turned.
In this study an experimenter demonstrated to each subject a different pattern of actions on how to open the device. Two subjects saw the sequence in which both bolts were removed (farthest first), pin then handle. Each of the two subjects saw different ways to manipulate each of the latching devices. The remaining two subjects saw the sequence pin, handle, and then bolts (farthest first). Each of the two subjects saw different ways to manipulate each of the latching devices.

Whiten found that half of the subjects imitated the sequence of behaviours in the first trial and the others imitated the sequence on the second trial. However some of the actions used differed from those used by the demonstrator.

Whiten, et al. (1996) used the artificial fruit apparatus in a similar fashion to study imitative learning in children ages 2-4 (the only difference from the procedure used with chimpanzees was that the children were given some limited instructions). All subjects in this study were found to copy the behaviour of the demonstrator. The children even copied behaviour that had no functional significance (i.e. turning the pin, twisting the pin).

As mentioned earlier, this procedure does not control for response-reinforcer learning. However, there is a way to control for this within the bidirectional control methodology. The key is to use multiple bidirectional manipulations, as in Caldwell and Whiten (2004). In this paper the authors used an artificial fruit apparatus to look at imitative learning in marmosets. They had two demonstrators and 12 observers. The subjects were placed in three observer groups: full demonstration, partial demonstration and no demonstration (control group). The subject who was the full demonstrator was trained to “turn the handle from the bottom and lift the lid by pulling it up from the bolt-holes” (pg. 80). The subject who was the partial demonstrator was trained to eat food from the lid of the apparatus.
The researchers found that none of the observers was able to open the artificial fruit, however the time spent manipulating the apparatus varied according to the type of demonstrations they saw. For example the subjects that saw the full demonstration spent more time manipulating the apparatus then the subjects that saw a partial demonstration. In addition those that saw the full demonstration touched the particular parts of the apparatus that they saw the demonstrator manipulate, which the authors conclude was localized stimulus enhancement. Although this sequential methodology has not gotten the criticisms that the other bidirectional literature has, it still hasn’t gotten the accolades that the “gold standard” for two-action method has received.

1.4.1.2 Standard Two-Action Method

In this methodology an observer watches a demonstrator manipulate an apparatus with two different parts of their body. Using two different parts of the body and not two different manipulations lets researchers determine if the individual is learning by observation or just learning about changes in the state of the environment. The first experiment to use this type of method was Zentall, Sutton, and Sherburne (1996). In this experiment demonstrator pigeons showed observers two distinct response topographies (pecking and stepping on a treadle) that each produced the same consequences (food) when it was imitated. Of the 10 pigeons that observed the treadle-stepping, 9 stepped on the treadle and none of them pecked the treadle (the remaining pigeon used its body to operate the treadle). Of the 10 pigeons that observed the treadle-pecking 5 pecked the treadle and 5 stepped on the treadle. Zentall, Sutton, and Sherburne (1996) concluded that “observing pigeons show a significant tendency to copy or imitate the topography of a demonstrator’s response” (Zentall et al., 1996, p. 345).
Akins and Zentall (1996) tested Japanese quail using the two-action method. In this experiment they trained two birds to be pecking and stepping demonstrators. The remaining 10 birds were used as observers. As in the procedures of Zentall et al (1996) birds watched either a pecking or a stepping demonstrator for 10 min. at a rate of one response every 10 s. Once the demonstrator was removed the observer was given access to the manipulandum for 30 min.

The researchers found clear evidence of imitative behaviour in Japanese quail. Although the subjects imitated both behaviours, they were more likely to imitate pecking than stepping. The authors argue that this might have been because of ease of the behaviour (it might have been easier to peck on the treadle than step on it).

A more recent study that uses the “two action” methodology was conducted by Voelkl and Huber (2000) with common marmosets. In this experiment they had two demonstrators show observers how to open film canisters either with their mouths or with their hands. They also had two control groups. The first control group was used to assess the frequency of untrained mouth opening of the canisters. The subjects in this group were given access to the canisters for up to 15 min. If they did not open at least three canisters within this time, they were given further sessions to accomplish this goal. The second control group was used to assess odour cues that may have influenced the behaviour of the marmosets. In this condition the subjects had access to canisters that had previously been opened by the mouth of another subject. These subjects did not watch a demonstrator and were also given up to 15 min. to manipulate the canisters. The authors found that marmosets copied the manipulations shown by a conspecific demonstrator. More specifically, all of the subjects that watched a hand demonstration opened the canister with
their hands and four out of the six subjects who watched a mouth demonstrator opened the canister with their mouths.

**1.4.2 Do as I Do**

As mentioned earlier the two action methodology is widely used to study imitation, however another procedure that is gaining popularity is the “Do as I do” methodology. In this method a subject is trained to match a few gestures of the demonstrator for reinforcement (i.e. the demonstrator raises her/his hand and the subject raises his/her hand) on the verbal command of “Do this” or “Do it”. After the subject reaches criterion on the trained behaviours a novel behaviour is added that has not been trained to see if the subject will spontaneously imitate the behaviour. Successfully copying a novel demonstration is taken as evidence of understanding the rule needed for imitative performance. This methodology is popular because it not only can distinguish between imitation and the other forms of social learning, but it can also show the subjects’ ability to generalize this type of learning.

Generalized imitation has been used to identify the functional relations between a model and an imitator and to emphasize the fact that many different responses of a model are often copied in diverse situations sometimes in the absence of extrinsic reinforcers. Baer and Sherman (1964) stated that generalized imitation is a functional response class or higher order operant, in other words a class of behaviours that has included within it other classes that can themselves function as operant classes. Thus a behaviour that is not reinforced within a group of behaviours may follow the contingencies of the group rather then the contingencies set up for that individual behaviour. Generalized imitation can be used to explain a child’s rapid acquisition of complex behaviours exhibited by their parents.
(Burgess, Burgess, & Esveldt, 1970) and as a key concept in theoretical analyses of language development (Brigham & Sherman, 1968).

1.4.2.1 Do as I Do with Humans

This procedure was apparently first used in a scientific context with humans by Baer and Sherman (1964) who used social reinforcement with a puppet to train three imitative responses (head nodding, mouthing, and strange verbalizations) in children. A fourth imitative response of bar pressing, which was never reinforced, increased in strength as the three other reinforced imitative responses increased in strength. In the next phase, two of the children’s three previously reinforced imitative responses were placed on extinction. The imitative responses were extinguished and so was the bar pressing response in the absence of reinforcement. In the third condition a non-modelling condition (where the experimenter did not model the behaviour), was implemented with two other children, and the bar pressing response was extinguished along with the other responses. When contingent reinforcement of the three imitative responses was reintroduced, the bar-pressing response increased along with the other three responses in all four children.

Baer and Sherman (1964) found that if the imitative behaviours were being reinforced then the non-imitative behaviours would occur at the same rate as the imitative behaviours. However, if the imitative behaviours were not being reinforced then both the reinforced imitative and the un-reinforced-imitative behaviours would drop in responding. They concluded that the reason could be that the un-reinforced imitative responses may be maintained during because the S-delta (stimulus present when reinforcement is delivered) responses act as conditioned reinforcers (Steinman, 1970).

Since this time there have been several further studies of the “do as I do” procedure with children. The typical methodology has changed slightly: some have reinforced
imitative responses only in the presence of one stimulus and not in the presence of another stimulus (Furnell & Thomas, 1976), while others have explored conditions which might maintain un-reinforced imitative behaviour in children by having the experimenter absent and varying the complexity of the stimulus situation (Peterson, Merwin, and Moyer, 1971). However, all of these experiments have given their subjects instructions, making their methodologies different from those used with animals.

1.4.2.2 Do as I do with non-human animals

Hayes and Hayes (1952) were the first to use the “Do as I do” procedure with non-humans. They used this methodology to demonstrated imitative learning in one subject, a home-reared chimpanzee named Viki, who was trained to imitate on the command “Do this”. Viki was (by their observations) spontaneously imitating the researchers’ behaviour from about 17 months until about 34 months of age. In the experimental procedure the subject was given one of 70 different behaviours which the researcher performed while saying “do this”. If the subject copied the behaviour within a few seconds she was given a food reward. If however, the subject did not imitate the behaviour then the researchers would repeat the demonstration or help her make the response.

Hayes and Hayes (1952) found that once they shaped the behaviour, Viki began to perform new untrained behaviours by herself in the presence of the command “Do this”. They concluded that this research not only showed imitation in a primate, but imitation combined with “higher mental processes”.

Whiten and Ham (1992) state that this is one of the most convincing studies in demonstrating the fact that chimpanzees can imitate. However, Custance, Whiten and Bard...
(1995) argue that Hayes and Hayes’ research is flawed by the lack of adequate detail on both their procedure and results.

As a result, Custance et al. (1995) replicated the Hayes and Hayes procedure. Their subjects were two nursery-reared chimpanzees, which were given a novel instruction 3 or 4 times without any direct instruction or shaping. They also used inter-observer reliability data to check the accuracy of their behaviour observations.

In the first phase of this experiment the researchers taught the chimpanzees to reproduce on the command “do this” 15 different actions through food reinforcement and shaping. Phase two was set up to see if the subjects could make the transition from taught imitation of actions to imitations of novel actions. Each novel behaviour was demonstrated a few times and new behaviours were introduced to the chimpanzees every week. No food reward or shaping procedure occurred during this phase.

Custance et al. found that chimpanzees can imitate arbitrary (or non-functional) actions, although some of the responses given were not “perfect”. They suggest two explanations for this, (1) It may have been difficult for the species to imitate humans; imitating a conspecific might have been easier. (2) The chimpanzees may not have been able to understand that the command “Do this” meant the researchers wanted the subjects to imitate the demonstration as accurately as possible.

Bjorklund, Yunger, Bering, and Ragan (2002) claim to have achieved the first study using a generalized imitation method with enculturated chimpanzees. They used three juvenile chimpanzees ranging in age from 5-9 years old. Sessions were divided into four sessions: baseline, demonstration, deferred imitation or generalization, and presentation of new materials. In the baseline session the participant was allowed to interact with a number of objects for 6 minutes; this was done to see if the participants had any response
predisposition to the objects before the experiment began. In the demonstration phase the model (a familiar caretaker) demonstrated the target toward each object behaviour several times to the participant. The deferred imitation trial in phase three involved the presentation of the same object that had been used during the demonstration phase. However, the generalization phase involved presentation of similar, but not identical objects. Phase 4 entailed the presentation of new materials not presented in phase three.

In every phase but phase 2 the participant was encouraged to manipulate the object if he/she had not done so in 30 s. Also during these phases the model made no gestures and no comments or food reward were given if the participant displayed the target behaviour.

The researchers found that all the participants displayed deferred and generalized imitation of action on objects. The stated that since the behaviours required for generalization of imitation were similar to those displayed by the model it was unlikely that these tasks were solved by emulation. The concluded that their study “provides the best experimental evidence to date for deferred, imitative learning in chimpanzees” (p. 56).

Although in my opinion the ‘Do as I do’ studies (Bjorklund, et al. (2002); Custance et al, 1995; Hayes and Hayes, 1952) also show generalized imitation, the experiment is the first to show generalized imitation of actions with the use of tools.

The ‘Do as I do” methodology has not only been used with primates. Topal, Byrne, Miklosi, and Csanyi (2000) investigated whether a trained dog (an assistance living dog) could copy the actions of a human demonstrator. The dog was first trained to perform novel behaviours (behaviours he had never been taught) that corresponded to that of the demonstrator. For example, the dog’s cue for spinning in a circle was the demonstrator saying “Do it” and spinning in a circle. This phase was conducted so that the dog could recognise a human demonstration and become familiar with the rule and generalize it later.
to untrained behaviours. The dog was taught nine actions over the course of 10 weeks using operant conditioning. Once he reached 80% correct on all behaviours the testing phase began.

In behaviours in the testing phase 16 behaviours were chosen by action type (body-oriented, manipulative, etc.) and complexity (number and length of action sequences). In any one session no more than three complex or simple actions were given in a sequence.

Topal et al. (2000) found that overall the dog matched the human demonstrator’s actions. In a second experiment Topal et al. (2000) tested the sequence of the action behaviours demonstrated in the first experiment. For example, in the first experiment, they had a behaviour in which there were two shoes on the floor. The demonstrator would pick up the shoe and drop it off at a given area. The observer would then pick up the second shoe and drop it off at a given area. The problem with this method is that the researcher couldn’t test the dog’s ability to copy the details from start and finish. The dog could have just picked up the last shoe and drop it near the other shoe, and wasn’t actually imitating the behaviour.

Thus in the second experiment they had several areas set up with objects so that they could test the accuracy of the imitative behaviour on these tasks. The observer watched a demonstrator take an object from one area and place it in another area. The object could be taken from and placed in any group and position.

The researchers found that even though this methodology might not be the best to test imitation in dogs (since their body schema is very different from that of a human), the subject showed imitative ability. Matching of the demonstrations was found 67% of the time. In the second experiment testing action sequences, they found that the dog picked up the object and placed it in the same location as the demonstrator more often than expected
by chance. The overall conclusion is that the subject shows ability to imitate and is able to map human demonstrations onto its corresponding motor schemes.

1.4.2.3 Discussion

The methodologies that researchers have used to study imitation in human and non-human animals differ. For example, in human studies the two-action method is not used. This could be due to the fact humans have verbal behaviour and can be given instructions and asked questions. This was true of the participants in the experiments cited about, even if some were cognitively disabled.

The current review of the literature for the two-action paradigm, suggests that researchers have solved the procedural problems and can conclude that some animals can imitate (for a table of these results see Caldwell and Whiten, 2002 pg. 189-190).

Both animal and human research uses the “Do this” command in hopes to elicit an imitation response, however researchers from these areas name the procedures differently; behaviour analysis calls the procedure generalized imitation. There are however not only differences in the name, but differences in the procedure. In most of the animal studies of generalized imitation researchers have used a large repertoire of behaviours (11+ reinforced behaviours and 34+ un-reinforced behaviours), whereas in the human studies they used a few select behaviours (five reinforced and un-reinforced behaviours). In addition, in the human studies all of the reinforced and non-reinforced behaviours weremixed in a single session, whereas in the animal studies the reinforced and non-reinforced behaviours were given in separate sessions.

Custance et al. (1995) replicated the Heyes and Heyes (1952) study and argue that critics cannot explain the chimpanzees’ non-trained imitative behaviour as shaping because no food reward was provided for the behaviour. However, the authors did not consider that
their own attention might also be reinforcement for the behaviour. It is highly possible that since the subjects were enculturated with humans, the researchers’ reaction to the imitation or just their presence could have been a reinforcer for the chimpanzees. Nevertheless, this point was never explored by the authors.

For human imitation research Baer et al. (1964) concluded that imitation acquires conditioned reinforcing properties since it is often followed by reinforcement. Since this study two major limitations of the generalized imitation paradigm have been recognized. The first is limits to the behavioural repertoires of response types. Some of the subjects might not have been able to imitate the responses because these behaviours were outside the range of movements in their repertoires. Second, subjects might not have been discriminating between contingencies (Baer et al., 1964; Peterson, 1968; Brigham et al., 1968; Furnell & Thomas, 1976). There are other disputed confounds such as: other variables which are affecting discrimination like experimenter presence (Peterson et al., 1971; Wilcox et al., 1973) or the addition of a DRO (differential reinforcement of other behaviour) condition (Bucher, et al., 1974).

The disagreements concerning why generalized imitation occurs (or does not occur) may be attributable to procedural changes across the literature. For example, in the disagreement about whether experimenters’ absence affected un-reinforced responding, Bucher and Bowman (1974) used a variable ratio schedule of reinforcement whereas Furnell and Thomas (1976) used a continuous schedule of reinforcement. But the major difference in all of these studies is the instructions, which vary by amount given and type. For example, Wilcox et al. (1973) used a type of token procedure in which participants were told what increased the number of blue lights. Peterson et al. (1971) on the other hand, didn’t use this procedure and gave minimal instructions.
Because of the results of these studies some authors have attempted to broaden Baer et al.’s (1964) definition of generalized imitation. Peterson (1971) suggests “it would be simpler if the word generalized were restricted to those examples where it can be demonstrated that a single variable applied to one of two classes of behaviours is the controlling agent. The term un-reinforced may serve in other situations” (p. 125). Young et al. (1994) suggests that the definition of generalized imitation should be restricted to specific topographical boundaries of response type.

1.5 Location

According to the World Association of Zoos and Aquariums (WAZA) “zoos and aquariums are fully and actively integrated into the research community” (WAZA, 2005, p.20). However, a search in Web of Knowledge of the terms cognition and zoo bought up 18 hits, compared to a comparable search using the terms cognition and laboratory which brought up 554 hits. Though not thorough this does suggest that cognition studies are probably rarely undertaken in zoos, but occur mostly in laboratories. Yet zoos offer a unique research facility which has many benefits relative to other research settings in which animals can be studied. We would suggest there are three main reasons why zoos should be chosen to study cognition, as well as many other disciplines.

First, zoos offer researchers opportunities that they may not gain when collecting data in the field. For example, zoos house species that cannot easily be seen or studied in the wild, either because they exist in small populations, are hard to find, or incur large field study costs (Melfi, 2005). In zoos, individual identification of subjects is usually quite easy, facilitating data collection and increasing the scope of hypotheses which can be addressed, whereas many field studies struggle with individual identification and in consequence suffer from pseudoreplication issues (Hurlbert, 1984). Both zoo and field research can
suffer from limited sample size, but in zoos this can be ameliorated by collecting data from multiple zoos, termed multi-zoo studies (Mellen, 1991). The questions which can be addressed in zoo research are increased further given the long-term data which may be available in the form of records or studbooks for multiple populations and even generations. Studbooks are also a great source of information about captive animals including births, deaths, transfers, census data, mortality of infants and founder allele representation and retention, and this information is available across many generations which gives researchers a resource for variety of investigations (Melfi, 2006; Pullen, 2006). A variety of basic and applied topics can be looked at either within a species across zoos, with variations in the husbandry regime allowing the impact of environmental variables to be assessed or across species within a zoo, with reasonably consistent husbandry regimes allowing species differences to be brought into focus (see Melfi, 2005).

Second, zoos offer opportunities that may not be available when data are collected in the laboratory. Zoos offer a more naturalistic environment compared to laboratories, and therefore may provide more meaningful results (Melfi, 2005). In fact, unlike laboratory housed animals, modern zoo populations have shown similar activity budgets to their wild counterparts (Melfi and Feisnter, 2000), increasing the value of research conducted in this type of setting. Data collected in laboratories can be quite erroneous and an artefact of the highly standardised housing and husbandry (Wurbel, 2007). Furthermore, the subjects available for study in laboratories are limited as is the flexibility of changing their housing and husbandry conditions due to licensing and other considerations. In summary therefore, zoos should be considered as increasing the opportunities to undertake basic research with a larger number of species that would otherwise not be available.
Finally, zoos offer a unique training venue for future field or laboratory researchers. Students can learn and observe specific behaviours displayed in a wide range of species with minimum time and financial costs, compared to those incurred in field studies or specialised research laboratories housing unusual species. Students can also learn data collection methods and implement them in research projects that they have created. It should also be noted that research in zoos frequently has an immediate application both to the welfare of the animals in the zoo and to the conservation of their conspecifics in the wild (Hosey, 1997; Melfi, 2005).

Inevitably, there are also disadvantages to collecting data in a zoo that may discourage researchers from using this environment; for the most part these are methodological in nature. The most difficult disadvantage to overcome is zoo management’s unwillingness to allow manipulations of the animals’ environment. This is mainly due to the differences in priorities between the zoo and the researchers (Hosey, 1997): The zoo’s priority is the welfare of the animals while the researcher’s priority is the integrity of the methodology. Thus certain variables may be difficult to control. These variables include but are not limited to: nutritional content of food, number of feeds/day, times of day fed; enclosure parameters, including size, complexity, access by the animals to different areas, removal or addition of members or entire groups; the provision of enrichment or husbandry training; and presence and type of zoo visitors and other animals in adjacent enclosures (Hosey, 1997).

Although these disadvantages are present currently, they can be ameliorated and overcome with some methodological changes. Overcoming these methodological difficulties allows interesting and advantageous research in a wide range of research topics to be undertaken in zoos. Research undertaken in zoos can be highly varied, not only
including traditional topics such as conservation and animal welfare, but also supporting other areas like cognitive research, parasitology, and nutrition (for examples see Melfi, 2007; Horton and Caldwell, 2006).

We feel that one of the topics that would benefit from the naturalistic setting and the wide range of species maintained in zoos is research on social learning.

1.6 Subjects

Only species that naturally live in social groups were chosen for this thesis. Since the topic is social learning, choosing species that would be more likely to learn from watching their conspecifics was the most logical. This thesis was naturally split further into studies of domesticated animals and primates. Primates were chosen because as far back as Thorndike, scientists have thought that primates were the key to finding human-like behaviours within the paradigm of social learning. Domesticated animals were studied because researchers have found that chimpanzees have had extensive contact with humans are better imitators than their wild-born conspecifics, suggesting that experience with humans play a substantial role either in enhancing imitative performance or in generating imitative ability (Heyes and Galef, 2004); there is also the possibility that genetic adaptation to domestic condition has led to a greater tendency to imitate humans (Heyes and Galef, 2004).

1.6.1 Primates

Three species of primates were chosen; two Old World and one New World. These species were chosen not only for their natural living arrangements, but also for their possible cognitive abilities.

Goeldi’s monkeys (*Callimico goeldii*) are believed to live in small family groups of three to ten individuals in the wild, all of which assist in infant caretaking (Garber & Leigh,
In captivity, Goeldi’s monkeys are most successful living in breeding pairs with their offspring (Pruett-Jones, 1998). In these groups infants learn what to eat from the female and juveniles learn from watching group members’ proper parental and sexual roles (Heltne, Wojcik and Pooke, 1981). Young juvenile males that were separated from the group before learning these behaviours sired offspring but did not help in the raising of the offspring (Heltne et al., 1981). Furthermore, females taken from the group were also found to be inept parents. These observations suggest that Goeldi’s monkeys might learn through types of social learning. As far as we know they have not been used in an experimental setting to study social learning and the research on other species in their subfamily have shown mixed results (see chapter 3).

As well as social learning, callitrichids have also been found to possess other cognitive abilities. One of these abilities is tool use. Beck (1980) defined tool use “as the external employment of an unattached environmental object to alter more efficiently the form, position, or condition of another object, another organism, or the user itself when the user holds or carries the tool during or just prior to the use and is responsible for the proper and effective orientation of the tool” (pg. 10). Researchers have been investigating tool use in a wide range of species since at least Köhler’s (1925) research on chimpanzees. In primates, researchers have not only looked at how they used the tool and which tools they prefer using, but also if they can distinguish between tools usefulness based on their design.

A number of tool use studies have been conducted with New World monkeys (although it can be argued that some of these wouldn’t be considered tool use by Beck, 1980’s definition). Hauser (1997) gave cotton-top tamarins (Saguinus oedipus) a choice between identical canes (straight sticks with a hook at the end) with the food either presented inside or outside of the hook. The subjects preferred the cane with the food in the hook and the
authors theorized that the reason why they preferred this was because it minimized the motor movement needed, expending less energy. After this condition, the authors then tested for generalization to novel canes. They placed canes that varied in size, colour, shape, texture and material to see which ones the subjects would pick out. They found the tamarins chose tools on the basis of their purpose (to pull in the food). Hauser concluded that tamarins seemed to have a concept of at least some of the function involved in using the canes as tools.

In 2002, Hauser followed up this study with naive infants using the same methodology and showed that the ability to distinguish between functionality could be innate. However, because spontaneous use of tools in the wild or captivity has not been seen in tamarins or marmosets (Spaulding and Hauser, 2005), some researchers suggest that an alternative explanation is that the tamarins learned about the tool’s function by trial and error during the placement of the food condition (Cummins-Sebree and Fragaszy, 2005; Spaulding and Hauser, 2005). So to test this theory Spaulding and Hauser (2005) replicated Hauser’s methodology without the test phase (placing the food in and out of the hook in the cane). Spaulding and Hauser (2005) used both cotton-top tamarins and common marmosets (Callithrix jacchus) and found that neither species was capable of selecting the “optimal” tool. However, they did find that the marmosets reached above chance levels as the sessions increased, showing that they could learn which tool to use. Spaulding & Hauser (2005) argues that these findings are supported by a study that found a positive relationship between neophobia and using tools (Day, Coe, Kendal, and Laland, 2003). In this study they gave 7 species of callitrichids both natural tasks (taking a peanut out of the shell or opening a bird’s egg) and artificial tasks (opening opaque boxes) to see if species that depend on manipulations and explorative foraging are less neophobic than species that are
less mobile and less manipulative. They found species that are more explorative (lion tamarins, *Leontopithecus*) were less neophobic compared to species that are less mobile (marmoset, *Callithrix* and tamarins, *Saguinus*).

Santos, Miller and Hauser (2003) showed tamarins different shaped and coloured tools to find out further if tamarins need to have physical experience with the tool to understand which properties are important. In this procedure they showed tamarins an L-shaped tool, a different coloured L-shaped tool and a straight tool (not functional) to see which tool they attended to more. They found the tamarins attended to the more functional tool more than the colour of the tool even when they didn’t have access to the tool.

Diana monkeys (*Cercopithecus diana*) live in large groups of 15-30 normally consisting of a single male, and a number of adult females (both related and unrelated) and their offspring (Bshary and Noe, 1997). Although to our knowledge social learning in Diana monkeys has not been explicitly tested, Diana monkeys have been found to follow the gaze of a conspecific in a photograph to obtain a toy (Scerif, Gomez and Byrne, 2004). Diana monkeys have also been found to inform nearby hearers about the nature and have different calls for different predators, a behaviour they learn by social interactions (Zuberbühler, Noe and Seyfarth, 1997). Furthermore, data shows that Diana monkeys learn the alarm calls of other species (Zuberbühler, 2000). These data suggest that Diana monkeys might have the capacity to learn manipulative behaviour from conspecifics as well and thus would be suitable candidates for this thesis.

Sulawesi black crested macaques (*Macaca nigra*) were the third primate studied in this thesis. Depending on the location Sulawesi black crested macaques live in groups of between 5 to 97 individuals (O’Brien and Kinnaird, 1997; Feistner, 2000). Field studies have found evidence of highly social behaviour among groups of Sulawesi blackcrested
macaques (Baker and Estep, 1985; O’Brien and Kinnaird, 1997). However, to our knowledge there has not been a study of social learning or cognitive abilities of Sulawesi black crested macaques.

There have, however, been studies of social learning with other species of macaques. Researchers studied Tonkean macaques (Macaca tonkeana) in two studies for evidence in social learning (Ducoing and Thierry, 2005). In the first study juveniles were allowed to watch their mothers eat novel fruits and then given access to these fruits. There was no evidence that the juveniles learned feeding technique socially from their mothers in this setting. A second study was conducted to see if these subjects would learn socially if given “innumerable chances for observing conspecifics’ behaviour” (pg.116). They found that the macaques did pick up carrot feeding technique from members of their group, showing that they are capable of some forms of social learning.

Tonkean macaques were seen to learn how to use a tool in a semi-free environment. Researchers observed one group member place a branch against the wall, climb it and then sit on the top of it. Over the course of a year three other members acquired this behaviour. Unsure how they acquired the behaviour, the researchers wanted to see if they could cause the social transmission of this behaviour to other members of the group in a more controlled setting (Ducoing and Thierry, 2005). The researchers let four naïve observers watch a demonstrator use the pole to obtain food. They found that although the observers were to learn the behaviour after being trained, they did not learn the behaviour after watching a conspecific demonstrator for 20 trials.

In another species of macaque, rhesus macaques (Macaca mulatta) were found to imitate facial movement of humans (Ferrari, Visalberghi, Paukner, Fogassi, Ruggiero, Suomi, 2006). Researchers studied three day old rhesus macaques and showed them five
different human facial gestures for 20 s preceded by a neutral face for 20 s they found that the macaques would imitate two (mouth open and tongue protrusion) of the five facial gestures. To our knowledge this is the only study that has shown imitation in macaques.

In addition to tool use, macaques have been found to possess other cognitive abilities. An example of this is numerical abilities. According to Judge, Evans and Vyas (2005), one of the most convincing series of experiments with nonhuman primates is a series of experiments on rhesus macaques by Brannon and Terrace (2000). In their experiments the subjects had to place stimuli (pictures and dots of various sizes) in decreasing or increasing order with quantities of 1-9. They showed that rhesus monkeys trained to discriminate between numbers 1-4 and generalized this behaviour to numbers 1-9. They also found that monkeys’ relied on the numerical attributes of stimuli to determine the correct order of responding on both ascending and descending sequences” (Brannon and Terrace, 2000, pg. 43).

Washburn and Rumbaugh (1991) studied ordinal judgements of numerical symbols in a group of rhesus monkeys. In this experiment they showed the subject a set of two Arabic numbers that were placed 5 cm apart. By manipulating a joystick the subject could choose a number (0-9) and thus would receive the number of pellets that corresponded with the value they had selected (e.g. if they chose Arabic number 5, they would receive 5 pellets). The authors found that rhesus monkeys learned quickly that the Arabic numerals were associated with different quantities of food. In addition they displayed a proficiency at ordering and discriminating quantities, thus showing ordinal judgement.

Hauser and colleagues conducted research to see if rhesus monkeys could add and/or subtract. Hauser, Carey, and Hauser (2000) provided evidence for rhesus monkeys’ ability to add. In this study, subjects were given one trial in which they could watch a
different amount of apples placed in one of two boxes, after which they could approach and eat from one of them. In order to calculate which box contained the most apples, subjects had to keep the information in their working memory because they could not see the pieces of apple being placed in the box after the first trial (Sulkowski et al., 2001). The authors found that the subject picked out the larger amounts when given values up to four. Furthermore, they did not choose the larger amounts when given values larger than five. Using the same method Sulkowski et al., (2001) studied subtraction in a semi-free ranging group of rhesus monkeys. The authors showed the subject two platforms with varying amounts of plums. They then obscured the view of the subject and took a plum from one side, leaving the other side with either no plums or fewer plums then and took data on which side the subject approached. To control for the subject choosing only the side in which a plum was removed, they also showed the subject platforms where one side had less plums than the other. The investigator covered both platforms and then let the subject watch them take one plum from each side. They found that rhesus monkeys can subtract number of three or less (they didn’t test amounts bigger than three in this experiment).

1.6.2 Domesticated Animals

In addition to primates, we also studied three species of domesticated animals (dogs, elephants, and camels).

Domestication is a phylogenetic process involving both natural and artificial selection. In the process of exploiting humans as a food source, individuals came to tolerate human companionship and in the process may increase their after biological fitness this is a process of natural selection. In addition, some traits may be preferred by humans and thus are chosen through artificial selection.
There is much debate about what distinguishes domestication from the kind of taming or training which can take place when wild animals have a close relationship with humans (Zeder, 2006). The main topic in this debate is the difference between four discriminable types: tame domesticated animals, individuals of domestic species that have returned to a wild lifestyle (e.g. feral dogs), or wild-type-not domesticated- yet tame (animals that may be reared by humans or are tolerant of human approach), also referred to as encultured, non-tame wild animals, (Udell, Dorey, Wynne, 2008).

At the heart of this debate is a famous study begun by Dimitri Belyaev in the late 1950s. He found that a line of foxes bred from wild stock who were aggressive and fearful of human physical contract, but were exposed to intense human interaction, emerged after only the sixth generation as what he termed a “domestication elite” (Trut et al., 2004). The domestication elite were a group of foxes that did not form aggressive-fearful reactions to humans after repeated physical contact (Trut et al., 2004). If this is true in foxes it could be true for any species that is raised in captivity such as zoo housed animals.

This study also showed the domesticated animals showed evidence of morphological change, becoming more like domestic dogs in appearance. However, it is not universally accepted that such change is a requirement for a species to be regarded as domesticated (Zeder 2006). In the current thesis, we will define domestication as the relationship between humans and animals in which humans control all aspects of the protection, movement, reproduction and food (Clutton-Brock, 1994). Normally we would require that this level of control had been exerted for several generations, so that changes in behaviour may have been inherited. It should also be noted that although the particular individuals that were used in this thesis might not be considered domesticated (although
they could be part of a domestication elite); the species concerned all have the capability to be domesticated, and are domesticated to some extent in other parts of the world.

To our knowledge elephants and camels have not been studied in any experimental setting to investigate social learning. Although elephants have been tested in discrimination tasks (Markowitz, Schmidt, Nadal, and Squier, 1975; Savage, Rice, Branagan, Martini, Pugh, and Miller, 1994), to our knowledge camels have not been studied for any kind of cognition learning. We chose these species because of their history of close association with humans and because they both live in social groups.

Although dogs were studied in a different setting than the rest of the thesis, we felt that the oldest domesticated species should be included. Using this species allowed us to use a large number of subjects, impossible in the rest of the experiments described in the thesis because of the small group size typically maintained by zoos. A search in Web of Science turned up 710 articles on “dog learning”. Thus a complete review of the literature would be infeasible. However, dogs have been found to have a memory for objects (Kaminski, Fisher and Call, 2008); spatial memory (Fiset, Beaulieu, Leblanc and Dube, 2007) and be able to discriminate between different shades of grey (Pretterer, Bubnall-Littitz, Windischbauer, Gabler, and Griebel, 2004) and barks (Maros, et al., in press). Although dogs have not yet been found to imitate using the “gold standard” two action methodologies they have been studied for the presence of social learning. Past research has found dogs learn from stimulus/local enhancement (Pongracz et al., 2001, 2003, 2005; Kubinyi, Topal, Miklosi & Csanyi 2003), social facilitation (Range, Viranyi and Huber, 2007); and imitation (Topal, Byrne, Miklosi and Csanyi, 2006).
1.7 Discussion

One of the intentions of this thesis is to expand on current methodologies so that they can be used in different settings. More specifically, the research will aim to find ways of studying social learning from a psychologist’s point of view in a zoo setting. Current zoo husbandry policy at many zoos state that separating social animals, even for a short time period, is to be avoided. Thus these methodologies need to be changed to accommodate animals that cannot be separated. To solve this problem, we propose to train a demonstrator in the group to perform two different behaviours in the presence of two different stimuli. This will allow all the subjects to stay with their group and by having certain behaviours performed in the presence of a particular stimulus, will help differentiate imitative learning from other forms of social learning. Furthermore, to deflect the criticism that the behaviour that is imitated should be novel and often is not (see Miklosi, 1999), we will first take a baseline in the presence of the stimuli being used, so that we can determine what behaviours the subjects emit in the presence of the stimuli and choose different behaviours. This way we can be sure that the behaviours we choose are not the spontaneous behaviours of the subject and therefore reduce the risk of claiming as imitative behaviour that is not even novel in origin. Secondly, we will be using strict definitions for the individual behaviours themselves (i.e. detailed descriptions of the model’s and the observer’s behaviour) so that there is no question about how comparable they are to each other.

In addition to expanding on the settings used in social learning research within psychology, we would also like to expand on the limited number of species used. Subjects currently claim to have found imitative learning do include a good range of species: rodents [rats (Heyes and Dawson, 1990)], birds [quails (Akins and Zentall, 1996), starlings
(Campbell, Heyes, and Goldsmith, 1998), ravens (Fritz and Kotrschal, 1999), carib grackles (Lefebvre, Templeton, Brown and Koelle, 1997), pigeons (Zentall, Sutton and Sherburne, 1996), budgerigars (Dawson and Foss, 1965; Galef, Manzig and Field, 1986), apes [chimpanzees (Whiten and Custance, 1996; Hayes and Hayes, 1952), gorillas (Byrne and Byrne, 1993), orang-utans (Russon and Galdikas, 1993)], monkeys [marmosets (Bugnyar and Huber, 1997), capuchins (Custance, Whiten and Freidman, 1999)], and cetaceans [dolphins (Bauer, and Johnson, 1994)]. However, most of these studies have been criticized by other researchers in the field (for a list of criticisms, see Caldwell and Whiten, 2002). Only a handful of species, namely pigeons (Zentall, Sutton, and Sherburne, 1996); Japanese quail (Akins and Zentall, 1996); chimpanzees (Custance, 1999; Hayes and Hayes, 1952); and marmosets (Vökél and Huber, 2000) have been subjects in studies where results of these have been accepted by more than one researcher (Caldwell and Whiten, 2002). So not only does this literature concentrate on a small group of species, which are mostly primates and common laboratory species (birds and rodents), this group is decreased even more by the criticism of other researchers in the field. To supplement the current literature, we plan to broaden the research available by expanded the diversity of species to include larger mammals (elephants and camels) and complement the current literature with other primates (Goeldis’ and macaques). In addition, although some of my chapters will be based on single animal studies, a majority of them will be conducted in larger social family groups, which will add to the diversity of current literature available. It has been suggested by some researchers that social learning may be a skill adapted for group living (Lefebvre and Giraldeau, 1996; Lefebvre and Helder, 1997), so it might not be shown by animals that are individually housed or that naturally live in isolation.
Another opportunity this research offers is helping to advance the animal cognition literature by introducing the idea of imitation as an operant class. The field of behaviour analysis, where most of the research on human imitation has emerged, uses similar methodologies as animal cognition, but the two fields are not referencing each others’ research. In particular, the methodological rigour of behaviour analysis should be helpful when examining a concept that has proved elusive in the way imitation has. For example, if a reinforcer follows directly after the first instance of an imitative behaviour subsequent occurrences of that behaviour should then be considered operantly conditioned, rather than imitative, if reinforcement was given to the observer (which wasn’t the case in our experiments). Imitation research in animal cognition has been found that imitation will only occur if a food reward is to follow (Lefebvre & Palameta, 1988; Heyes et al, 1993; and Akins & Zentall, 1996). Researchers in behaviour analysis have avoided reinforcing behaviour they consider to be imitative. In fact Baer and Sherman (1964) found that in humans, unreinforced generalized imitation can be used to identify the functional relations between a model and an imitator, and to emphasize the fact that many different responses of a model are often copied in diverse situations, sometimes in the absence of extrinsic reinforcers. Baer and Sherman (1964) stated that in generalized imitation, imitation itself is a functional response class or higher order operant. When behaviours form a group in this way, all behaviours in the group, even if not individually reinforced, will follow the contingencies corresponding to the group rather than the contingencies set up for that individual behaviour. One of my goals is to use this well defined criterion to examine the possibility of generalized imitation in an animal cognition setting.

To summarize therefore: in this thesis we hope to not only expand the social learning literature by drawing links to the field of behaviour analysis, but also to expand on the
range of settings and species studied in this discipline. In addition, we intend to develop
the methodology so that imitative learning research can be conducted in settings outside the
laboratory without the need to separate animals from their social groups. All of the above
will aid and supplement my overall topic, in which we hope to ask if, in the species studied,
imitative behaviour, generalized imitative behaviour and higher order operants can be
observed.
CHAPTER 2

Evidence of social learning in Diana monkeys and Sulawesi black crested macaque

2.1 Introduction

The aim of this study is to increase our knowledge of which species may show imitation, by studying two zoo housed Old World monkey species, Diana monkeys (Cercopithecus diana) and Sulawesi black crested macaques (Macaca nigra), neither of which have been the focus of imitation research previously.

For over a century, researchers have discussed the possibility of imitative learning in animals. Some of the first studies which claim to observe imitative learning are the classic studies where geographically isolated animals are found to possess behaviours not seen in their conspecifics who reside in other regions (for classic examples see, Fisher and Hinde, 1949 and Kawai, 1965). However, there is not a lot of additional data to support these finding and many field researchers find it difficult to show conclusive evidence for imitative learning through observation alone (van Schaik, Ancerenaz, Borgen, et al, 2003). This is probably why the majority of research on imitative learning, to our knowledge, has been conducted in laboratories, where the subjects are separated from the rest of the group and the investigators can control for many extraneous variables. By controlling the environment in the laboratory so tightly, the mechanisms controlling behaviour may appear clearer, but animals do not live in environments where one or two variables change at any given time. As a result these studies might not represent behaviour that would be shown in the subjects’ natural environment.

The majority of research on imitative learning has studied a few species of primates, birds, rats and dolphins (see for a full review). This study investigates imitative learning in two family groups of primates; Diana monkeys (Cercopithecus diana) and
Sulawesi black crested macaques (*Macaca nigra*). These species were chosen not only because they live in naturalistic social systems and living condition, but also because they may possess higher cognitive abilities.

Diana monkeys live in large social groups of 15-30 individuals (Bshary and Noe, 1997). Although to our knowledge research on social learning in Diana monkeys has not been explicitly tested, but they have been known to watch other conspecifics in their group (Scerif, Gomez and Byrne, 2004) and learn certain behaviours via social responses from conspecifics (Zuberbuhler, Noe, and Seyfarth, 1997) and other species (Zuberbuhler, 2000). Sulawesi black crested macaques (*Macaca nigra*) live in groups of between 5 to 97 individuals; though this varies according to food availability (O'Brien & Kinnaird 1997; Feistner, 2000). Field studies have found evidence of highly social behaviour among groups of Sulawesi black crested macaques (Baker and Estep, 1985; O’Brien and Kinnaird, 1997). Although there has not been any study of social learning or the cognitive abilities of Sulawesi black crested macaques, research on members of the same genus has shown that animals do learn certain behaviours from conspecifics (Tonkean macaques (*Macaca tonkeana*); Ducoing and Thierry, 2005) and from watching humans (Ferrari, Visalberghi, Paukner, et al. 2006). Therefore previous data suggest that these two species might have the capacity to learn manipulative behaviour from conspecifics and thus show imitation.

The present study combined the use of a free-living environment (naturalistic zoo environment) to conduct the research, using the two-action methodology which has been studied and validated extensively in laboratory conditions (see Dawson and Foss, 1965; Akins and Zentall, 1996). Currently, the two-action methodology is considered the most appropriate way to study imitative learning (Kaiser, Ochsenfeld, Lee, and Suits, 1997; Campbell, Heyes, and Goldsmith, 1999). This method uses two demonstrators who are
trained to operate a manipulandum using different parts of their body, e.g. to open a container with foot or mouth, for which they obtain a reward. Naïve animals (observers) are divided into two groups. One group watches the first demonstrator operate the manipulandum using one method (e.g. open with foot) and the other group watches the second demonstrator operate the manipulandum using the second method (e.g. open with mouth). After the two groups of observers have watched the demonstrators, they are given access to the manipulandum and observed. If more observers operate the manipulandum using the method they saw the demonstrators’ use, more often than an alternative method, the researcher concludes that imitation by the observers has occurred. In the current study a demonstrator was trained to perform five behaviours with either his mouth or hand to various parts of a console. Behaviour was only considered imitative if the observer’s behaviour occurred immediately (within 20 seconds) after the demonstrator performed the behaviour and if it resembled that of the demonstrator. For example, if the cue for choke behaviour was given and the demonstrator pulled the choke out and in, he obtained a reward. If the observer immediately performed the same behaviour, before performing any other console-directed behaviour, it was considered imitative.

2.2 Method

Subjects, Setting and Apparatus

Three Diana monkeys (*Cercopithecus diana*; a breeding pair and their female infant) and 12 Sulawesi black crested macaques (*Macaca nigra*; one breeding male, 5 adult females, 5 juveniles and an infant), were studied at the Paignton Zoo Environmental Park, Devon, UK. Both species were housed in enclosures with inside and outside areas. All experiments took place in the inside area, though throughout this time the animals had access to all areas of their enclosure.
The Diana monkeys’ inside enclosure measured 8m x 12m x 10m and contained a tyre swing, a rope hammock, various enrichment items, and a pool that was either empty, filled with water, or filled with enrichment items. The Sulawesi black crested macaques’ inside enclosure measured 8m x 12m x 10m and contained various rope hammocks, various enrichment items, and a pool that was filled similarly to the Dianas’ pool.

Procedure

The responses of all monkeys with the consoles were observed and recorded during:

i) baseline sessions (n = 10), when both consoles were available to all the monkeys, but responses were not reinforced;

ii) Training sessions, when the dominant male (demonstrator) from each group was trained by successive approximations (using grapes as a reinforcer) to perform five different responses directed at the left console in response to distinct cues; the number of training sessions varied according to how long it took to train the demonstrators each behaviour (see Table 2.1). The dominant male was chosen because he would have dominated the apparatus anyway, steeling any food the demonstrator received, and because his is most likely the member of the group that all members of the group watch. The behaviour was considered to be trained once the demonstrator performed the behaviour in the presence of the cue 10 times in a row.

iii) Experimental sessions (n = 10), where a cue for the different trained behaviours was given to the demonstrator. For each session the behaviour was given for an equal duration (i.e. if we presented two behaviours they were presented for 5 min each, if the session had all five behaviours each behaviour was presented for 2 min each). Each correct response was reinforced with a grape. The demonstrator was the only subject that was rewarded with food for responding with the correct behaviour directed at the correct console.
iv) Control sessions (n = 5), in this phase the session was conducted exactly like the experimental phase. The difference was that the demonstrator was not present in the inside enclosure, but lured outside; if he did come inside the session was suspended and restarted after he had left. Grapes were given before the session began so that the others in the group would approach the consoles. During these sessions grapes were given for any interaction with either console, because experimental session was over this had no effect on the observers behaviour.

<table>
<thead>
<tr>
<th>Cue for demonstrator</th>
<th>Picture on index card</th>
<th>Part of body trained to use</th>
<th>Definition of behaviour</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gear</td>
<td>Blue circle</td>
<td>hand</td>
<td>All digits flat on the gear moving it in a vertical downward direction.</td>
</tr>
<tr>
<td>Choke</td>
<td>Green triangle</td>
<td>hand</td>
<td>Digits touching the choke lever and moving it in a horizontal direction out and in (toward and away from their body), in one motion.</td>
</tr>
<tr>
<td>Orange horn</td>
<td>Orange star</td>
<td>hand</td>
<td>All digits or palm touching the horn and pushing it in (away from their body) until the horn sounded</td>
</tr>
<tr>
<td>Red wheel lever</td>
<td>Yellow arrow</td>
<td>hand</td>
<td>Digits touching the red wheel lever and moving it horizontally from side to side (across their body) in one motion.</td>
</tr>
<tr>
<td>Red music button</td>
<td>Red square</td>
<td>mouth</td>
<td>Lips pushing the button until the music either turned on or off.</td>
</tr>
</tbody>
</table>

Table 2.1: List of behaviours, description of picture cues and part of body trained.

Sessions lasted for 10 minutes. During baseline the session began when any subject (demonstrator or observer) touched either console or 2 minutes after the console was
attached to the wire windows, whichever came first. Training and experimental sessions began when the demonstrator correctly touched the left console with the correct part of the manipulandum (i.e. choke) with the correct part of his body.

Each behaviour was first trained as a free operant (meaning it was not associated with any cue or stimulus) and expression of the desired behaviour was rewarded with a grape. Once the demonstrator responded several times a cue was introduced and thereafter the behaviour was only reinforced after the appropriate cue had been given. The stimuli used for cues were visual delivered via cards, which showed different shapes and colours for the different responses (Table 2.1). Once the behaviour occurred reliably on cue, the behaviour was added to the pool of already trained behaviours. When the probability of making the newly added behaviour on cue within the context of other trained behaviours reached 90%, training of the next behaviour began. This procedure continued until all five behaviours occurred reliably on cue.

Apparatus

Two identical consoles were used for both species, measuring approximately 12.7 x 35.6 x 41.1 cm (see Figure 2.1).
Figure 2.1: An illustration of a console used. The five manipulanda the demonstrator was trained to manipulate are labelled.

They were brightly coloured plastic consoles, designed to be baby toys, which housed differently coloured and shaped objects which could be manipulated, affording the opportunity of making 23 different responses with the console. Preliminary observations suggested that these consoles were attractive to monkeys, without any obvious sex differences in the interest shown in them. Five of these responses were used in the present experiments; these are described in Table 2.1, and the parts of the consoles that they used to achieve these are shown in Figure 2.1. All responses the demonstrator performed could be achieved using either their nose or hand. Two consoles (40 cm x 30 cm width x 14 cm) were placed 56 cm apart in the indoor area, attached to the outside of a wire mesh window which still allowed the animals access to them; the windows were installed to allow operant conditioning of husbandry behaviours. One of the consoles (on the left hand side from the researcher’s point of view) was designated for the use of the demonstrator monkey. The remaining console (on the right hand side of the observer) was thus available.
to the observer monkeys, so could be used by the observer monkeys at the same time that
the demonstrator was interacting with ‘his’ console.

2.3 Results

Diana monkeys

The demonstrator was trained to perform five behaviours on cue. The number of
training sessions varied according to how long it took to train the demonstrator to perform
each behaviour. For the Diana monkey it took the demonstrator two sessions to train the
choke behavior, four sessions to train gear, seven sessions to train red music button, four
sessions to train orange horn, and three sessions to train red wheel lever.

Of the two observers in the Diana monkey group, one (Akea - the youngster) was
seen to imitate the demonstrator’s behaviour on the observer console (Table 2.2). Of the
five behaviours performed by the demonstrator, she was shown to imitate two of them (the
gear command $\chi^2 (1) = 11.54, p < 0.001$ and the choke command $\chi^2 (1) = 11.37, p < 0.001$).
Chi-squared values were calculated on the basis of the number of occasions when the
observer was the next animal to make a response after the demonstrator had made a
response. For each response class, the demonstrator’s behaviour could be divided into the
occasions when the response fell into that class and the occasions when it did not. The
observer’s behaviour could be divided into the same classes. A significant chi-squared
value indicates that the observer was more likely to make that response on occasions when
the demonstrator had made it.
Akea

<table>
<thead>
<tr>
<th>Cue given to demonstrator</th>
<th>Number of times the demonstrator performed the behaviour in the presence of the observer</th>
<th>Number of times the observer was the next subject to respond (less than 20 sec) after the demonstrator</th>
<th>Number of times the observer responded to other cues</th>
<th>hand</th>
<th>mouth</th>
</tr>
</thead>
<tbody>
<tr>
<td>Choke</td>
<td>116</td>
<td>21</td>
<td>5</td>
<td>11</td>
<td>5</td>
</tr>
<tr>
<td>Red music button</td>
<td>26</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Red wheel lever</td>
<td>56</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Gear</td>
<td>135</td>
<td>23</td>
<td>1</td>
<td>21</td>
<td>1</td>
</tr>
<tr>
<td>Orange horn</td>
<td>28</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>

Table 2.2: Number of times the Diana monkey, Akea, imitated the demonstrator; performed the appropriate behaviour with the correct body part and the incorrect behaviour with the wrong body part immediately (20 sec.) after the demonstrator performed the behaviour. It also shows the number of times the demonstrator performed the behaviour in the presence of the observer; the number of times the next one to respond was the observer and of the responses the number of times those responses were to other cues. The other Diana monkey showed no imitative learning.

In the control phase, Kasi (the breeding female) performed the correct behaviour for the cue given. She touched the correct manipulandum (gear) and used the correct part of body, however her performance occurred below chance at 14%. Akea touched the console once during this condition and did so incorrectly.

Sulawesi black crested macaques

The demonstrator was trained to perform five behaviours on cue. The number of training sessions varied according to how long it took to train the demonstrator to perform each behaviour. For the Sulawesi macaque demonstrator these behaviours it took four sessions to train choke, four sessions to train gear, two sessions to train red music button, six sessions to train orange horn, and four sessions to train red wheel lever.

Of the 11 observers in the Sulawesi black crested macaque group, two were seen to touch the console in a manner which fitted our definition of imitation (Table 2.3).
Table 2.3: Number of times the Sulawesi black crested macaques, Douglas and Aspen imitated the demonstrator; performed the appropriate behaviour with the correct body part immediately (30 sec) after the demonstrator performed the behaviour. It also shows the number of times the demonstrator performed the behaviour in the presence of the observer; the number of times the next one to respond was the observer and of the responses the number of times those responses were to other cues. The other Sulawesi black crested macaques (N=8) showed no imitative learning.

Other monkeys either remained away from the consoles during the experiment, or interacted with the console without touching the parts that the demonstrator wastrained to manipulate. The two monkeys (Aspen 6 months old and Douglas a year old) which did
imitate, matched the demonstrator’s behaviour for a few of the five behaviours performed by the demonstrator. Douglas imitated three of the behaviours performed by the demonstrator (the gear cue $\chi^2(1) = 6.04, p < 0.01$, hand to red wheel lever cue $\chi^2(1) = 32.31, p < 0.0001$, and mouth to red music button cue $\chi^2(1) = 13.91, p < 0.0002$). Whereas Aspen imitated two of the behaviours, but his behaviour was not significant $\chi^2(1) = 1.46, p < 0.2$ for gear and $\chi^2(1) = 1.91, p < 0.1$ for red wheel lever.

In the control phase, three (Jasmine, Puzzle and Teak) of the 11 observers performed the correct behaviour for the cue given. Only 2 observers (Teak and Puzzle) were truly successful, touching the correct manipulanda (gear and red wheel lever) with the correct part of body (hand). The other observers (Jasmine) touched the correct manipulandum, but did not use the correct part of body. All three fell below chance with the highest percentage being Teak at 17% of the times he touched the apparatus being correct. Interestingly, none of these observers showed imitative behaviour during the experimental phase.

2.4 Second experiment

Since we observed imitative learning in the first experiment with both species we wanted to see if we could observe generalized imitative learning. Generalized imitation has been used to identify the functional relations between a model, and an imitator and to emphasize the fact that many different responses of a model are often copied in diverse situations sometimes in the absence of extrinsic reinforcers. Generalized imitation has mainly been studied using the “do as I do” methodology (Baer and Sherman, 1964; Hayes and Hayes, 1952; Custance, Whiten, and Bard, 1995). In this methodology, an experimenter trains a subject to copy his/her behaviour (e.g. sticking the tongue out). Once the subject is reliably copying some behaviours performed by the experimenter, they are
then shown a novel behaviour to see if they will copy it. Previous research has shown that human infants are very good at this and will readily imitate an adult demonstrator between 92%-98% of the time (Poulson and Kymissis, 1988). Although chimpanzees (*Pan troglodytes*) have also been found to readily imitate humans, studies have shown that they only imitate the general actions of a behaviour they observe and don’t seem to master, perform, the exact details of the behaviour; for example when the experimenter touches his nose with his index finger, an chimpanzee may touch his nose with this whole hand (Custance, Whiten and Bard, 1995).

The purpose of the current experiment is to see if we could train one of the observers to imitate the demonstrator (perform the same behaviour they were observing) and whether the observer would then generalize this ‘concept’ and imitate other behaviours displayed by the demonstrator.

*Method*

In this experiment the observers were trained to imitate one of the behaviours of the demonstrator. The demonstrator in this experiment was the same as that of the first experiment. Sessions were similar to those in the experimental condition of the first experiment. However, the main difference was that one subject from each species was chosen as the observer (Douglas for the Sulawesi macaques and Akea for the Diana monkeys) instead of the entire group as in the first experiment. These subjects were chosen because they had the highest rate of imitative behaviours for their group.

The behaviour chosen was one that had not been imitated in the previous phase; therefore choke (for both subjects), red wheel lever (for Douglas), red music button (for Douglas), and gear (for both subjects) were excluded from the selection.
Douglas and Akea were trained by using successive approximation and positive reinforcement. After the behaviour was occurring readily, the experimental condition began. The experimental condition lasted 10 sessions. Akea was rewarded for touching the red wheel lever on the right console with her hand while the demonstrator was performing this behaviour on the left console. Douglas was rewarded for touching the orange horn on the observer console with his hand while the demonstrator was performing this behaviour on the left console.

**Results**

Douglas correctly performed the trained behaviour after the demonstrator a total of 14 times across all 10 sessions in the experimental condition after seeing it performed by the demonstrator 50 times. However, the behaviour extinguished after the third session and was not seen again in the following seven sessions in this phase. Douglas was not seen to imitate any of the other behaviours during this phase. Thus, generalized imitation did not occur.

Akea correctly performed the trained behaviour after the demonstrator total of 13 times across the 10 sessions in the experimental condition. However, the majority of the responses occurred in the first three sessions, though there were five responses in the last session. In total Akea demonstrated one correct untrained behaviour, touching the orange horn with her hand. However, because it occurred only once we would consider this a chance event rather than a case of generalized imitation.

**2.5 Discussion**

We found imitation in two species of zoo-housed primate, that to our knowledge have not been previously tested for this cognitive ability. In both species, imitative
behaviours did not seem to depend on the total number of times the observers saw the demonstration. Rather, if imitative responding was seen at all, it emerged early in the demonstration condition, and if anything it faded away rather than growing stronger with more demonstrations. Although only a minority of the observers (two Sulawesi black crested macaques and one Diana monkey) spontaneously imitated some of the behaviours, these results demonstrate the ability for imitative learning within the species’ repertoire. However, this did not seem to generalize across behaviours even after these subjects were trained and given a reward for imitating the demonstrators’ behaviour.

To our knowledge, all previous studies that have used the two action methodology with animals have physically separated the demonstrator from the rest of the group; so the observer(s) watch the demonstrator perform the behaviour at a distance from them and can not physically influence or disrupt the observer. It is suggested that this separation is necessary to “reduce the effect of stimulus enhancement” (Miklosi, 1999, pg. 360), because some investigators believe that the definition of stimulus enhancement should include the sharing of the stimulus that the demonstrator manipulates or touches. However, the current study was conducted at a zoo, whose housing and husbandry is determined by different priorities, compared to laboratories, so we were not allowed to separate out the animals. For example, in zoos their primary concern is with the welfare of the animals’ in their care and have the long-term objective of releasing some animals from their collection, or their descendents, back into their natural environment. As such, animals are maintained in social groupings and the modification of these groups, i.e. separating animals, is only carried when it is considered to be in the animals’ best interests e.g. if they are ill or being moved to a new zoo. In the current study we did not, therefore, have the opportunity of separating the animals for the purpose of enhancing the experimental design, and controlling for
stimulus enhancement. However, we controlled the other forms of social learning in other ways. First we used two identical consoles, one exclusively used by the demonstrator and the other for the observers, thus controlling for stimulus/local enhancement. Second, the demonstrators were only trained to perform the behaviour as defined by its end result (e.g. moving the lever), we did not train specifics of the behaviour (e.g. how they moved the gears with their hands). Third, we made sure that we only counted behaviours as imitative if they matched exactly from what the demonstrator had performed. If the demonstrator used all five digits to move the gear around, then the observer had to do so as well for the behaviour to be considered to be imitation. Even though there could have been slight differences between demonstrator and observer, the reality was that the behaviours were similar, probably because it was a natural tendency to manipulate the console; because of this we felt that formal assessment of inter-observer was not necessary. This may seem to limit the number of behaviours the observer could perform which we would consider imitative, however it was thought necessary given that Miklosi (1999) states “since the presence of imitation has to be judged by the degree of resemblance to the model, methods based on a proper description of the behaviour are necessary. However, most published investigations lack such detailed descriptions” (p. 349). We also conducted a baseline condition to see what behaviours already appeared in the subject repertoire. By doing this we could ensure that the imitative behaviours chosen in the training and experimental phases were novel to the group and thus did not represent behaviours learnt prior to the study. This condition eliminated the need for non-observer controls, and made a stronger case that the changes in behaviour we observed were the result of the demonstrators being seen to perform this behaviours (Miklosi, 1999; Caldwell and Whiten, 2002). Even though the behaviours might not have been novel after they had been performed for the first time,
the fact that they were not in the subject's repertoire before the start of the experiment and that they did not receive reward after touching the apparatus, makes a strong case that the behaviour that we did find is imitative learning. All of these additional controls allowed us to conclude that the behaviour we observed was imitative learning and not another form of social learning.

In both groups the observers that were seen to imitate the behaviour performed by the demonstrator were juveniles. Whether the age of the animals which successfully imitated, was a contributory factor the performance of this phenomenon is hard to compare with previous experiments that have used similar methodology, because they either used only adults, do not state the ages of their subjects, or do not compare the results of the older and younger observers. This could be because the majority of the researchers in this field believe that most object manipulation tasks require considerable ability on the part of the observer and that this ability develop with age (Miklosi, 1999), thus not finding it important to test juveniles. However, juveniles may be more willing to change their behaviour so that they can learn new behaviour (Miklosi, 1999) or may be able to imitate to facilitate survival by enhancing their ability to learn which foods they can eat (Snowdon, 2003) and/or what food preparation and processing behaviours are needed to eat this food (Byrne, 1995) from more experienced conspecifics.

In addition to demonstrating imitation in two hitherto untested species, the current experiment has shown that, with a slightly altered methodology, research on imitation can be carried out in zoos, in animals’ normal living quarters. We believe that the benefits of being able to carry out research in this type of environment will outweigh the inconvenience of altering the methodology. Conducting experiments in zoos will allow the expansion of the currently limited variety of species in which imitation, along with other
aspects of cognition, has been studied. Conducting imitation research in zoos will also
allow the animals to be studied in a more naturalistic environment where social animals are
in physical contact with each other as they are in nature.

In the next chapter I sought evidence for social learning in Goeldi’s monkey, an
unusual callitrichine which belongs to a monotypic genus and has not hitherto been tested
in this way. A two-action methodology was used, however the apparatus needed to be
changed from that used in this experiment to fit the species in manipulability and size.
CHAPTER 3

No evidence of imitative learning in a callitrichine, Goeldi’s monkey (*Callimico goeldii*)

3.1 Introduction

As has been explained previously, social learning is the process by which behaviour by one individual can influence the future actions of the same or similar behaviour in another individual of the same species. In lay terms, all such social learning is grouped together as “imitation”. However, there are several distinct mechanisms that can underlie social learning, and in an attempt to clarify the interactions underlying the mechanisms involved within the broader term of social learning, scientists have defined terms like local enhancement, stimulus enhancement, imitation, etc. We will only describe the few terms that are pertinent to this study.

Probably the most frequently confused for imitation is local enhancement (Thorpe, 1956). Local enhancement is said to occur when the actions of the demonstrator draws the attention of the observer to a particular location. Similarly, stimulus enhancement is when the actions of the demonstrator draw the attention of the observer to a particular stimulus. In contrast, imitation (or “true imitation”) is defined by most researchers as “learning to do an act after seeing it done” (Thorndike, 1898) once “one has controlled for or ruled out the other underlying mechanisms” (Zentall, 2004, pg. 18).

The majority of social learning research in New World monkeys has been undertaken with capuchins (*Cebus apella*) (Fragaszy & Visalberghi, 2004). However, results have found little or no evidence of imitation. Capuchins do not imitate the actions of conspecifics or humans (e.g. Custance, Whiten, & Fredman, 1999; Fragaszy & Visalberghi, 2004), though Custance *et al.* (1999) report that they do show signs of other types of social
learning such as “object movement re-enactment”. Social facilitation can induce capuchins to eat, but does not alter their choice of food items (e.g. Visalbergi & Addessi, 2000). It has not been found that capuchins avoid toxic food from observing other members in the group (Visalberghi & Addessi, 2001) and infants do not learn about novel foods from adults (Fragaszy, Visalbergi & Galloway, 1997). Similarly a study with squirrel monkeys (Saimiri sciureus) found that although they learned to avoid noxious foods, it was most likely done by trial and error as there was no evidence of social learning among the group (Fairbanks, 1975; Boinski & Fragaszy, 1989).

Among callitrichines, however, the findings are very different. Golden lion tamarin adults (Leontopithecus rosalia) learn about noxious food by observing conspecifics, and tend to share unfamiliar foods with their offspring more often than familiar foods (Rapaport, 1999), perhaps a form of instruction to the young. Offspring are less likely to consume an unfamiliar food if they found it on their own, rather than being given it by an adult. Saddle-back tamarins (Saguinus fuscicollis) and red-bellied tamarin, (S. labiatus) both learn about what to eat by observing “knowledgeable” conspecifics (one who had already come in contact with the food) (Prescott, Buchanan-Smith & Smith, 2005). Cotton-top tamarins (S. oedipus) can learn to avoid a once highly preferred food which has been made unpleasant by the addition of invisible white pepper, by observing the reactions of other group members that avoid the now tainted food (Snowdon & Boe, 2003).

In addition to learning about noxious food, Caldwell and Whiten (2004) found that marmosets (Callithrix jacchus) learn object movement by observing conspecifics. In their study marmosets observed a trained conspecific either partially open or fully open an “artificial fruit”. The authors found that although the observers did not succeed in opening the device, the observers in the full demonstration touched the device more and in the
correct part of the apparatus compared to those that observed a partial demonstration and no demonstration conditions. Similarly, Voelkl and Huber (2000) found that marmosets \textit{(Callithrix jacchus)} after observing a trained demonstrator opened a canister lid with either their mouth or hand, would imitate the method demonstrated.

Differences in social learning, between callitrichinae and other cebids, may be attributable to differences in natural history, for example in group size or parenting behaviour (Caldwell & Whiten, 2004). Marmosets and tamarins live in small family groups of three to ten individuals, all of which assist in infant caretaking. In contrast, capuchins live in larger groups of six to forty individuals, where females raise their offspring on their own. Social structure in Goeldi’s monkey is more like that of the tamarins and marmosets than the capuchins (Garber & Leigh, 1997). Thus we believe that Goeldi’s monkeys are a useful species for investigating social learning. Those species of Callitrichinae that have been tested show unambiguous evidence for some forms of social learning, whereas other New World monkeys (including other members of family Cebidae) do not (see Rapaport, 1999; Voelkl and Huber, 2000; Fragaszy & Visalberghi, 2004; Prescott, Buchanan-Smith & Smith, 2005).

The purpose of the current study was to investigate if Goeldi’s monkeys, like other callitrichines, show imitative learning. Although Goeldi’s monkeys’ social behaviour have been observed both in captivity (Heltne, Wojcik & Pook, 1981) and in the wild (Masataka, 1981), their social learning has not been studied experimentally.

A version of the two action method was used (Dawson and Foss, 1965): different individuals in a social group were trained to perform different responses to different stimuli. This design allowed for experiments to be conducted without separating the individuals (not possible in the zoo environment where they were studied) or allowing the
dominant member of the group to monopolize the apparatus. It also allowed imitation, if it occurred, to be distinguished from other forms of social learning. Imitation was considered to have occurred if a monkey who observed a trained demonstrator’s performance of a response to a stimulus matched the same pattern of body part and behaviour toward a stimulus. If other forms of social learning, such as stimulus or local enhancement, occurs the monkey would perform an incorrect behaviour (or the behaviour they were themselves trained on) to a stimulus.

3.2 Method

Subjects and Setting

Four captive-raised Goeldi’s monkeys were studied at the Paignton Zoo Environmental Park: one male (Cork, 14 years old) and three females (Kink 21 years old, Tuff 7 years old, and Neat 8 years old). The only previous human contact the monkeys had experienced was during husbandry and veterinary procedures.

Data were collected and procedures carried out in the indoor area of their enclosure. The inside of the enclosure was 2m x 2.78m x 2.75m, with one wall made out of plexiglass (where visitors could view them), two of wood and one of chain link fence (which backed into the keepers’ access area). A deep litter substrate of wood chipping was provided, along with lots of natural perches (branches, ropes, etc.), a swing made out of tree bark, daily enrichment and two heat lamps. In addition all subjects had access to an outdoor enclosure and their morning feed during the entire experiment.

A platform (.82m X .39m) was placed in the enclosure on the chain link and several coloured targets were placed above it during the sessions. The targets were five Lego Duplo ® blocks of different colours and shapes, fixed to the fencing by a small chain and a latch.
The reason why the Legos differed in both shape and colour was to ensure that the differences between them were salient for all individuals. Goeldi monkeys have polymorphic colour vision, meaning that some individuals only have medium and long wavelength photo pigments (see Surridge et al., 2003). Although this should not affect the results of the study, it might make colour differences less salient to some individuals than others; the added shape differences were intended to offset any such effect. Preference assessment

A preference assessment (see Fernandez, Dorey, & Rosales-Ruiz, 2000) was performed to establish what food item would make the best reinforcer for the subjects while training them. Pairwise choices between mealworms, bananas, grape, bread, and mushrooms were provided, counterbalanced for side.

Procedure

In the beginning of the experiment, five sessions of baseline were conducted, in which all five targets were present, to see if there was any predisposition to interact with any of them. After this initial baseline each subject (with the exception of Kink) went through three conditions; baseline, training and observation. Since Kink was the first one to be trained, she did not have an observation condition. The method used was a multiple baseline across subjects design so subjects were in different condition at different times throughout the experiment. At the beginning of each new training condition one target was added to those available. Throughout the experiment different individuals were trained to respond to each target, though all individuals’ behaviour to all available targets was recorded (touches to the targets with any part of the body). Training sessions continued until the target behaviour was trained after which time the subject was in the observation condition and a new subject started training. Subjects not being trained remained in
baseline and were considered naive. The number of sessions, the targets presented, and the responses reinforced at each stage are shown in Table 3.1.

At the beginning of each session the appropriate numbers of targets were put in place. Sessions lasted 10 min. from when one of the subjects correctly touched their assigned target. In addition to the assigned targets a black square target was always present, for two reasons: 1) to ensure that even from the beginning, the subject who was being trained had to choose between two targets and 2) to allow the recording of any trained behaviours that might occur to it, as a measure of stimulus generalisation, bearing in mind that no behaviour towards it was ever reinforced.

Each of the behaviours was trained using successive approximations to the target behaviour. Each correct approximation was immediately reinforced with a conditioned reinforcer (click) and a primary reinforcer of a small piece of grape.

Kink and Neat were trained to touch targets with their hands, respectively a red vertical rectangular and a yellow horizontal rectangle. Handling was behaviourally defined as more than three digits from one hand touching the assigned target at the same time. Tuff and Cork were trained to touch targets (respectively, a green square and a blue square with a curved extension) with their noses. Nosing was defined as any part of the nose touching the target. Neat was initially trained to touch her foot to the yellow rectangular target, but it was found that she could not reliably do this through the chain link fence, so after a week, her target response was changed to handling.

The animals were trained in the order Kink, Tuff, Neat and finally Cork.
<table>
<thead>
<tr>
<th>Stage</th>
<th>Sessions took to train individual</th>
<th>Number of sessions before behaviour was stable and new target was added</th>
<th>Targets available</th>
<th>Subjects reinforced</th>
</tr>
</thead>
<tbody>
<tr>
<td>Baseline</td>
<td>no training</td>
<td>5</td>
<td>Black</td>
<td>none</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Red</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Green</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Yellow</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Blue</td>
<td></td>
</tr>
<tr>
<td>Kink training</td>
<td>1</td>
<td>7</td>
<td>Black</td>
<td>Kink</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Red</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Kink</td>
<td></td>
</tr>
<tr>
<td>Tuff training</td>
<td>4</td>
<td>53</td>
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</tr>
<tr>
<td></td>
<td></td>
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<td>Red</td>
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</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Green</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Yellow</td>
<td></td>
</tr>
<tr>
<td>Neat training</td>
<td>8</td>
<td>25</td>
<td>Black</td>
<td>Neat</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Red</td>
<td></td>
</tr>
<tr>
<td></td>
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<td></td>
<td>Green</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Yellow</td>
<td></td>
</tr>
<tr>
<td>Cork training</td>
<td>1</td>
<td>42</td>
<td>Black</td>
<td>Cork</td>
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<td></td>
<td></td>
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<td>Red</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Kink</td>
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<td></td>
<td></td>
<td></td>
<td>Tuff</td>
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<td></td>
<td></td>
<td></td>
<td>Neat</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Cork</td>
<td></td>
</tr>
</tbody>
</table>

Table 3.1: The number of sessions given, and the stimuli available, at each stage of the experiment.

The experimental design meant that each monkey had one trained response and one non-trained response, one target stimulus and four non-target stimuli. For one of the non-target stimuli (black), no monkey had been trained to make any response to it. For a second non-target, another monkey had been trained to make the monkey’s trained response to it. For the remaining two non-targets, another monkey had been trained to make the monkey’s non-trained response to it. As a result, every response to a target made could be classified into one of the following eight categories:

- Reinforced operant: the monkey’s trained response made to its target stimulus.
Generalized modelled response: the monkey’s trained response was made to a stimulus other than its target, when another monkey had been reinforced for making that response to that target.

Generalized non-modelled response: the monkey’s trained response was made to a stimulus other than its target, when no other monkey had been reinforced for making that response to that target. Such responses could be made either to a target to which another monkey had been reinforced for making the alternative response (there were two such targets for each monkey), or to the black target, which no monkey had been reinforced for contacting.

Incorrect response to own target: the monkey’s non-trained response was made to that individual’s target (so no other monkey had been reinforced for making that response to that target).

Non-generalized modelled response: the monkey’s trained response was made to a stimulus other than its target, when another monkey had been reinforced for making that response to that target. For each monkey there were two such stimuli.

Non-generalized, non-modelled response: the monkey’s non-trained response was made to a stimulus other than its target, when no other monkey had been reinforced for making that response to that target. Such responses could be made either to a target to which another monkey had been reinforced for making a different response, or to the black target.

If the monkeys are able to imitate, each kind of modelled response should occur at a higher rate than the corresponding kind of non-modelled response. If local or stimulus enhancement occurs, non-modelled responses should occur at a lower rate to the black target than to the other targets. On the other hand, if behaviour to non-target stimuli can be
explained by stimulus generalization, each kind of generalized responding should occur at a higher rate than the corresponding kind of non-generalized responding. Thus, this design allowed for the independent detection of stimulus generalization, stimulus enhancement, and true imitation.

3.3 Results

All four subjects were successfully trained to perform the assigned behaviour to their assigned target. Discounting the sessions spent attempting to train Neat’s foot response, subjects required 1 to 8 sessions to achieve their target behaviour. After training, the subjects were more likely to touch their assigned target and perform the correct behaviour than any other combination of events.

After counterbalanced preference tests between five food items for each of the Goeldi’s monkeys we found Neat preferred mealworms and grapes (both chosen 6 of the 8 times they were presented), Tuff favoured mealworms (chosen 7 out of 8 times they were presented) with grapes a close second (5 out of 8), Kink chose both bread and grapes (both 7 out of 8 times they were presented) and Cork chose mealworms (6 out of 8 times they were presented) with grapes a close second with (5 out of 8 times they were presented).

Thus we chose grapes as the food to use as a reward because all monkeys chose them as either their first or second choice.

All monkeys showed much higher rates of response for their reinforced operant than for any other category (Table 3.2). Because different stimuli were available for different amounts of time, all results are summarized in terms of response rates per minute (number of responses for the entire experiment divided by the total number of sessions the target was available and by the session length (10).
<table>
<thead>
<tr>
<th>Monkey</th>
<th>Kink</th>
<th>Tuff</th>
<th>Neat</th>
<th>Cork</th>
<th>Cork</th>
<th>Example</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Hand</td>
<td>Nose</td>
<td>Hand</td>
<td>Nose</td>
<td>Nose</td>
<td></td>
</tr>
<tr>
<td>Target stimulus</td>
<td>Red</td>
<td>Green square</td>
<td>Yellow</td>
<td>Blue rectangle with curved extension</td>
<td>Blue rectangle with curved extension</td>
<td></td>
</tr>
<tr>
<td>Reinforced response</td>
<td>Hand</td>
<td>Nose</td>
<td>Hand</td>
<td>Nose</td>
<td>Nose</td>
<td>Example</td>
</tr>
<tr>
<td>Target stimulus</td>
<td>Red</td>
<td>Green square</td>
<td>Yellow</td>
<td>Blue rectangle with curved extension</td>
<td>Blue rectangle with curved extension</td>
<td>Example</td>
</tr>
<tr>
<td>Reinforced operant</td>
<td>2.021</td>
<td>2.383</td>
<td>0.535</td>
<td>3.519</td>
<td>Nose blue</td>
<td></td>
</tr>
<tr>
<td>Incorrect response to own target</td>
<td>0.013</td>
<td>0.011</td>
<td>0.000</td>
<td>0.014</td>
<td>Handle blue</td>
<td></td>
</tr>
<tr>
<td>Generalized modelled response</td>
<td>0.150</td>
<td>0.048</td>
<td>0.017 (49)</td>
<td>0.016 (108)</td>
<td>Nose green</td>
<td></td>
</tr>
<tr>
<td>Generalized non-modelled response</td>
<td>To another animal’s target</td>
<td>0.208</td>
<td>0.011</td>
<td>0.016 (49)</td>
<td>0.031 (108)</td>
<td>Nose yellow or red</td>
</tr>
<tr>
<td></td>
<td>To a non-target</td>
<td>0.086</td>
<td>0.022</td>
<td>0.005 (49)</td>
<td>0.032 (108)</td>
<td>Nose black</td>
</tr>
<tr>
<td>Non-generalized modelled response</td>
<td>0.000</td>
<td>0.011</td>
<td>0.000</td>
<td>0.000</td>
<td>Handle green</td>
<td></td>
</tr>
<tr>
<td>Non-generalized, non-modelled response</td>
<td>To another animal’s target</td>
<td>0.000</td>
<td>0.000</td>
<td>0.001 (1)</td>
<td>0.001 (1)</td>
<td>Handle yellow or red</td>
</tr>
</tbody>
</table>
Table 3.2: Summarizes the rates of responding per minute (number of responses for the entire experiment divided by the total number of sessions that the target was available and by the session length (10)). made by each subject to all targets, during the entire experiment according to the response categories. Numbers in parenthesis are the total number of responses made by that subject.

| To a non-target | 0.000 | 0.000 | 0.000 | 0.000 | Handle black |

Rates of responses for each category were averaged across all sessions in which the stimuli were available. Where a given class of response could be made to more than one stimulus, rates to the different coloured stimuli (reinforced targets for other monkeys) are added, but rates to the black stimulus (not reinforced for any monkey) are shown as a separate row. The final column shows which response(s) Cork would need to make for each category, as an example. Rates of making the alternative response to their own targets were non-negligible, and these responses could be interpreted as imitative, but there is no standard of comparison for them. Where a standard of comparison is available, there is no evidence of imitation: There is no sign that rates of modelled responses were higher than rates of corresponding non-modelled responses. For Kink and perhaps Neat there is a small tendency for generalized, non-modelled responding to occur at a higher rate to stimuli that had been targets than to the one that was never a target, but it is not seen in the other two monkeys.

3.4 Discussion

The results of this experiment lead us to conclude that imitation is not a driving force in the life of this zoo housed group of Goeldi’s monkeys. These conclusions concur with the authors’ impressions from observing the monkeys during training, detailed analysis of video records, and analysis of session by session data: although they interacted frequently with the targets and with each other, at no point did the monkeys give the appearance that they were attending to and copying each other’s behaviour. On the other
hand there is a small tendency for both modelled and non-modelled generalized responding to occur at a higher rate than the corresponding type of non-generalized responding, so that stimulus generalization does appear to have played a part in the monkeys’ behaviour towards the target set.

Although the sample size was small (n=4), the design of the experiment aimed to maximise the opportunities for subjects to observe each other interacting with the targets, therefore increasing the chances for us to observe any form of social learning. The subjects could observe each other and interact with the targets through the entire experiment. Furthermore, all subjects could act as observers and demonstrators at roughly the same time. Monkeys were frequently observed to be within the vicinity of the targets at times when another monkey was contacting them. Throughout the experiment, it was common to see more than one subject touching targets at the same time, but when this happened, the different individuals were always touching different targets. We never saw two subjects touching the same target at the same time.

Despite long exposure to the sight of familiar conspecifics obtaining reward by responding to targets very similar to those to which they had themselves been trained, using responses which they were certainly capable of making (because they did make them at measurable frequency) the Goeldi’s monkeys showed no evidence of imitation or even of a simpler kind of social learning such as local enhancement. Goeldi’s monkeys thus seem to differ from marmosets, which have been shown to copy some of the body movements of conspecific demonstrators (Caldwell & Whiten, 2004) or to imitate their entire behaviour to obtain a food reward (Voelkl & Huber, 2000). They also appear to differ from lion tamarins, which learn food preferences from each other (Rapaport, 1999). However, the distribution of this capacity within the New World monkeys thus remains
confusing; it seems unlikely that it is explained either by phylogeny, or by the social environment. In both of these Goeldi’s monkeys are closer to the other callitrichines, which do imitate, than to the other cebids, which do not.

Of course the monkeys were never reinforced for imitative responding, if it had occurred, so it would not have been expected to be sustained. But if they had a strong tendency to imitate they would have shown at least a measurable rate of imitative responding, just as they did show a measurable rate of generalized responding, despite the fact that they were never reinforced for this either. Furthermore, in some ways the present procedure offered more scope for observing imitation, because the animals were kept together as a group, and as Miklosi (1999) argues, to “show the real effects of imitation in groups of animals we have to find ways of observing this phenomenon in interacting members of the group” (p. 360). The multiple baseline design used allowed data to be collected on demonstrator(s) and observers at different stages of the experiment to see if any one animal was more likely to imitate the behaviour of another (e.g. subordinate animal imitating a dominant one or vice versa). This is because the multiple baseline design allows one subject to be trained while the rest of the subjects remain in baseline. In addition, the extended training provided every opportunity for social learning to emerge.

There could be, however, other reasons why we didn’t see movement imitation in this species. It could be that there was not enough motivation to imitate the behaviour of a conspecific. Theorists of cultural evolution hypothesise that the reason why social learning has evolved is so that animals can learn survival skills quicker than by trial and error learning (Boyd & Richardson, 1988). The behaviour chosen for this experiment was not one that was important to the survival of the individual. Animals that are well (as in this
case) do not imitate the behaviour of a conspecific as readily as those that are food deprived (Dorrance & Zentall, 2001)

More types of social learning research should be conducted with Goeldi’s monkey, for “socially biased learning is always a collective outcome of interacting physical, social, and individual factors” (Fragaszy & Visalberghi, 2004, p. 24). It is necessary to try a number of different experimental designs before concluding that a species is not capable of imitative learning. Nonetheless, at present, we must conclude that there is no evidence that Goeldi’s monkey can show imitative learning.

The next chapter will begin the domesticated animal chapters. Studies reporting that chimpanzees that have had extensive contact with humans are better imitators than their wild-born conspecifics suggest that experience with humans could play a substantial role either in enhancing imitative performance or in generating imitative ability (Galef and Heyes, 2004).

In these chapters we will investigate social learning in three different species (dogs, camels, and elephants) that have long histories of domestication. Other than dogs, none of these animals has been studied for social learning in a captive setting. My hopes for these chapters are to shed some light on the types of social learning these species may use, if any.
CHAPTER 4

Indication of social learning from a demonstrator in a dog (*Canis familiaris*).

4.1 Introduction

In the previous chapters we tested the evidence of social learning in two Old World primates’ species and one New World primate species in a zoo. In the current chapter we investigate the presence of social learning in dogs.

Dogs have become increasingly popular subjects for studies in animal cognition in the past decade. According to Miklosi, Topali and Csanvi (2004) studies using dogs have more than doubled between 1991 and 2001. In fact, Bloom (2004, pg. 1605) says “For psychologists, dogs may be the new chimpanzee.” The increased popularity for using dogs in research could be due to a combination of factors such as they are easy to work with, have huge populations across the world, and live in similar environments to humans, environments which are therefore somewhat controllable.

As mentioned in section 1.6.2, the current thesis we will define domestication as the relationship between humans and animals in which humans control all aspects of the protection, movement, reproduction and food (Clutton-Brock, 1994) and have done over several generations. As the first domesticated animal, domestic dogs have shared a social relationship with humans that spans at least 14,000 years (Nobis, 1979; Morey, 2005). Evidence suggests that this long history with humans, in a common environment, has led to unique social behaviours and sensitivities not shared even with wolves, the domestic dog’s closest ancestor (Hare and Tomasello, 2005) and are found to be better at understanding human gestures than great apes (Hare and Tomasello, 1999).

One of the ways that researchers test this relationship is by testing how well a subject can understand human gestures. In these experiments a researcher hides a piece of
food in one of several opaque containers (all are controlled for smell). The experimenter either looks at or points at the container that holds the obtainable piece of food. Human infants can complete this task at about 14 months of age (Hare and Tomasello, 1999). Researchers have found that chimpanzees have difficulty solving this task (Call, Agnetta, and Tomasello, 2000). However, dogs have demonstrated that they can follow a human-provided cue (Miklosi, et al., 1998). To date, domestic dogs have been shown to use a variety of different cues to aid in locating a hidden item including: Variations on pointing using the arm or extensions of the arm (Miklosi et al. 1998; Miklosi, Pongracz, Lakatos, et al., 2005; Soproni, Miklosi, Topal, et al. 2001; Hare and Tomasello, 1999), head turning (Miklosi et. al. 1998;), nodding (Miklosi et al. 1998;), bowing (Miklosi et al. 1998;), and glancing (Miklosi et al. 1998; Soproni et al. 2001).

Researchers have also looked at the social relationship dogs have with each other. A few studies with dogs have looked at how well a subject could follow the actions of a conspecific demonstrator Adler and Adler (1977) tested to see if puppies could learn a task faster if they watched a conspecific rather than by trial and error. Puppies (21, 28, 38 and 60 days old) watched a demonstrator for, 15 observations, pull a string to obtain food. After the last demonstration, the observer was given access to the string. The authors found that older puppies (38 and 60 days old) could solve the task and they took less time to solve the task after watching a demonstrator, than the demonstrator took using trial and error learning. The authors conclude that puppies 21 and 28 days old might not have been mature enough to complete the sting pulling task because of insufficient motor development.

Slabbert and Rasa (1997) wanted to see if puppies could learn how to locate and retrieve bags of narcotics after observing their mothers perform this behaviour. Litters of
puppies were placed into groups depending on how long they were raised by their mothers and whether their mother was trained to retrieve narcotics or untrained. Group one puppies were standard raised (taken from mother at 6 wks of age) and had untrained mothers. Group two puppies had extended maternal care (taken from mothers at 12 wks of age) and had untrained mothers. Group three puppies were standard raised and had trained mothers and group four had trained mothers and had extended maternal care. In addition, for two weeks, group four puppies were allowed to watch their mother be praised for retrieving bags of narcotics. This occurred three times a week for 15 min. a day.

After 12 weeks all puppies were placed into standard police dog training classes for 6 months and did not have contact with narcotics. At 6 months of age the puppies were given the task of retrieving bags of narcotic. Each puppy was scored (on a scale of 1-10) on attention to the training (if the puppy was focused on the task at hand) and how well they performed the task (technique used for searching and retrieving, speed and success of retrieval, etc). Puppies who had watched their mothers retrieve hidden bags of narcotics for less than once a week had significantly higher performance scores six months later.

Johnson and Ross (2007) examined if a dog could learn what to eat from a conspecific. In this experiment a dog was fed food flavoured with either thyme or basil before given access to another conspecific of a similar size. The conspecific was then exposed for an equal amount of time with both herbs. They found that the naive dogs showed a significant preference for the same herb as the conspecific they came into contact with.

Another way that researchers test the dog/human social relationship is by investigating how well a subject can follow the actions of a human. For example, researchers found that dogs who were shown by a human demonstrator which way to go
around a fence were more likely to follow that way than dogs who did not watch a


Rooney and Bradshaw (2006) conducted two experiments to examine what dogs

learn by watching dog-human interactions. In the first experiment dogs watched a

conspecific demonstrator and a human playing tug of war during which various outcomes

resulted: winning vs. losing and signalling indicating play vs. non-signalling. For the

control condition, the handler sat in a chair and gently stroked the demonstrator dog.

Stroking was chosen because it was thought to contain little status related to social

information. The experimenter then evaluated how the observer dogs reacted to each of the

players after these interactions. The authors found that observer dogs gained information

from direct observation and subsequent behaviour of the players (e.g. submissive behaviour

from the dog after it lost). After watching a tug of war match observers were more likely to

approach the winner (either dog or human) and were found to approach sooner than they

did in the control condition.

So why do dogs show this capability for social learning from both conspecifics and

humans? According to Cooper et al. (2003) there are three theories. The first theory they

propose is that dogs are descendents of the wolf and they have retained the ability to work

in a social setting. Wolves live in organized social groups (or packs) of six to 15 animals

and they work together to hunt and defend their territory (Whitt, 2003). In addition,

wolves, like humans and apes, form intense social bonds as a result of intense physical

contact and prolonged association between individuals (Whitt, 2003). This bond “therefore

meets another important criterion underlying the selective advantage of social cognitive

skills” (Cooper et al., 2003 pg. 231). Cooper et al.’s second theory is that since dogs have
gone through domestication they have most likely undergone neotenisation, the evolutionary process whereby juvenile characteristics are retained into adulthood, which may allow them to increase their learning capability. Their third theory, and one that has been discussed in a number of papers (Hare & Tomasello, 2005; Miklosi, et al., 2004; Pongracz, Miklosi, Vida, & Csanyi, 2005), is that dogs live in a human environment and thus may have acquired the ability to interpret some human behaviours through natural or artificial selection during the evolution of the species (Miklosi et al., 2004).

The first experiment in this chapter was conducted to see if dogs would imitate object movement behaviour after observing a conspecific demonstrator perform a pedal push in one of two ways (using its nose or paw). A two-action methodology (see chapter one or Akins & Zentall, 1996) was used because Zentall (2003) states that this method can be “used to control for each of the alternatives to imitation” (pg. 92) and “provides for the most convincing evidence yet for imitative learning in animals” (Zentall, 2006, pg. 344).

4.2 Experiment 1

Although these studies have shown that dogs can learn observationally, none of these studies have looked at a dog’s ability to imitate a conspecific’s object manipulation with a two action task. This methodology was chosen because Campbell, Heyes, and Goldsmith (1999) argue that the results of this procedure can help investigators differentiate between local enhancement (learning only to attend to the location of the demonstrator), stimulus enhancement (learning only to attend to the stimulus in which the demonstrator interacts with) and “true” imitation.

4.2.1 Method

*Subjects and Setting*
A total of 27 dogs (*Canis familiaris*) were used in this experiment of which two dogs were assigned the role of demonstrator with the remaining 25 dogs were categorised as observers. The observers varied in breed and age (see Table 4.1 for details); and were all ≤ 10 years old and 11 different breeds were represented.
<table>
<thead>
<tr>
<th>Dog's name</th>
<th>Breed Type</th>
<th>Age</th>
<th>Dog's name</th>
<th>Breed Type</th>
<th>Age</th>
</tr>
</thead>
<tbody>
<tr>
<td>Meg</td>
<td>Springer Spaniel</td>
<td>2 years</td>
<td>Tesse</td>
<td>Jack Russell</td>
<td>10 years</td>
</tr>
<tr>
<td>Ben</td>
<td>Springer Spaniel</td>
<td>1 year</td>
<td>Daisy</td>
<td>Boxer</td>
<td>7 months</td>
</tr>
<tr>
<td>Molly</td>
<td>Bearded Collie</td>
<td>2 years</td>
<td>Paddi</td>
<td>Terrier</td>
<td>3 years</td>
</tr>
<tr>
<td>Iris</td>
<td>Collie Bearded</td>
<td>1 year</td>
<td>India</td>
<td>Weimeraner</td>
<td>2 years</td>
</tr>
<tr>
<td>Charlie</td>
<td>Welsh Collie</td>
<td>7 months</td>
<td>Cholmonday</td>
<td>Labrador</td>
<td>7 months</td>
</tr>
<tr>
<td>Hunter</td>
<td>Border Terrier</td>
<td>1 year</td>
<td>Sirius</td>
<td>Lurcher</td>
<td>5 years</td>
</tr>
<tr>
<td>Kira</td>
<td>Siberian Husky</td>
<td>1 year</td>
<td>Guinness</td>
<td>Labrador</td>
<td>1 year and 5 months</td>
</tr>
<tr>
<td>Millie</td>
<td>Alaskan Malamute</td>
<td>1 year</td>
<td>Louis</td>
<td>Rhodesian Ridgeback</td>
<td>7 months</td>
</tr>
<tr>
<td>Doughie</td>
<td>Labrador Cross</td>
<td>1 year</td>
<td>Buster</td>
<td>Jack Russell</td>
<td>9 months</td>
</tr>
<tr>
<td>Sam</td>
<td>Springer Spaniel</td>
<td>14 months</td>
<td>Lucy</td>
<td>Chocolate Labrador</td>
<td>1 year</td>
</tr>
<tr>
<td>Smudge</td>
<td>Springer Spaniel</td>
<td>14 months</td>
<td>Ollie</td>
<td>Springer Spaniel</td>
<td>9 months</td>
</tr>
<tr>
<td>Jess</td>
<td>Border Terrier</td>
<td>3 years</td>
<td>William</td>
<td>Spinone</td>
<td>9 years</td>
</tr>
<tr>
<td>Pippa</td>
<td>Springer Spaniel</td>
<td>7 months</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Table 4.1: This table shows a summary of the dogs used as observers. It includes their names, breed type and age (to nearest month if known).

The dogs were recruited at Canine Etiquette™ facility in Barnstable, England where dogs took part in either private or small group training classes. None of the observer dogs had been in contact with the apparatus before this current experiment and the owners of the observer dogs were not informed about the procedure or the hypothesis under test until after the experiment, to prevent any intentional or unintentional prompting.
The experiment was held in a room within the Canine Etiquette facility. The room was 7 m x 7 m and contained chairs, video cameras and the testing apparatus. During the session there were four people (caretaker of the dogs, videographer, time keeper and experimenter) in the room along with the demonstrator dog.

Apparatus

The apparatus was a wooden box (0.6 X 0.6 m) with a pedal that could be pushed down. During the experiment the apparatus was placed in the middle of the room so that the experimenters could see when the pedal was pushed down and what part of the dog’s body was used to push it.

Demonstrator training

Demonstrators were trained to push the pedal down fully either with their nose or with their paw. Each dog was trained using successive approximations with positive reinforcement. The dogs were trained individually before the experiment began and were not seen by any of the observers.

Procedure

In this experiment there were two conditions. The first condition was a baseline, where the dogs had five minutes’ access with the apparatus in the absence of a demonstrator and food reward. This provided the opportunity to see whether the dogs could manipulate the apparatus in one of the two ways (nose or paw) prior to the experiment. If they were found to manipulate the apparatus, they were placed in the group that would observe a demonstrator performing the opposite behaviour. For example, if they pushed the pedal down with their nose, then they were placed in the paw group. If they did not press the pedal at all during the baseline, they were assigned in equal numbers to the two groups, for nose or paw discrimination.
Following baseline, the appropriate non familiar demonstrator dog was brought in. The observer had to be looking in the general direction of the demonstrator before a demonstration began. The observer saw the demonstration 5 times. Observers in the nose group saw the demonstrator push down the pedal with its nose five times and those in the paw group saw the demonstrator push down the pedal with its paw five times. Food reward was delivered to the demonstrator once the pedal was fully down. The reinforcement consisted of pieces of all beef hotdogs. After the observation sessions the demonstrator dog was removed, the apparatus was wiped down (Clorox hand wipes) and the observer dog was allowed access to the apparatus. The observer dog was given 5 min. in the room to manipulate the apparatus. The setting in the testing conditions was identical to those in the baseline condition.

4.2.2 Results and Discussion

During baseline 14 dogs touched the apparatus (Figure 4.1). None of the observer dogs manipulated the pedal with both the nose and paw during baseline. All of them touched the pedal on the apparatus with their nose and were placed into the paw demonstration group (even though none of them fully pressed down the lever). After these dogs saw the paw demonstration only one of them pushed the pedal down with their paw, five of them pushed the pedal with their nose and six of them didn’t respond. Eleven of the dogs did not touch the pedal during baseline and these dogs were placed evenly into either nose demonstration groups or paw demonstration groups. Of the five dogs placed into the nose demonstration group four of the dogs nosed the apparatus and one of the dogs did not respond. Six dogs were placed into the group that watched a demonstrator press the pedal down with its paw. In this group none of the dogs pressed the pedal down with its paw, four pressed the pedal down with its nose and one did not respond.
Baseline

Nothing

Nosing

Pawing

Shown

Pawing

0

Performed

14

Pawing

Performed

Nosing

0

Performed
Nosing  | Pawing | Nothing  
---|---|---
4  | 0  | 2  
7  | 1  | 6  

**Figure 4.1:** The break down of the observers’ response during baseline, what behaviour they were shown by the demonstrators and their responses after watching the demonstration.

As Figure 4.2 shows, dogs that saw a paw appeared to press the pedal down with their nose (occurred in $4+7=11$ dogs) or not respond (occurred in $2+6=8$ dogs) as opposed to copying the behaviour of the demonstrator (occurred $0+1=1$ dog). Similarly, dogs that saw a nose demonstration appeared to press the pedal down with their nose (occurred in 4 dogs) more or not respond (occurred in 1 dog) as opposed to pressing the pedal with their paw (never occurred).

**Figure 4.2:** Shows proportion of responses of each type made each demonstration condition.

Only two of the observer dogs pressed the pedal fully down with the same part of the body as the demonstrator (Figure 4.3).
Figure 4.3: Pictures on the top show the demonstrator pressing the petal down with his nose and the observer dog (Cholmodley), pressing the lever down with his nose (although the behaviour doesn’t match exactly). Pictures on the bottom show demonstrator
performing paw push and Tessa pushing the pedal with her paw after seeing the demonstrator.

After seeing the demonstration, Tess began to use her paw and Cholmodley began to use his nose to press down the pedal. However, we could only class one of these as imitative learning because imitation is judged by how closely the movement of the demonstrator matches the movement of the observer (Miklosi, 1999). Chomodley did not show similar body movement to that of the demonstrator (Fig. 4.3). He used his nose to push the pedal downward whereas the demonstrator dog used more of its chin to push the pedal down. Therefore we would conclude Cholmodley possibly showed emulation (attempting to recreate the results, i.e. the depression of the pedal, rather than attempting to copy the demonstrator’s behaviour) or stimulus enhancement (responding to the same apparatus or particular part of the apparatus as a demonstrator); whereas Tessa showed behaviour that met the criteria for imitative learning- even though Tessa used a different paw (demonstrator used left paw, whereas Tessa used her right).

One limitation to this study was the positioning of the pedal. During the pilot study we tested the best placement of the pedal so that using the paw or nose would require roughly equal exertion. Nevertheless, during the experiment most dogs were found to use their nose to contact the pedal, even after seeing a demonstrator use his paw. This is probably because dogs mostly use their noses to apply force on objects in their environment (Kubinyi et al., 2003). Ideally in a two-action task, the two actions involved should have equal operant rates, though this is difficult to secure in practice.

There are reasons to suspect that the type of demonstrator used could explain why the dogs did not learn socially. The demonstrators in this study were unfamiliar to the conspecific observers unlike earlier studies (e.g. Adler and Adler, 1977; Slabbert and Rasa,
Furthermore, many studies have shown that dogs learn from watching humans (Miklosi et. al. 1998; Pongracz et al. 2001, 2003, 2005; Kubinyi et al., 2003; Miklosi et al., 2005; Soproni et. al. 2001; Hare and Tomasello, 1999).

To test this we conducted another experiment.

4.3 Experiment 2

This experiment was run for a number of reasons. First, to see if there was a difference between having a baseline (run with the same subjects as are subsequently used in experiments) or having a control condition (run with different group of subjects). Both are effective to see the normal behavioural tendencies of the species. A baseline was used previously to deflect the criticism that the demonstrator’s behaviour was not novel, but the control condition is the more widely used method. The second reason why this experiment was conducted was to see if choosing an action that may already be in the dogs’ repertoire would increase the dogs’ chances to learn socially. Third reason was to see if there would be a difference between human and conspecific demonstrators. Finally, we wanted to see if there would be a difference in responding between unfamiliar and familiar demonstrators.

4.3.1 Method

Subjects and Setting

Sixty four dogs (*Canis familiaris*) living as household pets in the Gainesville, FL, area served as subjects in this experiment. Of the 64 dogs used, one dog served as demonstrator for the unfamiliar dog condition and three dogs were used as demonstrators for the familiar dog condition. Table 4.2 shows their breeds and ages. Observer dogs were naïve to the apparatus and all dog owners were kept ignorant of the procedure and hypothesis of the experiment until the experiment was complete. Sessions were held indoors either at a local dog exercise establishment or in the owner’s home.
<table>
<thead>
<tr>
<th>Dog's name</th>
<th>Breed Type</th>
<th>Age</th>
<th>Dog's name</th>
<th>Breed Type</th>
<th>Age</th>
<th>Dog's name</th>
<th>Breed Type</th>
<th>Age</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chloe</td>
<td>German Shepard</td>
<td>2 yrs. old</td>
<td>Enzo</td>
<td>Retriever</td>
<td>2 yrs. old</td>
<td>Resse</td>
<td>Dachshund</td>
<td>3 yrs. old</td>
</tr>
<tr>
<td>Sasha</td>
<td>Boxer Retriever</td>
<td>3 yrs. old</td>
<td>Cider</td>
<td>Springer spaniel</td>
<td>4 yrs. old</td>
<td>Rex</td>
<td>Pitt</td>
<td>5 yrs. old</td>
</tr>
<tr>
<td>Stan</td>
<td>Retriever</td>
<td>3 yrs. old</td>
<td>Merlin</td>
<td>Shi tzu</td>
<td>3 yrs. old</td>
<td>Gibson</td>
<td>Boxer</td>
<td>6 yrs. old</td>
</tr>
<tr>
<td>Tottie</td>
<td>Shar-pei Springer</td>
<td>8 yrs. old</td>
<td>Xochitl</td>
<td>Shepard</td>
<td>11 yrs. old</td>
<td>Jackson</td>
<td>Unknown mix</td>
<td>5 yrs. old</td>
</tr>
<tr>
<td>Princess</td>
<td>Springer spaniel</td>
<td>4 yrs. old</td>
<td>Jack</td>
<td>Lab mix</td>
<td>18 mon.</td>
<td>Chloe-3</td>
<td>Bichon Frise</td>
<td>3 yrs. old</td>
</tr>
<tr>
<td>Scooby</td>
<td>greyhound</td>
<td>10 yrs old</td>
<td>Jaco</td>
<td>Lab mix</td>
<td>3 yrs. old</td>
<td>Wookie</td>
<td>Bichon Frise</td>
<td>2 yrs. old</td>
</tr>
<tr>
<td>Gabby</td>
<td>schnauzer</td>
<td>2 yrs. old</td>
<td>Kiera</td>
<td>Husky</td>
<td>2 yrs. old</td>
<td>Jesse</td>
<td>Lab mix</td>
<td>1 yrs. old</td>
</tr>
<tr>
<td>Andy</td>
<td>Dalmation Border</td>
<td>1 yrs. old</td>
<td>Kodo</td>
<td>boxer</td>
<td>3.5 yrs. old</td>
<td>Lolita</td>
<td>Pit bull</td>
<td>4 yrs. old</td>
</tr>
<tr>
<td>Ellie</td>
<td>collie</td>
<td>7 yrs. old</td>
<td>Nailah</td>
<td>Australian Shepard</td>
<td>2 yrs. 5 mon</td>
<td>Arlo</td>
<td>Austrailan shepard</td>
<td>5 yrs. old</td>
</tr>
<tr>
<td>Dolly</td>
<td>Blue Heeler</td>
<td>1 yrs. old</td>
<td>Ronin</td>
<td>Min Pin</td>
<td>10 mon.</td>
<td>Kia</td>
<td>Huskey</td>
<td>2 yrs. old</td>
</tr>
<tr>
<td>Frannie</td>
<td>Poodle</td>
<td>1 yrs. old</td>
<td>Harley</td>
<td>Lab mix</td>
<td>10 yrs old</td>
<td>Indy</td>
<td>Unknown mix</td>
<td>10 yrs. old</td>
</tr>
<tr>
<td>Faith</td>
<td>Pit Bull</td>
<td>2 yrs. old</td>
<td>Auggie</td>
<td>Beagle mix</td>
<td>11 yrs old</td>
<td>Toby</td>
<td>Rhodesian Ridgeback</td>
<td>7 yrs. old</td>
</tr>
<tr>
<td>Mima</td>
<td>Lopso opso Pug</td>
<td>4 yrs. old</td>
<td>Yarah</td>
<td>Yorkie</td>
<td>7 yrs. old</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Marlo</td>
<td></td>
<td>6 yrs. old</td>
<td>Jose</td>
<td>Lab mix</td>
<td>3 yrs. old</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Nico</td>
<td>Fox Terrier</td>
<td>7 months</td>
<td>Kristy</td>
<td>Jack</td>
<td>1 yr. 9 mon.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Destiny</td>
<td>German Shepard</td>
<td>10 yrs old</td>
<td>Chloe-2</td>
<td>Boxer</td>
<td>3 yrs. old</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Henry</td>
<td>Terrier</td>
<td>4 yrs. old</td>
<td>Sasha-2</td>
<td>Chow</td>
<td>9 yrs. old</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Raven</td>
<td>Yorkie</td>
<td>5 yrs. old</td>
<td>Izzy</td>
<td>Boxer</td>
<td>4 yrs. old</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Paploo</td>
<td>Unknown mix</td>
<td>2 yrs. old</td>
<td>Micki</td>
<td>Aussie</td>
<td>7 yrs. old</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ron</td>
<td>Chow</td>
<td>3 yrs. old</td>
<td>Lena</td>
<td>Unknown mix</td>
<td>10 mon.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Susie</td>
<td>Pit Bull</td>
<td>9 months</td>
<td>Emma lou</td>
<td>Australian Shepard</td>
<td>1 yr. 6 mon.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Jasimen</td>
<td>Border</td>
<td>8 yrs. old</td>
<td>Pearl</td>
<td>Rough</td>
<td>8 mon.</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Table 4.2: This table shows a summary of the dogs used as observers and ones used in the control condition. It includes their names, breed type and age (rounded to the nearest month).

<table>
<thead>
<tr>
<th>Name</th>
<th>Breed</th>
<th>Age</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hailey</td>
<td>Poodle</td>
<td>2 yrs. old</td>
</tr>
<tr>
<td>Max</td>
<td>Bull dog</td>
<td>3 yrs. old</td>
</tr>
<tr>
<td>Larry</td>
<td>Unknown mix</td>
<td>16 mon.</td>
</tr>
<tr>
<td>Camilo</td>
<td>Tenn. Mt. dog</td>
<td>9 yrs. old</td>
</tr>
</tbody>
</table>

Apparatus

The apparatus was a wooden door measuring 0.6 m x 0.6m with a baby gate (1.5m .x 0.8m x 0.7m) that was placed in a square behind the door. The apparatus was placed centrally as possible in the testing room. Testing rooms varied in size from 4.3m x 5.5m to 3.9m x 3.7m.

Procedure

Prior to the experiment, each dog was led through the door frame with the door open. This ensured that the dog was not scared of the door and could walk through the frame. Once the dog walked through the frame into the gated area and out again with no hesitation the dog was then placed so that it could watch a demonstrator about 1.5m from the door. The subjects were randomly categorized into three groups; human demonstrator, conspecific demonstrator, and control. Observer dogs were randomly placed into two groups (snout/nose or paw/hand). The demonstrator opened the door either with its paw (or hand) or snout (nose) in sight of the observer five times (see Figure 4.4). The dog demonstrator was rewarded (with pieces of bacon strips dog treats and human demonstrator with cheese) once the door was fully open and they had walked through the door. If an observer dog’s gaze direction (as rated by the experimenter) strayed from the demonstrator, then that demonstration was repeated. After the observation sessions, the demonstrator was
removed from the room and the observer dog was placed in the gated area. The dog was then called to come through the door by saying the dog’s name and “come on.” No other encouragement or reinforcement was offered. The observer dog was given 2 min. to open the door.

Figure 4.4: Shows a diagram of the demonstrator dog opening the door with her paw as the observer dog watching the demonstration.

Dog Demonstrator condition

Twenty four dogs were placed in the dog demonstrator condition. Dog demonstrators were trained to open the door with their snout and paw by successive approximations with positive reinforcement. So that the command would not be recognized by the observer dogs, approximations to the German words for paw (Pfote) and snout (Schnauze) were used.

Familiar demonstrators were dogs that lived in the same house with the observer and unfamiliar demonstrator was a dog that none of the observers had been introduced to before.

Human Demonstrator condition

Twenty four subjects were placed in the human demonstrator condition. Human demonstrators were asked to either open the door with their hand or nose from a position on all-fours. Familiar demonstrators were the dogs’ owners and the unfamiliar
demonstrator was the author. In this condition the human opened the door on instruction, the experimenter said “good,” gave the demonstrator a piece of cheese and closed the door again.

Control Condition

In the control condition a naive group of 12 dogs saw no demonstrator Prior to having access to the door, each dog was led through the door frame with the door open, until they entered without hesitation. The dog was then placed in the gated area and called through the door by its caregiver (as in the testing conditions).

4.3.2 Results

Contingency tests were used to assess the significance of the effects of demonstrator behaviour on observer behaviour Fisher exact tests were used because sample sizes for each group were small enough that expected frequencies were less than five in numerous cells so that chi-square tests were not appropriate. Figure 4.5 shows the number of observer dogs that showed no response, a non-matching response or a matching response. A matching response is one where the observer makes the same response as the demonstrator.
Figure 4.5: Shows the number of observers making responses after watching either a familiar human demonstrator, an unfamiliar human demonstrator, a familiar dog demonstrator, or an unfamiliar dog demonstrator.

As Figure 4.5 shows, when a familiar human was demonstrator, we found three dogs that did not respond, three dogs that matched the response of the demonstrator and six dogs that did not match the response of the demonstrator. If the demonstrator was an unfamiliar human, we found seven dogs matched the response they saw the demonstrator model, three dogs did not model the demonstrator’s behaviour and two dogs did not respond at all. If the demonstrator was a familiar dog we found that seven dogs matched the response compared to three dogs that did not respond and two dogs that did not match the response. In the unfamiliar dog condition of the two dogs that responded both did not match the response of the demonstrator. The distribution of observer response type differed significantly between the four experimental groups (P=0.009). To break this difference down, responses were grouped into no response or any response and include match or non-match responses. The distributions into these groups differed significantly between experimental groups (P=0.001). The dogs that made a response were then divided into
those that made a matching response and those that made a non-matching response. The
distribution between these two groups did not differ between experimental groups.

Figure 4.6 shows the proportion of responses made for each type of demonstrated
behaviour (none, nose or paw) pooled across the four demonstrator types (dog and human;
unfamiliar and familiar). Of the 12 dogs in the control condition (where there was not a
demonstration) 6 dogs opened the door with their nose and 6 dogs paw. Dogs that watched
a demonstrator open the door with her paw, opened the door more with their nose then they
did with their paws or not respond at all. When watching a nose demonstrator, the
observers opened the door with their nose more than they did with their paw or not respond
at all. The distributions of responses were significantly different between experimental and
control groups (P=0.006). Thus watching a demonstrator affected the likelihood of making
some response. However, of the observers that made a response, watching a demonstrator
did not affect the response that they made among the experimental groups, the
demonstrator’s behaviour did not significantly affect the response made by the observer
(P=0.287). Dogs were not found to imitate the behaviour shown by the demonstrator.

Figure 4.6: Shows proportion of responses of each type made for the control (no
demonstration) condition and each of two demonstration conditions (nose and paw).
4.4 Overall Discussion

An interesting finding is that in both experiments very little imitation was found and the imitation that was found was not statistically significant with both human and conspecific demonstrators. These results could be due to the fact that we used a variety of different breed or animals that came from different living arrangements. Research has shown that there are differences among breeds and differences in the same breed depending on the environment in which the breed lives in (i.e. same breed could be either a show dog, pet dog or working dog) in temperament (Scott and Fuller, 1965) and differences within breeds and between breed when it comes to trainability (Serpell and Hsu, 2005).

According to Topal et al. (2006) dogs show “some imitative abilities” after watching a human demonstrator (pg. 365). Other researchers state that “there is less direct evidence for social learning from other dogs” (Rooney and Bradshaw, 2006, pg. 72). It is thought that since dogs are separated from their mothers at an early age they have a short period of time to learn from conspecifics (Miklosi et. al, 2004). Cooper et al. (2003) propose that since dogs have smaller brains and cranial capacity than wolves, they are less likely to learn socially than their wild forebears.

Either way the results that we are found are interesting for a number of reasons. First, it is one of only a small number of research projects that look at object manipulation with dogs using conspecifics as demonstrators. Also, this is the first research project, to our knowledge, that has investigated imitative learning in dogs using the two-action methodology. Third, the results show that unfamiliar dog demonstrators may distract unfamiliar observers to perform less than they did when no demonstrator was present. These differences can layout the ground work for further research projects.
An interesting finding is that both experiments show the observer dogs using their noses to manipulate the apparatus more than they used their paws. This could be due to watching the demonstrator repeatedly get food for opening the door. Research has shown that animals sometimes associate a stimulus with food and thus treat it the same way (Timberlake, Wahl, and King, 1982; Timberlake, 1983). In a few studies with rats, researchers found that when they used ball bearings as a token to obtain food, the rats would “seize the bearing...stuff it into their mouth, and run to the end of the chamber near the food tray, where they handled, chewed, dropped, and retrieved the bearing for lengthy periods before finally releasing it” (Timberlake, 1983, pg. 309). Further research needs to be conducted to test if the reason the dogs were using their mouth more was because they were associating the door with the food that they watched the demonstrator receive.

Subsequent studies could look at younger dogs, or dogs that are used to working together in a group (e.g. herding or hunting dogs) to see if imitation is more frequent in those situations. In addition, future research could look further into the decrease in responding by dogs observing unfamiliar conspecifics. A similar result is not new and has been seen in cats (Chesler, 1969). In this research, two groups of kittens were shown how to press a lever to obtain food. One group was shown the task by their mothers, whereas the other group was shown the task by an unfamiliar female cat. They concluded that kittens shown the lever pulling task by their mothers performed the response sooner than those that watched an unfamiliar female cat. They also found that kittens who did not watch a demonstrator never acquired the response.

We investigated social learning in a family group of camels, focusing our methodologies on the juvenile in the group. Because this species does not have the ability
to manipulate objects like dogs, we went for a simpler methodology, but still incorporating a slightly altered two action method.
CHAPTER V

No Evidence of social learning in a group of Bactrian camels (*Camelus bactrianus*)

5.1 Introduction

Social interaction plays an important role in assisting the development of adaptive patterns of behaviour in both humans and other social animals (Boyd and Richerson, 1988; Wechsler and Lea, 2007). These social interactions can provide an opportunity for social learning. Social learning is the process by which behaviour by one individual can influence the future actions of the same or similar behaviour in another individual of the same species. There are several distinct mechanisms that can underlie social learning, and in an attempt to clarify the interactions underlying the mechanisms involved within the broader term of social learning, scientists have defined terms such as local enhancement, stimulus enhancement, emulation, imitation, etc. I will only describe the few terms that are pertinent to this study.

Probably the most frequently mistaken for imitative learning is local and stimulus enhancement (Whiten and Ham, 1992). Local enhancement is said to occur when the actions of the demonstrator draws the attention of the observer to a particular location. Similarly, stimulus enhancement is when the actions of the demonstrator draws the attention of the observer to a particular stimulus. In contrast, imitation (or “true imitation”) is defined by most researchers as “learning to do an act after seeing it done” (Thorndike, 1898) once “one has controlled for or ruled out the other underlying mechanisms [of social learning]” (Zentall, 2004, pg. 18).

Domestic animals are important in studying social learning for a number of reasons. Researchers have found that enucleated chimpanzees who have had extensive contact with
humans are better imitators than their wild-born conspecifics, suggesting that experience with humans play a substantial role either in enhancing imitative performance or in generating imitative ability (Heyes and Galef, 2004); there is also the possibility that genetic adaptation to domestic condition has led to a greater tendency to imitate (Heyes and Galef, 2004). A single definition of domestication has not be agreed upon by researchers, so for this paper domestication will be defined as the relationship between humans and animals in which humans control all aspects of the protection, movement, reproduction and food (Clutton-Brock, 1994) and have done over several generations.

Data on animals that have been raised in close proximity to humans have been limited to dogs and a handful of encultured apes. These studies have found that these animals are capable of stimulus/local enhancement (Pongracz et al., 2001, 2003, 2005; Kubinyi, Topal, Miklosi et al., 2003), social facilitation (Range, Viranyi, and Huber, 2007); and imitation (Heyes and Heyes, 1952; Custance, Whiten and Bard, 1995; Topal, Byrne, Miklosi and Csanyi, 2006).

Camels are among the most recent animal to be domesticated, although the evidence for an exact date when this process began is not particularly clear (Wilson, 1984). Reasons why historians can not find a date of domestication for camels include the sparse and discontinuous archaeological record and the fact that there have been few morphological changes during domestication (Wilson, 1984). Most scientists believe domestication occurred around 2000 BC in Southern Arabia (Wilson, 1984; Gauthier-Pilters and Dagg, 1981), which is relatively recent compared to other animals (such as sheep, goats and cattle which were domesticated around 9,000 BC). However, others have argued that camel domestication could have occurred from as early as 4th millennium B.C. (Epstein, 1971). The first documented use was by the Midianites who were in war against
Palestine around 1100 BC. At least since then, camels have been a major part of human life in parts of Asia, Africa and the Middle East and have been used for military operations, as transportation or riding animals and as a source of milk or even food (Wilson, 1984; Gauthier-Piltes and Dagg, 1981).

Bactrian camels live in social groups up to 30 that are found in mountainous, rocky regions. Their group size varies in size and composition with each area and season (Gauthier-Piltes and Dagg, 1981). They have more body mass and shorter legs than the dromedaries (*Camelus dromedarius*), which makes them more suitable for cold climates. Bactrian camels are present in North-Eastern Afghanistan, Siberia, Mongolia, and Northern China (where they reach altitudes as high as 4,000 meters), but coexist and may interbreed with dromedaries in Turkey (Gauthier-Piltes and Dagg, 1981).

Not much is known about the camel’s social learning abilities. However, there has been some anecdotal evidence on camels’ cognitive abilities. Handlers claim that camels can find their way back home over 1,600 kilometres (to an area they used to live or were born) after months or years of being away (Baker, 1972; Gauthier-Piltes and Dagg, 1981). Though no one has studied how camels are finding their way across vast tracts of desert, it is reasonable to consider that they may be using spatial memory to navigate their way home. In addition, camels may have long/short term memory, reasoning, problem solving skills and other cognitive abilities associated with animals that can be trained. Camels have been trained for centuries to wear a harness and saddle, follow a handler on a lead, and even push carts (Wilson, 1984).

The purpose of the current study was to investigate what form of social learning, if any, would be used by Bactrian camels. Specifically, we wanted to see if the youngest member of the group (James) would learn how to touch specific targets, from watching the
older group members. The zoo housed Bactrian camels (*Camelus bactrianus*) were trained to perform different responses (nose and hoof) to different stimuli (targets placed on the ground and on the fence). These responses were chosen to facilitate the zoo’s husbandry training programme.

For this experiment, changes needed to be made from that of other social learning experiments conducted with domesticated animals. These changes ensured that the camels did not need to be separated (not possible in the zoo environment where they were studied) or allow for the dominant member of the group to monopolize the apparatus. Finally, these changes allowed for long periods of exposure to the stimuli and the opportunity to respond, so that if any form of social learning was not observed, it would be possible to say with some conviction that they do not form a major component of the social life of the species.

5.2 Method

*Subjects and Setting*

A family of four, captive raised Bactrian camels (*Camelus bactrianus*) housed at Paignton Zoo Environmental Park were studied: Oscar (8 year old father), Carmel (7 year old mother) and their offspring James (1 year old son) and Alice (2½ year old daughter).

Data were collected and procedures carried out in the main paddock of their enclosure. The main paddock was a grass field that measured 100m x 26m and was surrounded by chain link fence.

The experiment was run prior to the morning feed time and evening feed time. During the experiment the camels could leave at any time to graze, but no additional food or enrichment was available to them at this time.
Apparatus

Targets consisted of a wooden 0.6 m x 1.27 m pole with a wooden shape at the end of it (each shape was painted a different colour). In total there were six targets, three used for nose training (white triangle and blue square) and three used for hoof training (red triangle, white square, blue circle). Three of the targets were assigned to a camel, and the other two (red triangle hoof target and a white triangle nose) were used to control for stimulus/local enhancement. All targets were attached to the fence by a carabiner clip and rope. Nose targets were hung at a height of 1.2 m and foot targets were laid on the ground (see figure 5.1 for diagram).

Figure 5.1: Shows a diagram of the experiment all set up. The experimenter was behind the chain link fence while the nose and hoof targets were assessable to the camel.

Procedure

Before training began, five sessions of baseline were conducted in which all five targets were present, to see if there was any predisposition to interact with any of them. In training, a multiple baseline across subjects design (see Hersen and Barrow, 1976) was used.

Each behaviour was trained using successive approximations to the target behaviour (Johnston and Pennypacker, 1993). Each correct approximation was immediately reinforced with a conditioned reinforcer (click) and a primary reinforcer of a
small piece of carrot (carrots were used because, by anecdotal observation, they were the first thing eaten out of their daily diets).

Different camels were trained to respond to each target, though all camels’ behaviour to all available targets was recorded (Table 5.1). The camels were trained in the order Carmel, Oscar and Alice. Oscar was trained to touch the blue square target with his nose. Nosing was defined as any part of the nose touching the target for more than a second. Carmel and Alice were trained to touch either a white square or blue circle targets, respectively, with their right hoof to placing a hoof on the target was defined as the whole hoof touching the target for more than a second. James was trained to perform both nose and hoof behaviours at the end of the experiment to show that he could perform the behaviours.

In addition to the assigned targets a red triangle hoof target and a white triangle nose target were always present, for two reasons: 1) to ensure that even from the beginning, the subject who was being trained had to choose between two targets (help in discrimination) and 2) to allow the recording of any trained behaviours, from both trained and untrained subjects, that might occur to it, bearing in mind that no behaviour towards them was ever reinforced for any subject.
<table>
<thead>
<tr>
<th>Targets</th>
<th>Subjects</th>
</tr>
</thead>
<tbody>
<tr>
<td>White Square</td>
<td>Carmel</td>
</tr>
<tr>
<td>hoof target</td>
<td>X</td>
</tr>
<tr>
<td>Blue Circle</td>
<td>Oscar</td>
</tr>
<tr>
<td>hoof target</td>
<td>X</td>
</tr>
<tr>
<td>Blue Square</td>
<td>Alice</td>
</tr>
<tr>
<td>nose target</td>
<td>X</td>
</tr>
<tr>
<td>Red Triangle</td>
<td>Control</td>
</tr>
<tr>
<td>hoof and</td>
<td>X</td>
</tr>
<tr>
<td>White Triangle</td>
<td></td>
</tr>
<tr>
<td>nose</td>
<td></td>
</tr>
</tbody>
</table>

Table 5.1: Shows the targets assigned to each of the older members in the group and the targets used as controls.

After the behaviour of the camel currently being trained was well established; the next camel and their target were added and training began. However, the preceding subjects’ targets were still present until the end of the experiment. For example, once Carmel’s behaviour was well established, training Oscar began, but Carmel still got a food reward making correct responses to her target. The number of sessions, the targets presented, and the responses reinforced at each stage are shown in Table 5.2.
Stages | Subject that could obtain a food reward | Sessions numbers | Targets available
---|---|---|---
1 | None | 1-5 | Square hoof
| | | | Circle hoof
| | | | Triangle hoof
| | | | Square nose
| | | | Circle nose
| | | | Triangle nose
2 | Carmel | 6-37 | Square hoof
| | | | Triangle hoof
3 | Carmel and Oscar | 38-76 | Square hoof
| | | | Triangle hoof
| | | | Square nose
| | | | Triangle nose
4 | Carmel, Oscar, and Alice | 77-116 | Square hoof
| | | | Triangle hoof
| | | | Square nose
| | | | Triangle nose
| | | | Circle hoof

*Table 5.2: The sessions each subject could participate in, and the stimuli available, at each stage of the experiment.*

At the beginning of each session the appropriate numbers of targets were put in place. Sessions lasted 10 min. from when one of the subjects correctly touched their assigned target. All sessions were video taped and data were collected from the tapes after the session was completed.

### 5.3 Results

All four subjects were successfully trained to perform the assigned behaviour to their assigned target. It took the subjects between five to 14 sessions to achieve this. The subjects were more likely to respond to their assigned target and perform the correct behaviour than any another combination of events.
Figure 5.2 shows the rate of responding per session for Carmel, Oscar and Alice for their trained behaviour. It also shows James’ responding during the experiment (before his training) towards the targets that were available. Carmel was the first to be trained, to touch the white square target with her hoof. The graph shows that her responding started to increase in the 29th training session from 26 responses to a high of 198 responses in the 86th session before averaging about 47 responses in the final 5 sessions prior to Oscar starting training.
Figure 5.2: Shows the rate of responding per session for Carmel, Oscar and Alice for their trained behaviour. It also shows James’ responding during the experiment (before his training) towards the targets available. Note that James was present for every demonstration. Vertical lines show the transition from baseline to training.

After 36 sessions of Carmel’s initial training, Oscar was trained to response by touching his nose to the blue square target. Oscar started to increase his responding from an average of five responses to 35 in the eighth session. Oscar’s highest response rate was 125 responses in the 100th session, whereas, in a couple of session Oscar didn’t respond to the target at all. Oscar only touched his hoof to the target twice in the entire experiment; a behaviour he was not trained to perform and responded to the incorrect nose target (white triangle) 57 times during the experiment.

After 38 sessions of training Carmel and Oscar, Alice’s blue circle hoof target was added and she was trained to touch her hoof to this target. Alice started to touch her hoof to the blue circle target in the first training session with 11 responses which increased to a high of 86 responses in session 109 before averaging about 48 responses in the final 5 sessions prior to James starting training. In addition to Alice responding to her own target correctly she also nosed Oscar’s target twice and the unassigned white triangle nose target
four times. She touched Carmel’s target with her hoof 32 times and the unassigned red triangle hoof target 10 times.

James was not trained until Alice’s responding was established. He was trained to perform both (nose and hoof responding) behaviours to prove that he was capable of performing those behaviours. James was first trained to touch his hoof to the unassigned triangle target and after five sessions the rest of the targets were added for two sessions to make sure he could discriminate between his targets and the other targets. In these two sessions James exclusively responded to the hoof target, at a rate of 15 and 12 responses per session. After he was trained to response the hoof target, we started training James to put his nose to a circle target. After his responding was well established (this took one session) the circle target was added to the rest of the other targets. During these sessions, he responded the circle nose target exclusively with a rate of 10 and 27 responses per session.

Table 5.3 shows rate of responses per minute made by Carmel, Oscar and Alice to all targets and the type of social learning each would indicate. It should be noted that it is physically impossible for the camels to touch their hooves to the nose targets, but a nose response could be made to the hoof targets. Two of the non-target stimuli (white triangle for nose behaviour and red triangle for the hoof behaviour), were not assigned to any camel in the group. Thus no behaviour towards them could be either imitative or stimulus/local enhancement. The other targets were assigned to other camels within the group. If the camels are able to imitate, each kind of modelled response should occur at a higher rate than the corresponding kind of non-modelled response. For James, modelled responses should have occurred more on assigned targets than non-assigned targets. If local or stimulus enhancement occurs, non-modelled responses should occur at a lower rate to the non-assigned targets than to the other targets. Different stimuli were available for different
amounts of time, so all results are summarized below in terms of response rates. As a result, every response made could be classified into one of the following six categories:

Reinforced operant: the camel’s trained response made to its stimulus.

Generalized modelled response: the camel’s trained response was made to a stimulus other than its target, when another camel had been reinforced for making that response to that target (could only occur for Oscar).

Generalized non-modelled response: the camel’s trained response was made to a stimulus other than its target, when no other camel had been reinforced for making that response to that target. Such responses could be made either to a target to which another camel had been reinforced for making the alternative response (there were two such targets for Oscar and one such target for Carmel and Alice), or to the triangle targets which no camel had been reinforced for contacting.

Incorrect response to own target: This could only occur for Alice or Carmel, if their non-trained response (nose) was made to their own target.

Non-generalized modelled response: Oscar’s trained response (nose) was made to a stimulus other than his target.

Non-generalized, non-modelled response: This could occur if Alice, Oscar, or Carmel made a non-trained response to a stimulus other than its target, when no other camel had been reinforced for making that response to that target (i.e. touching the triangle targets) or if Oscar made an untrained response to any of the nose targets. Such responses could be made either to a target to which another camel had been reinforced for making a different response, or to the non-assigned targets.
Unlike Alice, Carmel and Oscar, James only had three possibilities, because he was not trained on a target, so he could make an incorrect response, a modelled response to correct stimulus, or a modelled response to an incorrect stimulus.
<table>
<thead>
<tr>
<th>Reinforced response</th>
<th>Carmel</th>
<th>Oscar</th>
<th>Alice</th>
<th>Carmel (example)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Response rates</td>
<td>Hoof</td>
<td>Nose</td>
<td>Hoof</td>
<td>Hoof</td>
</tr>
<tr>
<td>(responses/min)</td>
<td>White square</td>
<td>Blue square</td>
<td>Blue circle</td>
<td>White square</td>
</tr>
<tr>
<td>Reinforced operant</td>
<td>4.016</td>
<td>4.407</td>
<td>3.573</td>
<td>Hoof to White Square</td>
</tr>
<tr>
<td>Incorrect response to own target</td>
<td>0</td>
<td>N/A</td>
<td>0.000</td>
<td>Nose to White Square</td>
</tr>
<tr>
<td>Generalized modelled response</td>
<td>0.030</td>
<td>N/A</td>
<td>0.029</td>
<td>Hoof to Blue Circle</td>
</tr>
<tr>
<td>Generalized non-modelled response</td>
<td>N/A</td>
<td>0</td>
<td>N/A</td>
<td>Hoof to Blue Square or White Triangle</td>
</tr>
<tr>
<td>To another animal’s target</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>To a non-target</td>
<td>0.079</td>
<td>0.070</td>
<td>0.009</td>
<td>Hoof to Red Triangle</td>
</tr>
<tr>
<td>Non-generalized modelled response</td>
<td>0.00</td>
<td>N/A</td>
<td>0.000</td>
<td>Nose to Blue Circle</td>
</tr>
<tr>
<td>Non-generalized, non-modelled response</td>
<td>0.000</td>
<td>0.002</td>
<td>0.002</td>
<td>Nose to Blue Square or White Triangle</td>
</tr>
<tr>
<td>To another animal’s target</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>To a non-target</td>
<td>0.000</td>
<td>0.000</td>
<td>0.005</td>
<td>Nose to Red Triangle</td>
</tr>
</tbody>
</table>

Table 5.3: Responses averaged across all sessions in which they were available. Where a given class of response could be made to more than one stimulus, rates to the different stimuli (reinforced targets for other camels) are added, and rates of the unassigned stimulus (not reinforced for any camel) are shown. The final columns shows which response(s) by Carmel would fit each category, as an example.

Oscar had the highest response rate at 4.5 responses per min. for his trained behaviour to his target. Oscar did perform the trained hoof behaviour to Carmel’s target, but at a very low rate of 0.002 responses per minute. Other then his assigned target, the
highest number of responses occurred on the non-assigned triangle nose target with a rate of 0.070 responses per minute.

Carmel had the second highest response rate to her white square hoof target with a rate of 4.0 responses per minute. She did not perform nose targeting (untrained behaviour), but did respond to the other hoof targets at a rate of 0.030 for blue circle hoof target and 0.079 responses per minute, for the unassigned red triangle target.

Alice had the lowest response rate to her blue circle target, with a rate of responding at 3.6 responses per minute. She performed both hoof and nose targeting behaviours on most targets, but rates of responding were low with the highest at 0.029 responses per minute to the white square hoof target.

Table 5.4 shows rates for James’s responding. His rates after training were 1.40 responses per minute for the hoof target and 1.8 responses per minute for the nose target. Before training his rates were very low with the highest rate of responding being 0.018 responses per minute on Oscar’s blue square target.

<table>
<thead>
<tr>
<th>Reinforced response</th>
<th>Nose</th>
<th>Hoof</th>
<th>Stimuli touched</th>
</tr>
</thead>
<tbody>
<tr>
<td>After training</td>
<td>1.850</td>
<td>1.400</td>
<td></td>
</tr>
<tr>
<td>Before training (No reinforcement)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Possible imitation</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>To hoof targets</td>
<td>N/A</td>
<td>0.003</td>
<td>Hoof to White Square or Blue Circle</td>
</tr>
<tr>
<td>To nose target</td>
<td>0.017</td>
<td></td>
<td>Blue square</td>
</tr>
<tr>
<td>Possible stimulus enhancement</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Nose to hoof target</td>
<td>0.005</td>
<td></td>
<td>White square, blue circle or red triangle</td>
</tr>
</tbody>
</table>

*Table 5.4: Rates of responding per minute across all sessions in which they were available for James.*
5.4 Discussion

The results of this experiment found that this group of camels do not learn by watching other members of the group. Although camels live in social groups there has not been any experiments conducted to investigate if they learn from observing each other.

This experiment was designed to investigate if the youngest of the group would learn the behaviour of the adults. As previous research has shown, younger members of social groups have been found to learn how to use tools (for example, Lonsdorf, 2005; chimpanzees) what food to eat (for example, Cadieu and Cadieu, 2002; canaries) and what vocal calls to make (for example, Powell, Dooling and Farabaugh, 1997; budgerigars) from adult members.

This experimental design meant that James was an observer for the entire experiment and was trained only at the end to prove that he could perform both nose and hoof touching behaviours at a high rate. During the experiment James did touch the other group members’ targets. However, the highest response rate was 14 nose touches made to Oscar’s target across the 80 sessions that the target was available and the lowest rate was to Carmel’s hoof target (4 touches across the 116 sessions the target was available). Neither one of these responses are above chance rate.

Rates at which Alice and Carmel made alternative responses to Oscar’s target were non-negligible, and these responses could be interpreted as imitative, but there is no standard of comparison for them. Where there is a standard of comparison, there was no evidence of imitation: There is no sign that rates of modelled responses were higher than rates corresponding non-modelled responses. There is also little evidence for local or stimulus enhancement: for all the camels as the rate of responding to targets assigned to other camels were no higher than to the corresponding non-assigned targets.
These conclusions are somewhat surprising considering that many studies testing social learning in domestic animals have found some form of social learning. However, it would be premature to conclude that camels are incapable of social learning, because it could be that camels find it difficult to manipulate objects. Future research should look at other tasks to see if they are susceptible of social learning. However, the present evidence makes it less likely that social learning plays a big part either in the normal social life of domestic camels, or in their training.

In the next chapter I investigate generalized imitation in an Asian elephant. Because I found very little evidence for social learning in both camels and dogs, I wanted to study one more domesticated species. However, this particular subject was housed with one other elephant thus making it difficult to use a two action methodology. So I decided to use the other “gold standard” method for investigation imitation, the “do as I do” methodology. This methodology also let me test any evidence of a higher order operant in this species.
CHAPTER 6

Investigating social learning in an elephant.

6.1 Introduction

In the experiments described with the Diana monkeys and the Sulawesi macaques we conducted an experiment to study whether generalized imitation was present. In that experiment we found imitation, but did not find generalized imitation. However, because generalized imitation can be viewed as a higher order operant- a class of behaviours each individual behaviour may be under a different contingencies, but follow the contingency of the group (see section 1.4.1 for explanation)- we felt that it might be more likely to be seen in a well trained animal with centuries of domestication. Such an animal would be, on the one hand, adapted to be responsive to human commands through being around humans (see Udell, Dorey, and Wynne, 2008), and on the other might have already learned some higher order strategies for dealing with new commands through formal training.

The “do as I do” methodology has been used for investigating generalized imitation in children for decades (Baer & Sherman, 1964; Poulson, Kymissis, Reeve, Andreatos, & Reeve, 1990; Young, Krantz, McClannahan, & Poulson, 1994). In this method a subject is trained to match a few gestures of the demonstrator for reinforcement (i.e. the demonstrator raises her/his hand and the subject raises his/her hand) on the verbal command of “Do this” or “Do it”. After the subject reaches criterion on the trained behaviours a novel behaviour is added that has not been trained to see if the subject will spontaneously imitate the behaviour. Successfully copying a novel demonstration is taken as evidence of understanding the rule needed for imitative performance.

To our knowledge the first formal experiment with animals to use the ‘do as I do’ methodology was Hayes and Hayes (1952). In this experiment they taught a chimpanzee
named Vicki to imitate a series of behaviours directed to an object and non-object related actions under the verbal command ‘do this’ for food reward (e.g. brushing her hair). After the subject had performed a few of these trained behaviours, the authors added novel behaviours that were not trained and found that Vicki would imitate these behaviours as well in response to the “do this” command. However, as Custance, Whiten and Bard (1995) mentioned, the Hayes and Hayes (1952) article is flawed because “they did not provide scientifically adequate detail on either their procedure or results…and begs replications (pg. 841)”. Thus since this study an updated methodology has been used with parrots (Moore, 1993), dolphins (Herman, 2002a; 2002b) and great apes (Custance et al., 1995; Myowa-Yamakoshi & Matsuzawa, 2000). The updated methodology consists of shaping a few behaviours under the command ‘do this’. After the subject reaches a required criterion (which varies between experiments) the subject is shown novel or untrained behaviours by the demonstrator with the command ‘do this”. If the subject matches these behaviours in response to the human performing the behaviours and the verbal command, this in taken to be evidence of generalized imitative learning.

The “do as I do” methodology is advantageous for three reasons. First, it is similar to the two action methodology, both of which control for local/stimulus enhancement (when the actions of the demonstrator draws the attention of the observer to a particular stimulus) because “arbitrary actions were presented instead of solutions to technical problems” (Custance et al., 1995, pg. 840), so the researcher can tell true imitation from other types of social learning. Second, this methodology also controls for contagion (a behaviour -probably instinctive- performed by the demonstrator tends to act as a releaser for the same behaviour in an observer e.g. yawning), because a large number of actions can be reproduced. With each added action the likelihood that the behaviour is being produced
by contagion decreases (Custance et al., 1995). Third, unlike the two action methodology, the “do as I do” methodology tests for generalized imitation and not just movement imitation; this is the only methodology within the current literature that tests for generalized imitation. Because the command ‘do this’ is used to mean copy whatever behaviour the demonstrator does it is possible for the subjects were able to generalize this across many different behaviours and not just to show one specific movement. If the subject learns this relationship it would show that imitation itself has become a higher order operant. Finally, with this method we are training the animal to imitate the behaviour, not just looking to see if it does so spontaneously.

There are many responses that animals can easily be trained to make that are only merely, if ever, emitted spontaneously. By putting imitative behaviour in the animals’ repertoire we are increasing the likelihood that this type of behaviour will occur.

Elephants were chosen for this experiment for four main reasons; they have not been previously used to study social learning in an experimental setting although there is anecdotal evidence in field studies (see Sukumar, 2003 for examples), they are social animals, they have been domesticated and researchers have shown they have some cognitive ability. In the following paragraphs we will elaborate on these facts.

Elephants are among the most advanced social organizations known amongst mammals (Norton, 1994; Lee and Moss, 1999). Group sizes range from 2-35 individuals for African elephants (Loxodonta africana) and fewer than 5 individuals for Asian elephants (Elephas maximus). However these group sizes can vary and have been known to reach over 100 individuals. Group size has been known to decrease due to the lack of food and water and increase for protection, mainly against humans (Sukumar, 2003). Calves are thus born into a stable family unit where females stay with the group their entire lives and
males stay with the group until about the age of 14 years old. After which the adult males either join an unrelated family unit or a group of young bulls before becoming completely independent.

The matriarch of the group has been shown to reliably find food and lead the group to it, from its long history of social interactions and learning, where to find food and water for her family group. This knowledge makes her presence in the group vital for the safety and survival of her family. This information is believed to be learned through observation by her daughters and granddaughters so that when she is gone, they can teach the next generations this knowledge (Sukumar, 2003). An individual elephant, thus experiences a complex social life that reaches into this “multitier society during its lifetime” (Sukumar, 2003, pg 125).

Domestic animals are important in studying social learning for a number of reasons. Researchers have found that chimpanzees who have had extensive contact with humans are better imitators than their wild-born conspecifics, suggesting that experience with humans play a substantial role either in enhancing imitative performance or in generating imitative ability (Heyes and Galef, 2004); there is also the possibility that genetic adaptation to the domestic condition has led to a greater tendency to imitate (Heyes and Galef, 2004). A single definition of domestication has not be agreed upon by researcher, so for this paper domestication will be defined as the relationship between humans and animals in which humans control all aspects of the protection, movement, reproduction and food (Clutton-Brock, 1994) and have done over several generations. Elephants are thought to have been domesticated as early as 3000 B.C. (Sukumar, 2003). Even though elephants are skittish by nature they can be trained to put up with just about anything if they trust their handler
(Sukumar, 2003). They have been used as status symbols, in war, for their strength to haul goods and building supplies, and entertainment across the years.

Intelligence in elephants has been considered to be one of the highest within mammals (Nakajima, Arimitsu and Lattal, 2003; Arimitsu, & Lattal, 2002; Savage et al., 1994; Romanes, 1882), however there are little data to support this theory. However, elephants have been shown to discriminate between objects (Rensch, 1957; Savage et al, 1994), use tools such as twigs for scratching and branches to aid in repelling flies (Sukumar, 2003) and are able to recognize themselves in a mirror (Plotnik, deWaal and Reiss, 2006). However, self recognition in elephants has been contentious. Povinelli (1989) argued against the existence of self recognition, but Plotnik et al. (2006) claims the reason Povinelli’s study did not find evidence of self recognition is because they used small mirrors that the elephants couldn’t touch.

In summary, elephants live in complex social world and are ideal subjects for research in cognition (Schulte, 2000). The purpose of the present study is two fold. First we wanted to see if generalized imitation could be learned through the “do as I do” methodology. Second we wanted to see if the subjects were able to discriminate between the different commands given to them. Discrimination tasks have been the favoured method of assessing perceptual and cognitive capabilities in animals (Jeffery, 2007). This could be because “discrimination tasks are easy to administer and score, and provide ready data in the form of easily quantified learning curves” (Jeffery, 2007, pg 213).

6.2 Method

Subjects and Setting

The subjects in this experiment were one Asian elephant (*Elephas maximus*), Gay and one African elephant (*Loxodonta africana*), Dutchess aged 30 and 38 respectively.
These subjects were normally housed together during the day at the Paignton Zoo Environmental Park. Prior to this experiment human contact received by these animals were during training sessions, husbandry duties and veterinary procedures. Training sessions were conducted daily by the head keeper who has worked with this pair for over a decade. All the training for this experiment was done by the subjects’ regular trainer, the head keeper. The role of the researcher was to video tape the sessions and collect data.

Sessions were conducted inside of their indoor enclosure. The enclosure was 83.6 m² and consisted of heavy iron walls surrounding a concert floor. On the outside of the bars there was a cage that was filled with hay during certain times of the day. Above the enclosure there was a blue barrel that was used as enrichment.

During the training phase, (though not the baseline) of this experiment a food reward (apple and/or banana) was used along with a conditioned reinforcer (whistle). Both of these were also used in the daily training sessions conducted for husbandry purposes.

Procedure

Behaviours that were going to be used for the subjects to model and the order in which these behaviours were presented for both phases were chosen by the trainer and experimenter. Both had prior experience of the elephants’ behaviour gained from them watching the behaviour of the elephants. They independently ranked the behaviours in order from easy to difficult, and a final order was determined by discussion. These behaviours were then presented to the elephants in an order so that the level of difficulty was alternated. The reason for alternating the behaviour difficulty was so that if a learning curve was seen it should not be due to the fact that the behaviours were getting easier, and also so that we wouldn’t lose the elephants’ interest by giving them a series of difficult behaviours.
Phase one: Two baseline sessions were given before the target behaviour was trained. Each of these sessions included 10 trials. A trial included a body gesture (e.g. trainer lifted his leg) and a verbal command (“Do this”) given to the subject. Responses were counted as correct if the first observed behaviour that occurred after the command resembled the trainer’s body gesture. If the correct behaviour (that is, the same behaviour that the trainer had modelled) occurred in half the trials during baseline the behaviour would have been considered imitative and a new behaviour would be introduced. If fewer than 5 correct behaviours occurred then the behaviour was trained using successive approximations. Once the percent correct reached 80% (not including the first session) the behaviour was added to the pool of already trained behaviours, and a baseline session started for a new behaviour. During baseline there were no food rewards.

All but a few sessions were video taped. Data were collected at the time of testing and were checked for accuracy later from the video.

Phase two: Gay was the only subject that participated in this phase. In this phase we used the same behaviours that were used in the first phase except we combined them together, thus the elephant was to perform two behaviours simultaneously (lift trunk and cross legs). This phase was conducted to see if the would be easier for imitation or discrimination if the behaviours were sequences of elements that were already in the animal’s repertoire. The procedures were the same as phase I, except the behaviours were combinations of those trained in phase one.

6.3 Results

Dutchess, the African elephant, continued in this experiment until it was recognised that cataracts were affecting both of her eyes and she could no longer see the experimenters clearly. Thus all the data presented are of Gay’s performance.
Because the methodology was a multiple baseline across behaviours, different behaviours were trained for a different number of trials and trial numbers decrease as new behaviours are added (Table 6.1). Table 6.1 also shows the order in which the behaviours were presented.

<table>
<thead>
<tr>
<th>Demonstrated Behaviour</th>
<th>Number of times the behaviour was demonstrated</th>
</tr>
</thead>
<tbody>
<tr>
<td>Single behaviours</td>
<td></td>
</tr>
<tr>
<td>Lift leg (LL)</td>
<td>340</td>
</tr>
<tr>
<td>Cross legs (CL)</td>
<td>308</td>
</tr>
<tr>
<td>Lift trunk (LT)</td>
<td>217</td>
</tr>
<tr>
<td>Lift something w/trunk (LST)</td>
<td>180</td>
</tr>
<tr>
<td>Shake head (SH)</td>
<td>153</td>
</tr>
<tr>
<td>Lower head (LH)</td>
<td>61</td>
</tr>
<tr>
<td>Combination behaviours</td>
<td></td>
</tr>
<tr>
<td>Lift trunk and Lift leg (LTLL)</td>
<td>175</td>
</tr>
<tr>
<td>Cross legs and Shake head (CLSH)</td>
<td>192</td>
</tr>
<tr>
<td>Lower head and lift trunk (LHLT)</td>
<td>83</td>
</tr>
<tr>
<td>Lower head and Shake head (LHSN)</td>
<td>47</td>
</tr>
</tbody>
</table>

Table 6.1: The number of trials for each behaviour after training for the entire experiment in the order they were trained for both phase one and phase two.

Table 6.2 shows the percent of hits (correct behaviours made by Gay) and false positives (behaviour was made but was incorrect for the command given, e.g. demonstrator lifted his leg and Gay crossed her legs) for each behaviour, averaged across all sessions after training had begun with the relevant command. For the single behaviours, *lift trunk* and *lift something with trunk* ended up being the ones that were most reliably expressed.
when and only when the corresponding gesture was demonstrated. *Lower head* and *lift leg* commands were the least well discriminated for Gay. The combination behaviours were easier for Gay to discriminate with the lowest false positive rate being for the combination of *cross legs* and *shakehead*.

<table>
<thead>
<tr>
<th>Behaviour performed</th>
<th>Hits</th>
<th>False positives</th>
</tr>
</thead>
<tbody>
<tr>
<td>Single behaviour</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Lift leg (LL)</td>
<td>66.3%</td>
<td>68.3%</td>
</tr>
<tr>
<td>Cross legs (CL)</td>
<td>39.0%</td>
<td>32.9%</td>
</tr>
<tr>
<td>Lift trunk (LT)</td>
<td>94.5%</td>
<td>27.4%</td>
</tr>
<tr>
<td>Lift something w/trunk (LST)</td>
<td>65.1%</td>
<td>0.06%</td>
</tr>
<tr>
<td>Shake head (SH)</td>
<td>60.3%</td>
<td>49.3%</td>
</tr>
<tr>
<td>Lower head (LH)</td>
<td>76.0%</td>
<td>76.2%</td>
</tr>
<tr>
<td>Combination behaviour</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Lift trunk and lift leg (LTLL)</td>
<td>71.1%</td>
<td>12.0%</td>
</tr>
<tr>
<td>Cross legs and shake head (CLSH)</td>
<td>46.8%</td>
<td>10.8%</td>
</tr>
<tr>
<td>Lower head and lift trunk (LHLT)</td>
<td>58.3%</td>
<td>16.7%</td>
</tr>
<tr>
<td>Lower head and shake head (LHSH)</td>
<td>69.6%</td>
<td>0%</td>
</tr>
</tbody>
</table>

*Table 6.2: The percent hits and false positives for each behaviour; averaged across all sessions after training had begun with the relevant command. The behaviours are listed in the order in which they were trained. Only the first response made after a command was counted.*

The graphs show the percent correct (number of times the behaviour was performed correctly in the presence of the demonstration/the number of times the demonstration was presented) of each behaviour across all sessions (Figure 6.1). The vertical lines indicate the phase change between baseline and training and the gaps indicate sessions when the behaviour was not modelled, not all behaviours could be modelled in all sessions because of time constraints. As shown by the graphs, Gay did not spontaneous imitate any of the
behaviours. Most of the behaviours were performed above chance (with the exception of cross legs) with lift trunk having the most sessions at 100% percent correct.

Figure 6.1: The percent correct across sessions for all the behaviours trained in phase one. The vertical lines indicate the phase change between baseline and training and the gaps
indicate sessions when the behaviour was not modelled, not all behaviours could be modelled in all sessions because of time constraints.

For the second phase, Gay did not spontaneously imitate the combination behaviours (Figure 6.2). Most of the combination behaviours were performed above chance except for the combination of *cross legs and shake head*

![Graphs showing percent correct across session for different behaviours](image)

*Figure 6.2: Shows the percent correct across session for all the behaviours trained in phase two. The vertical lines indicate the phase change between baseline and training and the gaps indicate sessions when the behaviour was not modelled, not all behaviours could be modelled in all sessions because of time constraints.*

6.4 Discussion

Gay was successfully trained to perform all the behaviours, however generalized imitation did not emerge after training 10 behaviours (both single and combination) under
the “do this’ command. There are at least two possible reasons why Gay was not successful in the “do as I do” methodology. First, she may not have been trained in enough individual behaviours to bring about generalized imitation. We were limited on the number of behaviours the head keeper could model and have them look similar to an elephant’s movement. Second, Gay may not have been able to associate the head keeper’s leg with her leg or the head keeper’s arm in the area of his nose as her trunk; in effect, she may not have perceived the responses she was making as imitation of the commands. Arguably such perception requires a self concept and while it has been claimed that elephants do show such a concept (Plotnik et al., 2006), this rests on the data from a single experiment carried with a single elephant, and a previous study (Povinelli, 1989) failed to find evidence of self awareness.

Although the results did not show imitation, the results did formally demonstrate Gay’s ability to discriminate between different commands including sequence of commands. In previous studies of elephants the level of observed discrimination has been limited. Elephants have been known to discriminate between light and dark (Squier, 1964; Markowitz, Schmidt, Nadal, and Squier (1975) and objects (Rensch, 1957; Savage et al., 1994). We gave Gay 10 commands and found that she had more difficulty discriminating between the combination commands than she did with the single commands. The percent correct for the single behaviour phase (with the exception of cross legs) was at 100% in the first sessions after training, whereas with the combination behaviours the percent correct was at 60% or below (with the exception of shake head/lower head combo). The combination commands may have been more distinct because there were two behaviours occurring in sequential order. In Savage et al. (1994) the objects the elephants were asked to discriminate were household objects (soda can, brick, spoon) and they found elephants
could discriminate up to 24 items in about 8-9 months taking up to 350 trials for one object which a decreased to less than 50 trials by item 20. In our experiment Gay took up to 8 trials to reach criterion before a new behaviour was trained and aided. This difference could be because gestures may be easier to discriminate for elephants than objects. This could be due to elephants’ poor vision (Kern, Howard and Murphy, 1992); they have arrhythmic vision and are dichromatic during the day (Yokoyama et al. 2005).

This current experiment lasted about a year. Even with breaks between data collection, some as long as a month, in training there did not seem to be any interruption effects. Gay’s ability to perform the correct behaviour after the command was no different than when she was participating in the experiment on an every day basis. Her ability to remember the commands even after months of not taking part in the study shows that Gay, and perhaps Asian elephants, could possess a rather good long term memory, as previously suggested by Markovitz et al. (1975). However more research needs to be conducted to test the limits of this ability.

Although this study did not succeed to demonstrate imitative learning in an Asian elephant, the results add to the small pool of research on elephant cognitive abilities. Further investigation needs to be conducted to find the extent of these abilities. In particular the animals’ capacity for discriminating and producing sequences of body gestures seems worth further investigation.
Chapter 7

Conclusion

7.1 Overall conclusion

Of 110 individuals from a range of 6 species tested in the experiments reported in this thesis, only 5 individuals showed evidence of imitative learning. The results may suggest that, though social learning may be important in the lives of a few species, or in the acquisition of particular responses, it is unlikely that it plays an essential role in the acquisition of behaviour in general, although this might depend on the task (Box and Gibson, 1999), especially behaviour through which animals directly manipulate their environment.

Although some psychologists feel the need to understand how much one animal understands the actions of another, this thesis has not concluded the behaviour observed as being evidence of an animal possessing a theory of mind. Instead this thesis draws conclusions from the field of behaviour analysis, who believe that scientist should study observable behaviour and not theorize what is going on in the animals mind, as well as by extending the range of settings and species in which it has been studied. In addition, a new variation of the ‘two action’ method was developed to allow for imitative learning research to be conducted in settings outside the laboratory without the need to separate animals from their social groups.

7.2 Summary of results

Only species that naturally live in social groups were chosen for this thesis. Since the topic is social learning, choosing species that would be more likely to learn from watching their conspecifics was the most logical. This thesis was naturally split further into studies of domesticated animals and primates. Primates were chosen because as far back as
Thorndike, scientists have thought that primates were the key to finding human-like behaviours within the paradigm of social learning. Domesticated animals were studied because chimpanzees that have had extensive contact with humans are better imitators than their wild-born or non-encultured conspecifics, suggesting that experience with humans plays a substantial role either in enhancing imitative performance or in generating imitative ability (Heyes and Galef, 2004); there is also the possibility that genetic adaptation to the domestic condition has led to a greater tendency to imitate humans (Heyes and Galef, 2004).

In the Goeldi’s monkey experiment (chapter 3) a multiple baseline design was used, which allowed for the independent detection of stimulus generalization, stimulus enhancement, and true imitation. No evidence of imitation or stimulus enhancement was found despite extended exposure to the conditions, in contrast with results that have been obtained from other callitrichines (e.g. marmosets, *Callithrix jacchus*, opening film canister lids). It appears that this group of callitricids do not always show social learning.

This outcome makes sense if you consider the natural behaviour of Goeldi’s monkeys. In the wild, Goeldi’s monkeys are seen to disappear into the trees when a human observer approaches (Pook and Pook, 1979). In my observation while conducting the experiment we found the monkeys to be evasive at first. Thus I had to spend a few weeks just sitting on the floor in front of their enclosure before they habituated to my presence. They are clearly attentive to the presence of other individuals, whether of their own or a different species. However, detailed analysis of video records, and analysis of session by session data, show that, although they interacted frequently with the targets and with each other, at no point did the monkeys give the appearance that they were attending to and copying each other’s behaviour. Research is now being conducted at Paignton
Environmental Park to see whether they learn socially about noxious food, a simpler task and one that has been demonstrated in a wider range of species than the imitation of object manipulations.

In the Diana and macaque experiment (chapter 2) we found similar results with both groups. Two subjects in the Sulawesi black crested macaques group and one subject in the Diana group were found to imitate some of the trained behaviour of the demonstrator. However, imitative behaviours did not occur at a high rate and extinguished quickly. Furthermore the tendency to imitate did not seem to generalize even after these subjects were trained and given a reward after imitating the demonstrator’s behaviour. An interesting observation made in the experiments was that the subjects that were shown to imitate the demonstrator’s behaviour were juveniles. In a primate social group it makes sense for the juveniles to be the ones that watch and copy the behaviours of an adult in the group as this is a faster way to learn about their environment. In capuchins, juveniles watch adults more when they are younger and decrease this time as they age (Fragaszy, Vitale and Ritchie, 1994), although other research has found no affect (see Prescott and Buchanan-Smith, 1999).

In addition to studying non-human primates we also studied domesticated animals. In the first study we used one of the longest domesticated species, the dog. We conducted two experiments with this species. In the first experiment we used a pedal as the apparatus and let the subject watch a demonstrator operate it in one of two ways (either with its paw or with its nose). In this condition we found one dog out of 25 showed convincing evidence of imitative learning. This is after a baseline where she did not touch the apparatus, showing that the behaviour wasn’t previously in her repertoire.
A second experiment was conducted for a number of reasons. First, to see if there was a difference between having a baseline (run with the same subjects as are subsequently used in experiments) or having a control condition (run with different group of subjects). Both are effective ways to see the normal behavioural tendencies of the species for comparison will behaviour after watching a demonstrator. A baseline was used previously to deflect the criticism that the demonstrator’s behaviour was not novel, but the control condition is the more widely used method. The second reason why this experiment was conducted was to see if choosing an action that may already be in the dogs’ repertoire would increase the dogs’ chances to learn socially. A third reason was to see if there would be a difference between human and conspecific demonstrators. Finally, we wanted to see if there would be a difference in responding between unfamiliar and familiar demonstrators.

Unlike that found with the macaques and Diana’s monkeys, some of the dogs did show the nose and paw behaviour during baseline in both experiments. Of those that did not respond in baseline, we did not find significant signs of social learning, we did find that the dogs responded significantly less in the presence of an unfamiliar dog. A similar result that was found in cats (Chesler, 1969) and such findings have been used to explain Thorndike’s results (Wynne, 2004). This suggests that dogs find an unfamiliar conspecific demonstrator distracting. This is a factor that has not been studied with any species, but one that might affect the results when conducting these types of experiments since most social groups live together in hierarchies. It seems worth investigating further what kinds of demonstrators are more likely to be copied. For example, would a subordinate dog pay attention more to another subordinate or a dominate dog? This line of research was not able to be perused within the scope of this thesis.
The next experiment was conducted with another domesticated species, the camel. This experiment focused on examining social learning of the youngest in the group, but data were taken on all members. Social learning was not observed in this experiment in any of the members of the group. We concluded that this could be due to the type of method used in this experiment. Camels may not learn how to manipulate an object by social learning, but other types of behaviours might be learned in this way. Future research should look at other behaviours to investigate social learning in this species.

The final experiment was conducted with elephants, another domesticated animal. However, because we were limited in group size a decision was made to study this species by using a ‘do as I do’ method, which would also test for the animal’s generalized imitative learning.

The results of this experiment did not produce any findings of imitative behaviour. However, this could be due to a number of reasons. First, we were trying to train the subject to follow a human who has a different body shape and has never asked this subject to pay attention to their movement before. Second, we were limited on the amount of behaviours we could match and perhaps did not have enough behaviours for the subject to pick up on what we were asking her to do.

7.3 Is the low rate of imitation surprising?

Thorndike (1898) was unable to find evidence of imitation in chickens, cats, dogs and monkeys that he brought into his laboratory, though all learned by trial and error. He interpreted these failures to imitate and their ability to learn by trial and error as animals’ inability to solve problems (Galef, 2004). Today many studies claim they have found imitation and have moved the study of imitation in animals “beyond a theoretical, autonomously motivated search for evidence of a phenomenon to ask what is imitated, who
imitates and under what conditions is imitation most likely to occur” (Galef, 2004, pg. 295). The present results, however, seem more consistent with Thorndike’s generalization then Galef’s. Why?

Within the psychological social learning paradigm, imitation is the behaviour that all researchers in the area strive to find. This is because it is believed that imitation is evidence of theory of mind. Theory of Mind is the recognition of the knowledge states of others. Of course social learning driven by forms of enhancement can be a highly adaptive behaviour, but only “true imitation,” in which the observer attends to the consequences of the action for the demonstrator, can be evidence of theory of mind (Meltzoff, 1996).

For just over 100 years psychologists, have been studying social learning and in that time only a handful of researchers have been able to show clear evidence of an animal’s ability to imitate the actions of a demonstrator (Byrne, 1999; Hurley and Chater, 2005; Zentall, 2006). In addition, these experiments have rarely been independently replicated. This lack of evidence may not be the result of the lack of behaviour in the repertoire of nonhuman animals, but rather the limited definition that that field has confined themselves to and the strict methods that they use in their search.

Since Thorndike’s first and simplest definition of “learning to do an act from seeing it done”, psychologists have sought to answer once and for all whether species can or cannot imitate and in the process havemade the definition more complex. Zentall and Galef (1988) attempted to distinguish imitation from other forms of social learning. However, others disagreed with their fundamental distinctions and have created their own (see Whiten and Ham, 1992). Zentall (2004), however, took a different approach altogether and defined imitation by describing what imitation is not. Thus, “imitation is a form of social learning that remains when one has ruled out or controlled for all of the alternative
mechanisms (mimicking, observational learning, stimulus/local enhancement) that might contribute to the higher probability of a copied response” (Zentall, 2004 p. 18).

Furthermore, some have defined imitation by the intentions of the animals (Heyes, 2002).

In addition to authors not being able to agree on one definition, another reason why others have shown imitative learning with similar methodologies could be because of differences in analysis, interpretation of results or methodology. Of the research that has been conducted with the “gold standard” two-action method or sequentional bidirectional, only four studies have found imitation (Zentall, Sutten and Sherbourne, 1996 with pigeons; Akins and Zentall, 1996, with Japanese quail; Whiten, 1996 with chimpanzees; and Voelkl and Huber, 2000 with common marmosets).

For some of these studies there might be other explanations as of why they found imitation. Voelkl and Huber (2000) showed marmosets either opened a film container with its mouth or one that opened a film container with its hand after watching a conspecific demonstrator. The authors found that “common marmosets copied the response topography of a conspecific demonstrator to open a Kodak film canister” (p 200). However according to the table provided both mouth and hand opening occurred in all but two subjects in the mouth group (see table 7.1).
Table 7.1: Reproduction of table from Voelkl and Huber (2000). “The total numbers of nose-near-lid approaches, mouth-opening and hand-opening actions and opened canisters and the discrimination ratio (the number of hand-opened canisters divided by the total number of opened canisters) are shown for session 1. For session 2 only the total number of opened canisters is shown, as all canisters were opened by mouth. For the nonexposed control group (N=11) only the mean values are shown” (p 199).

<table>
<thead>
<tr>
<th>Group</th>
<th>Subject</th>
<th>Nose-near-lid approaches</th>
<th>Mouth opening</th>
<th>Hand opening</th>
<th>Opened canisters</th>
<th>Discrimination ratio</th>
<th>Session 2 Opened canisters</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mouth</td>
<td>DV</td>
<td>3</td>
<td>0</td>
<td>15</td>
<td>15</td>
<td>1.00</td>
<td>0</td>
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<td></td>
<td>MO</td>
<td>2</td>
<td>6</td>
<td>8</td>
<td>14</td>
<td>0.57</td>
<td>15</td>
</tr>
<tr>
<td></td>
<td>W1</td>
<td>4</td>
<td>13</td>
<td>2</td>
<td>15</td>
<td>0.13</td>
<td>15</td>
</tr>
<tr>
<td></td>
<td>SQ</td>
<td>5</td>
<td>11</td>
<td>4</td>
<td>15</td>
<td>0.27</td>
<td>15</td>
</tr>
<tr>
<td></td>
<td>NI</td>
<td>7</td>
<td>2</td>
<td>13</td>
<td>15</td>
<td>0.87</td>
<td>6</td>
</tr>
<tr>
<td></td>
<td>MA</td>
<td>0</td>
<td>0</td>
<td>15</td>
<td>15</td>
<td>1.00</td>
<td>15</td>
</tr>
<tr>
<td>Mean</td>
<td></td>
<td>3.5</td>
<td>5.3</td>
<td>9.5</td>
<td>14.8</td>
<td>0.64</td>
<td>11</td>
</tr>
<tr>
<td>Hand</td>
<td>KL</td>
<td>2</td>
<td>0</td>
<td>15</td>
<td>15</td>
<td>1.00</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>SU</td>
<td>2</td>
<td>0</td>
<td>15</td>
<td>15</td>
<td>1.00</td>
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<td></td>
<td>VI</td>
<td>3</td>
<td>0</td>
<td>15</td>
<td>15</td>
<td>1.00</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>GI</td>
<td>5</td>
<td>0</td>
<td>15</td>
<td>15</td>
<td>1.00</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>SH</td>
<td>5</td>
<td>0</td>
<td>14</td>
<td>14</td>
<td>1.00</td>
<td>0</td>
</tr>
<tr>
<td>Mean</td>
<td></td>
<td>3.4</td>
<td>0</td>
<td>14.8</td>
<td>14.8</td>
<td>1.00</td>
<td>0</td>
</tr>
<tr>
<td>Control</td>
<td>Mean</td>
<td>1.0</td>
<td>10.9</td>
<td>13.0</td>
<td>0.92</td>
<td>1.6</td>
<td></td>
</tr>
</tbody>
</table>

In fact some of the subjects in the mouth group used their hand to open the canister more (NI for example had 13 hand openings and only 2 mouth openings). Data were not provided for the first trial which might have given us a true sense of which behaviour would have occurred naturally after watching the demonstrator. Furthermore, in the graph they counted subjects’ data twice. According to the method section they only had 6 observers total for the mouth demonstration condition and 5 observers for the hand demonstration conditions (see Figure 7.1). However if you add the number of subjects...
reported in the graph you have 11 for the mouth condition and 4 for the hand condition.

What they did was let each individual open 15 canisters and counted all the methods of opening the canisters. We wonder what the data would look like if they counted
only the behaviour that was correct for that demonstrator (as we did with all our experiment) and what happened in the first trial (as we did with the dog experiment).

The third study that has claimed to have found imitation was Whiten et al. (1996) who used a sequence of bidirectional actions instead of the “gold standard” two-action method. In this study they used an apparatus they called an artificial fruit and had chimps watch a demonstrator open the fruit in one of two ways. Human demonstrators were used and showed the chimps which way to open the box. The results were that for one of the observed demonstrations there was some evidence that chimpanzees were more likely to copy the demonstrator’s behaviour. The authors thus claim to have found imitative learning. However, Tomasello (1996) argues that the chimpanzees could have learned how to open the device by emulation, and not imitation. Emulation differs from imitation in that the observers are not learning the exact way in which to manipulate the device, they are only learning the end goal (in this case to obtain food that is in the artificial fruit). Zentall (2006) argues that these findings can be accounted for by affordance learning because the actions of the demonstrator have detectable different effects on the environment. Overall, experiments that set out find imitative learning most of the time actually find other forms of social learning or social facilitation (for example Caldwell and Whiten, 2004).

In looking through the literature there is an interesting trend towards an increase in responses made with the body part the animal would typically use to obtain food. Of the experiments that were conducted using the two-action methodology, most of them show a preference for the behaviour the animal naturally uses to obtain food. Akins and Zentall (1996, p. 318) report “overall mean frequency of pecking was greater than that of stepping”. Dorrance and Zentall (2001) found that quail that were food deprived for longer periods of time pecked the treadle more than quail that were not as food deprived. Voelkl
and Huber (2002) found that marmosets were more likely to open the canister with its hand that its mouth. Our research found similar results. Dogs appeared more likely to open the door with their nose than with their paw. Camels appeared to nose the target more than stepping on the targets. Sulawesi macaques appeared to hand the targets more than mouth.

Although all of this could be a coincidence, it could also be the “operant-instinctive-drift” (Timberlake, Wahl, and King, 1982). Timberlake et al. (1982) argue that “misbehaviour resulted from the drift of behaviour originally under control of operant contingencies into more primitive phylogenetic pathways related to the natural food gathering behaviours of a particular species” (p. 62). Thus the animals become Pavlovianly conditioned to pair the object that is the discriminative stimulus for food (treadle for the pigeons, film canisters for the marmosets) with food and therefore used that body parts typically used to obtain food (see Timberlake, 1983).

7.4 Experimental procedures and imitation

Whether or not imitation is observed has also been found to depend on other extraneous variables, not just the methodology. Dorrance and Zentall (2001) found that the occurrence of imitation depends on the motivation of the observer. In this study, the authors used a two-action methodology with two observation conditions. Before the experiment began the Japanese quail were food deprived for 22-23 hours for several weeks. During the experiment they were either fed before observation, or deprived of food before observation and fed after testing. Quail were tested either immediately following observation or after a delay. Results show that the delay didn’t have an effect on behaviour, but quail that were hungry imitated and satiated quail did not.

Most of the animals in the present studies were run before their meals (except the Goeldi monkeys, who had access to food during the experiment). However, husbandry
guidelines and pet owners would not allow these animals to be deprived of food like some laboratory animals (especially pigeons) before participating in an experiment. So we might have seen a larger effect if we had food deprived the animals for 22-23 hours as done in Dorrance and Zentall (2001).

Additional research has found that the relationship of the demonstrator to the observer has an effect on the behaviour of the observer. Saggerson and Honey (2006) used rats as subjects, and allowed observers to watch a demonstrator pull a chain in the presence of a discriminative stimulus. Demonstrators in this study were either familiar to the observer and from the same strain or unfamiliar and from a different strain. They found that observers were more likely to match the behaviour of the demonstrator if the demonstrator was a stranger rather than if the demonstrator was familiar.

The human literature has found imitative learning in various populations. However, one thing that has not been controlled for when comparing this literature is the instructions given to nonhuman primates. In every study reviewed that used human subjects instructions were given. At the minimum these instructions consisted of the researcher telling the child that they are going to play a game. Even this simple instruction would cause the child to pay attention to the researcher in the hopes of understanding and winning the rewards associated with the game (Loftus, 1979 for effects with adults). Attending to the demonstrator is the mainpoint of any social learning experiment; we feel that instructions are a major advantage and might be the only reason that these experiments get these results. Would a child imitate an experimenter if he walked into the room and started playing with a toy and obtained a reward, if they weren’t told that they were involved in a game?
A difference between the current research and that of previously published research is the environment in which they are studied. Research has shown that minor differences in the research environment may cause vitally different results in the same experiment (Wurbel, 2002). Differences in how experimenters handle the animals, disturbances in early social environment, how subjects are housed (singly or group), types of groups they are housed in, placement in social hierarchies, changes in social conditions, etc all effect the behaviour of subjects in experiments (for a full review Olsson and Westlund, 2007). Thus there are many different variables that can affect the behaviour of the individual outside of the methodology.

The zoo environment is not exempt from all of these problems; however modern zoos offer a more naturalistic environment than a laboratory. In the wild as in a zoo, observers are able to interact with demonstrators. Wild individuals would not be separated out or isolated from the group before or after a demonstration. Zoo animals frequently live in more natural groups and are raised in a more natural setting than laboratory animals (although this isn’t always the case, it was with the experiments described in this thesis). In fact, unlike laboratory housed animals, modern zoo populations have shown similar activity budgets to their wild counterparts (e.g. Melfi and Feisnter, 2000), increasing the value of research conducted in this type of setting.

Although the zoo environment is a more natural setting than that of a laboratory there are also some disadvantages when studying social learning in such a population. In our research, subjects were expected to manipulate objects after watching a demonstrator. However wild animals use tools less than captive animals (Thierry 1985) and manipulate objects less in general (Menzel, 1966; Fragaszy and Adams-Curtis, 1991). Also, animals that live in the wild are not as tolerant of each other as animals in a laboratory setting may
be (Fragaszy and Visalberghi, 1990) and in particular they will not learn from a
demonstrator unless they have an established affiliative relationship (Itani and Nishimura,
1973; Westergaard, 1988). The final disadvantage is that animals living in their natural
environment have not been seen to imitate behaviour as researchers who study laboratory
animals have defined it (Byrne, 1999).

Overall, even with these disadvantages this line of research should continue in a zoo
setting, so that these behaviour can be studied more closely and so that the mechanisms
that are controlling the differences in behaviour between the laboratory and natural
environments can be teased apart. Furthermore, although this thesis found very little
evidence of social learning and even less evidence for imitation, we did find a methodology
that would work with zoo housed primates and a possible reason why dogs do not imitate
unfamiliar conspecifics. Although both of these projects could not be extended within the
scope of this thesis, future projects could look into these areas. In addition, future studies
could also look further into the differences between juveniles and adults social learning,
what are the best demonstrators to use in a two action method, which type of demonstrators
are distracting to different species.

This thesis used a large range of species. The goal was to choose species that live in
groups and might be adapted to learn by imitation. However, because a range of different
species were used the methodologies had to vary to suit each species. Because of the time
limit, only a small number of experiments could be conducted. However, given more time
we would have concentrated more on other types of social learning such as learning about
what foods to eat or vocalizations. We would have also liked to conduct some studies that
looked at other forms of social learning to see if once you had the observers learning from
the demonstrators in similar tasks (e.g. local enhancement) and then built up to imitation.
Imitative learning seems to be an advanced capability, as it seems to be one of the keys for the development of cultures in chimpanzees and, especially, in hominids. Having this capability has allowed these species to adapt to the environment in a new way. However, imitative learning is not widespread. This could be because of social pressures in the wild. Some primates will not even go to the same location as another conspecific because if food is sparsely distributed what is the purpose of going to a location that is stripped of resources (Chapman, White and Wrangham, 1994)? On the other hand species that exploit "honeypot" resources do approach feeding conspecifics.

It has been a common theme of this thesis, as of the previous imitation literature, that researchers who set out to look for imitation often find other forms of social learning that are cognitively less demanding, e.g. emulation. From an adaptive point of view that is perhaps not surprising. Except for species that specialize in using complex manipulation to prepare food that is difficult to access, emulating (copying the end goal) is just as useful as or more useful than imitating the whole behaviour as it takes up less cognitive effort for the same outcome. Byrne (2007) has argued that the distinctive foraging strategy of great apes is precisely the use of such complex food preparation technologies (pg. 581). It is perhaps not surprising that convincing evidence of "true" imitation in non-ape species has been hard to find.
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