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Capuchin monkeys (*Cebus appella*) do not match the actions of a ghost condition or live model.

By

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Advisor: F.B.M. de Waal, Ph.D

An abstract of a thesis submitted to the Faculty of the James T. Laney School of Graduate
Studies of Emory University in partial fulfillment of the requirements for the degree of
Master of Arts in Psychology 2012

Abstract

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Although many species rely on social learning, the exact mechanisms that animals employ to gain knowledge from one another are still unknown. Some researchers view social learning as a hierarchy with imitation as the most cognitively demanding form of social learning followed by emulation and then stimulus enhancement. This view, though, is changing, due in part, to the discovery of mirror neuron mechanisms that are thought to regulate action understanding at a subconscious level. While investigating social learning, some researchers have confounded study results by using conspecific models interchangeably with human models without a systematic analysis of how these different conditions might influence the type of information that an animal acquires. To further explore means of social learning as well as account for inconsistencies in choice of social model, this study investigated social learning mechanisms in capuchin monkeys by comparing the degree to which a test subject copied a conspecific model, a human model and a ghost condition. We found that the test subjects' decision making was not influenced by a ghost condition and they did not match the actions of a conspecific or human model. Since there was no statistical difference in matching between the model conditions the results of this study indicate that our test subjects did not use social means to determine the affordances of the test apparatus.

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Introduction:

Capuchin monkeys (*Cebus spp*.) have been shown to socially learn in both the wild and captivity (Bonnie & de Waal 2007; Dindo, Thierry, & Whiten, 2008; Ottoni & Izar 2008), but have also been unable to solve a problem after watching a social model (Fragaszy, Visalberghi, & Fedigan, 2004). Even when capuchins have been successful in social learning experiments, the neural and behavioral mechanisms they employ to acquire information from either a conspecific or human model have not been delineated (Hopper, 2010). Past empirical studies have used traditional paradigms, such as social diffusion and two-action tasks, to distinguish between methods of social learning like imitation and emulation (Bugnyar & Huber, 1997; Dawson & Foss, 1965; Horner & Whiten 2005; Whiten & Mesoudi 2008; Zentall, Sutton, & Sherburne, 1996).

Current research has included “ghost” control conditions to define whether animals attend to the unique characteristics of an animate social model or whether they determine the affordances of a task from the movement of an apparatus (Hopper et al., 2007; Hopper, Lambeth, Schapiro, & Whiten, 2008; Tennie, Call, & Tomasello, 2006). Ghost controls applied to a two-action task involve both an actual social model as well as an apparatus that seemingly moves on its own (inconspicuously activated by researchers), in a ghost condition. Success on a ghost condition indicates that a subject does not rely on cues from an animate being to solve a task but can learn from changes in the environment, whereas failure in a ghost condition, when compared to success in a social condition, indicates that the actions of a social model enhance the subjects ability to imitate actions, perhaps through bodily identification or enhanced salience of stimuli. The results of experiments using ghost conditions with nonhuman primates have been inconsistent with most studies concluding that apes fail to accomplish a task in ghost conditions, yet Hopper and colleagues (2008) demonstrated that apes would match a “ghost model” on their first trial, though matching was not sustained. (Tennie et al., 2006; Hopper et al., 2007). Currently, only one experiment using a ghost control has been conducted with monkeys. This study concluded that monkeys had the ability to “cognitively imitate” a social model, over a ghost model, through the use of a computer screen (Subiaul, Cantlon, Holloway, & Terrace, 2004). These results were potentially confounded, however, by the small sample size and the interchanging role of the subjects and models (Subiaul et al., 2004).

Although experimental procedures exploring the mechanisms of social learning are still under debate (Hopper, 2010), functional magnetic resonance imaging (fMRI) and single cell recordings have offered evidence of neurons, called mirror neurons, that form a physical connection between sensorimotor areas and perception centers in the brain. These neurons are theorized to be a pathway for the understanding of goals and actions, providing a neurological mechanism for social learning (Gallese, Fadiga, Fogassi, & Rizzolatti, 1996; Rizzolatti & Craighero, 2004). In addition, mirror neurons have been found to respond more strongly when the subject has greater experience with a task as well as a higher degree of familiarity with a social model (Heyes 2010; Jackson & Decety, 2004). This information strengthens the experimental findings that relationship characteristics such as kinship, affiliation and dominance status play a role in motivating social learning (Bonnie & de Waal 2006; de Waal 2001; Dindo, Whiten & de Waal, 2009) and is in agreement with de Waal’s (2001) model of Bonding-and-Identification-based Observational Learning (BIOL).

In order to examine whether or not an animate model is necessary for social learning and to test which animate characteristics are important, this study explored the role of different types of model in the completion of a searching task. We hypothesized that capuchin monkeys (*Cebus apella*) would match the actions of a social model at a level above chance, but would preferentially copy the actions of an affiliative conspecific model over a familiar human model and would follow the actions of a human over those of an inanimate ghost model.

Methods:

Study subjects were 12 brown capuchin monkeys, 6 from each of two separate social groups, both housed at Yerkes National Primate Research Center in Atlanta Georgia. Each enclosure had indoor and outdoor access, the combined areas of which were 25 m^2 for group 1 and 31 m^2 for group 2. Monkeys were given primate chow and water *ad libitum* as well as enriched with fruits and vegetables each afternoon. Testing was conducted, on a voluntary basis, in a mobile testing chamber (144 cm x 60 cm x 60 cm) that could be partitioned into two areas of equal size with a clear Lexan panel. This allowed for physical but not visual separation of the conspecific model and the subject. Clear Lexan panels with small round holes covered the front of the testing chamber making it possible for the monkeys to see out as well as reach outside of the chamber to manipulate the apparatus and to gain food rewards.

The testing apparatus consisted of a wooden box with a diameter of 30.5 cm x 15.2 cm x 15.2 cm that held three vertically stacked removable drawers. Each drawer was painted with a unique design and given a number so as to be easily differentiated from the others. A different set of drawers was used for each condition and drawers were counterbalanced between condition and group. The apparatus had a 10.1 x 15.2 cm hole cut into the back so that the drawers could be accessed from behind. It also had a white screen extending 15.2 cm from the top and sides to conceal any manipulation of the back of the drawers. All subjects started the study with minimal experience with the apparatus and any previous exposure was used to confirm that the subjects were not afraid to interact with it. In order to accomplish this the experimenter held the apparatus in front of the test subjects for three minutes or until the subjects attempted to reach out and touch the drawers, which all subjects did within the three-minute window.

Each subject participated in a repeated measures design based on that of Bonnie and de Waal (2006) that tested the degree to which the subject opened the same drawer as a conspecific model, a human model or a ghost model in three separate conditions. The different model conditions were randomized as well as counterbalanced between the subjects in each group and were made up of two 10-trial sessions that were run on consecutive testing days for a total of 60 trials for each subject. Each trial consisted of one presentation of the apparatus to the social model that opened an assigned drawer and obtained a food reward, the drawers were then shuffled and presented to the test subject who then had 30 seconds to open a drawer. The conspecific social model for both groups was a high-ranking, older, dominant female who occupied the same side of the test chamber in all three-model conditions in order to control for the mere presence of a conspecific. While the test subject was attending to the model, the conspecific model was presented with the apparatus and opened an assigned drawer to retrieve a food reward which they consumed as the test subject watched. The human model was a familiar researcher, other than the experimenter, who opened an assigned drawer as the test subject was watching, took out a food reward and pretended to consume it, making sure to create the sounds of eating while the subject was observing. In the ghost model condition the experimenter secretly pushed open the assigned drawer from the back of the apparatus, as the test subject watched, and showed the food reward present in the drawer to the subject. The experimenter then gave the food reward to the monkey who acted as the conspecific model in other conditions. After each presentation to the model, the drawers were shuffled and presented to the subject who was never rewarded for opening a drawer. The average interval between presentation to the social model and presentation to the test subject was 15 seconds and one subject was excluded from the study because she failed to choose a drawer after four presentations in a row for three separate sessions.

The drawer number and its location were recorded to measure how often the subject's choice matched that of the model. Additionally, the drawer number and location of the first drawer that the subject touched was recorded, if different from the drawer that was opened, in order to ascertain whether general stimulus enhancement was influenced by a social model but completion of a task was not. Because the drawers were shuffled after presentation to the model and before being shown to the subject, the correct drawer was usually in a different location than when presented to the model. This allowed the subject to choose the same drawer as the model (stimulus enhancement), or the same location (local enhancement) with a 33.3% chance of choosing drawer or location independent of each other. Under normal circumstances the chance of a subject pulling either the same drawer or the same location would be 66% but in this study drawer and location were not always independent, since, although the drawers were shuffled, a certain percentage of the time the assigned drawer landed in the same location as when it was presented to the model. Because of this the chance of each subject pulling the same combined drawer/location as the conspecific model was 58%, for the ghost condition 60% and for the human model was 57%. See Appendix I for a more detailed description of the methods and see Appendix II and III for the methods of additional experiments.

Results:

We analyzed whether the subjects chose the same drawer, or the same location, as the model at a level above chance by running a two-tailed, one-sample, t-test for each condition (SPSS 17.0). To determine if there was a difference in the degree of matching between each condition we used a repeated measures analysis of variance (ANOVA). In order to match the social model, the subject could pull open the same unique drawer as the model, which would be considered stimulus enhancement, or the subject could pull a different drawer from the same location as the one that the model had previously pulled, which would be considered local enhancement. Because of this we ran analyses of matching according to drawer and according to location, in which case chance was 1/3 or 33.3%. We also combined drawer and location (an analysis called drawer/location), in which case chance varied slightly per condition (conspecific 58%; ghost 60%; human 57%). According to a one-sample Kolmogorov-Smirnov test all of our data was normally distributed and because there was no significant difference in matching between group A and group B (t (5)= -1.06, P= .337), we combined the results of both groups.

When restricting our analyses to just the measure of matching for drawer or for location versus chance (33.3%) we concluded that the subjects did not significantly match the drawer of the model at a level above chance (conspecific (t (11)= -.134, P= .895); ghost (t (11)= -.171, P= .867); human (t (11)= -.686, P= .507), or the location of the model at a level above chance (conspecific (t (11)= -.270, P= .792); ghost (t (11)= .812, P= .434); human (t (11)= .186, P= .856) and neither the number of drawer matches or location matches differed between conditions (drawer (F(2)= .123, P= .885); location (F(2)= .204, P= .817) (see Figure 1). If the number of drawer matches and the number of location matches were combined a one-sample t-test showed that the subjects did not match at a level above chance in any of the conditions (conspecific t (11)= -.266, P= .795); ghost t (11)=.353, P= .731; human t (11)= -.555, P= ..590). When binomial tests with odds ratios of .50 and N=12 were conducted none of the subjects matched at a level above chance (ghost control (P= ..774); conspecific condition (P=1); human condition (P=1)). A repeated measures ANOVA indicated that there was no difference in matching between the different model conditions (F(2)= .741, P= .488) (See figure 2). When all trials where the model's drawer was in the same location for both the demonstration and test were removed from analysis all conditions were significantly negative (conspecific t (11)= -5.08, P < .000; human t (11)= -7.27, P < .000; ghost t (11) = -3.28, P=.007) but there was no difference between the model conditions (F(2)= .983, P=.39. An analysis of just the trials where the model's drawer was in the same location for both the demonstration and test revealed no significance (conspecific t (11)= -.77, P= .457; human t (11)= -.995, P= .341; ghost t (11)= .606, P=.557). Because the subjects initially touched a drawer that was different from the one that they pulled open less than 5% of the time and since the occurrences were spread evenly between all subjects and all conditions, we did not analyze the measure of first touch.

In response to a lack of interpretable statistical results between the first three conditions, two additional conditions were added but also failed to reach criteria for the subject to statistically match the drawer, location or drawer/location of the model at a level greater than chance or to differ in the degree of matching between conditions (see Appendix I and III). Although subjects did not match the social model at a level above chance nor did we find a difference between the social model conditions, more subjects used local enhancement (8 of the 12) than stimulus enhancement (4 of the 12). There was no significant difference, though, between the average number of location matches and the average number of drawer matches across all conditions (t(35)= -.578, P= .567).

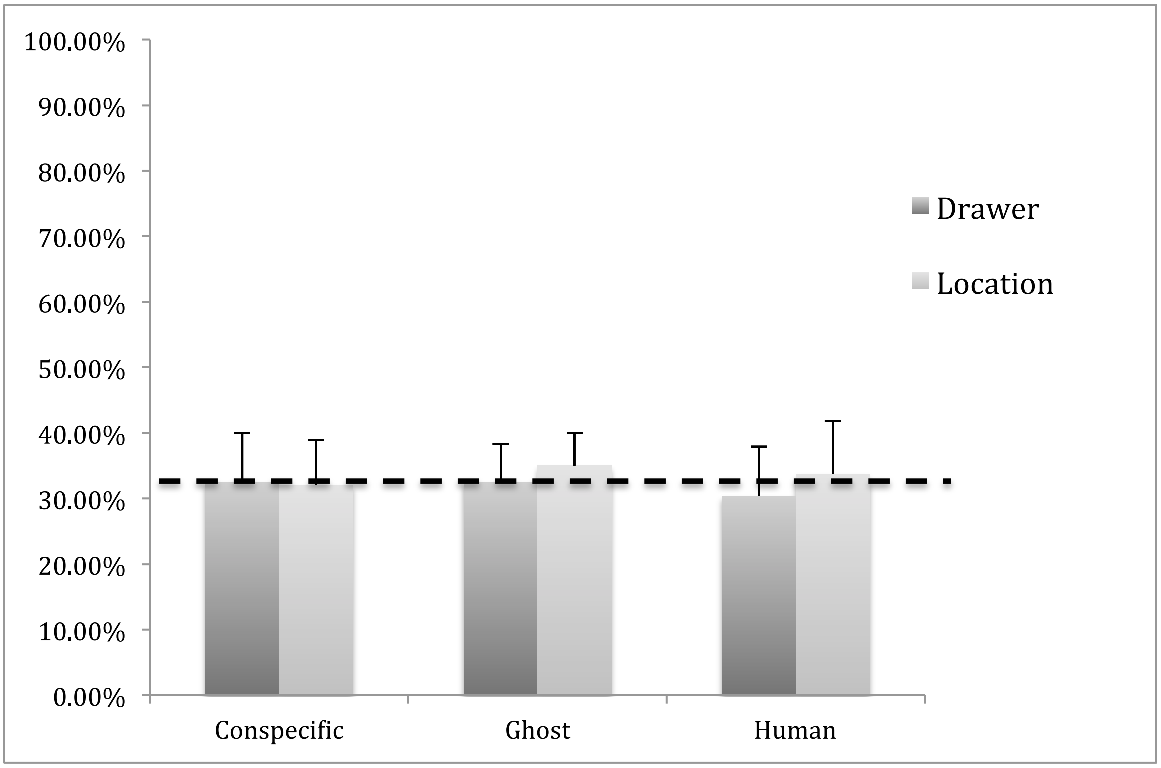

Figure 1. Average proportion of trials in which the subject matched either the drawer or the location of the conspecific model, the ghost model or the human model. The dashed line represents chance.

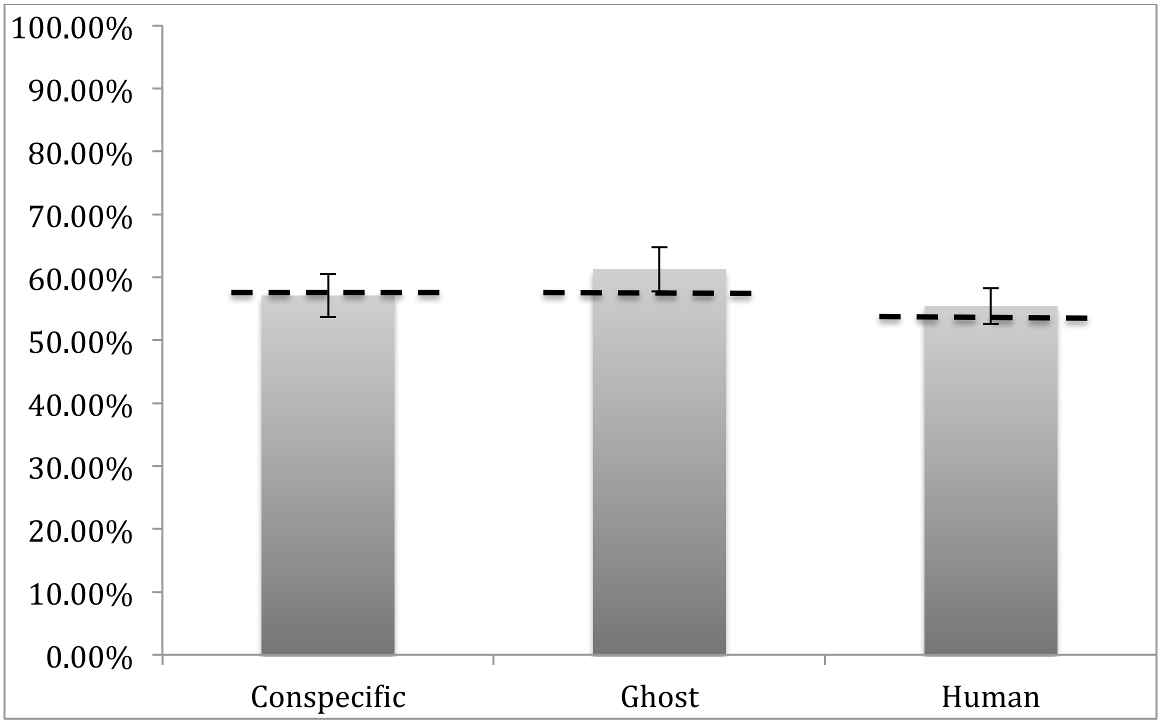

Figure 2. Overall average proportion of trials in which the subject matched either the conspecific model, the ghost model or the human model. Drawer matches and location matches are combined and the dashed lines represent chance.

Discussion :

Bonnie & de Waal (2007) reported that capuchin monkeys significantly match a conspecific model by opening the same box (out of three), which they do even in the absence of a food reward for the subject. In the present study, however, capuchin monkeys from the same colony did not match the actions of a conspecific model, a human model or a ghost condition. There was no difference in matching between the three conditions. These results imply that capuchins use individual learning to solve a task and do not need an animate being in order to learn about the environment. This interpretation conflicts with the results of several studies, though, that found capuchins to preferentially match the actions of a conspecific model over individual innovation (Bonnie and de Waal, 2007; Dindo et al. 2008, 2009, 2010). Because we found no difference between the conditions we can conclude that, in this study, the unique characteristics of the two models and ghost condition did not differently influence the degree of matching.

It is important to explore why the capuchins did not match a social model in this study and one key difference between this study and that of Bonnie & de Waal is the type of apparatus used. Bonnie & de Waal used three separate boxes in three different locations, placed side by side. The drawers in this study, in contrast, were stacked vertically, and were not separated in space. Possibly, the subjects in our study perceived the drawers as less different or separate than the boxes in the study of Bonnie and de Waal (2007). Also, in an attempt to keep the monkeys from forming a bias towards or against the apparatus or any of the drawers, the animals were not given an opportunity to explore the characteristics of it. In doing so we did not give them an appropriate chance to realize that the drawers were closed off from each other and from the rest of the apparatus, the result of which may have been a misunderstanding of the task. In order to conclude that this is why the monkeys matched close to chance for all conditions, it would have to be investigated further, as monkeys have been found to solve complex problems such as tracking the path of an invisible reward and understand the characteristics of objects moving separately as well as together, so the separation of drawers within a box should not pose a major problem (Call 2000; Munakata, Santos, Spelke, Hauser, & O'reilly, 2001).

Further analysis of our data could reveal if specific aspects of the conspecific and human conditions in this study kept the capuchins from matching the social model. It is possible that the monkeys did not match the actions of the conspecific model because they were not attending to the model. The researcher, though, only presented the capuchin model with the apparatus when the test subject was looking in the direction of the model so it is almost certain that the subjects did see the actions of the models. Although there was no difference in matching between conditions, additional data could help determine whether the test subjects differentially attended to any of the conditions. This could be measured by determining how much time each subject spent looking in the direction of the model and reveal why the subjects did not copy the actions of the models. We were not able to obtain this information, though, due to an inability to see both subject and model within the frame of the camera that was used and difficulty in determining exactly what the subjects were seeing when they were looking at the models.

The test subject's motivation to attend to the model or to copy their actions could have been limited by the relationship between conspecific model and test subject . Bonnie and de Waal (2007) selected three models of various ranks from each social group whereas only one high-ranking dominant female per group was used in the present study. Dindo and colleagues though found in various studies (2008, 2009, 2010) that capuchins copy the actions of a dominant conspecific so we cannot conclude that dominance was the primary reason that our test subjects failed in the conspecific model condition. Some of the subjects may have been intimidated by being in the testing chamber with a dominant female but since only one test subject was related to one of the models we could not analyze the results based on kinship. One explanation for our results is that the monkeys were in fact attending to the social models but due to a small sample size and the number of trials the effect was not strong enough to be detected. Another option was that the capuchin subjects attended to the model but then learned that there was no reinforcement for doing so after which they switched to pulling the drawers randomly. This scenario would not explain Bonnie and de Waal's (2007) results, however, which also included conditions without rewards for the subject.

When we separated the number of drawer matches from the number of location matches we found that the capuchins did not match any of the models at a level above chance. Apparently, the subjects did not rely on one strategy, such as either stimulus or local enhancement, to solve the task and one strategy was not more successful than the other. Overall, because the subjects did not match at a level below chance in any of the conditions, we cannot conclude that they were using a strategy of avoiding the choice of the model or that the presence of a conspecific or human in these conditions distracted the subjects from choosing the same drawer. Since the subjects were not rewarded for their actions we cannot argue that they were relying on trial and error but we can conclude that for this task the capuchin subjects in our study did not use the actions of a model to inform them about the affordances of a testing apparatus and they did not make a distinction between a conspecific model, a human model or a ghost condition.

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Appendix I: Additional Methods

Model choice and training

Social learning studies in monkeys and great apes have indicated that primates will preferentially follow the actions of a high ranking, older, skilled social model (Biro et al. 2003; Dindo et al. 2009; Horner, Proctor, Bonnie, Whiten, & de Waal 2010; Ottoni, de Resende, & Izar, 2005). Based on these results we chose one older, high-ranking female conspecific from each group to act as the same-species social model. The capuchin social models were trained to open one unique drawer and when they consistently pulled their assigned drawer with 90% accuracy for three 10-trial sessions in a row they were deemed fit to act as models. For the human model condition, we used three researchers, other than the primary experimenter, with whom all capuchins were familiar. Only one human model was used per subject and the researchers were randomized and counterbalanced across both groups. The primary experimenter was responsible for moving the apparatus in the ghost condition.

Protocol for subjects that aborted trials

Each model was presented with the apparatus as the test subject was looking in their general direction. When the test subject was subsequently presented with the apparatus they were given 30 seconds to pull open a drawer. If they did not, a timeout of 30 seconds was applied. They were then presented with the apparatus for another 30 seconds. If they still did not choose a drawer, the trial was marked as aborted and the next trial began. If the subject refused to choose a drawer for two trials in a row the session was aborted. Subjects that aborted three consecutive sessions were excluded from the study. This only happened with one subject.

Video recording

Each session was recorded with two video cameras. One camera was trained on the capuchin model and test subject in order to capture behavior, while another was pointed toward the apparatus to verify what drawer the test subject touched first and what drawer they pulled.

Name	Birth Year	Group	Role
Winnie	1984	A	Model
Star	~ 1970s	B	Model
Lulu	1984	A	Subject
Lance	2002	A	Subject
Nancy	1985	A	Subject
Luther	2005	A	Subject
Lark	2002	A	Subject
Lucas	2000	A	Subject
Gonzo	2005	B	Subject
Bias	1987	B	Subject
Bailey	1999	B	Subject
Beeker	2006	B	Subject
Scarlett	2004	B	Subject
Benny	2003	B	Subject
Winter	2004	A	Aborted Study

Table 1. The name, age, group and role of each subject in the study

Photograph 1. A photograph of the apparatus and drawers used in experiment I. Different drawers were made for experiment II and III.

Appendix II: Experiment II

Methods

In an attempt to clarify the results from experiment I, a second experiment was added. Since Bonnie & de Waal (2007) found that when both a model and a subject were rewarded, the subject matched the model a majority of the time, we added a subject rewarded condition to identify whether or not the test subjects were attending to the conspecific model at a very low level that could be amplified with reinforcement. In addition we wanted to explore the possibility that the absence of reward was confounding the subjects choices in a way that could be overcome by rewarding the test subjects. Because there was no significant difference in matching between the three model conditions (F(2)= .741, P= .488), the conspecific model was chosen as the only model for experiment II. In the first of two new conditions both the model and the test subject were rewarded. In the second condition there was no model but the subject was rewarded for pulling a pre-assigned "correct" drawer or location. In the conspecific condition it was possible to either reward the subject for matching the unique drawer that was pulled by the model or the location of the drawer that the model pulled, so we chose to reward the subject for the strategy that they most often used to match from experiment I. To obtain this bias we simply summed the number of drawer matches and number of location matches for each subject and used the number that was highest. Because of this some subjects were rewarded for matching the drawer and some were rewarded for matching the location of the drawer that the model pulled depending on their bias for one or the other during the first experiment. In the no-model condition a unique drawer was randomly chosen to be the “correct” drawer for the drawer biased subjects and, for the location biased subjects one location was chosen randomly as the correct location for the entire condition. To begin each trial in the no-model condition, the apparatus was still presented to the conspecific model but she was blocked from interacting with it. The drawers were then shuffled, for consistency, and the apparatus was presented to the subject. The subject had no information as to what drawer or location was correct unless they explored the apparatus but in the conspecific condition they had the option to use social cues to find the reward. The two conditions within this experiment were counterbalanced and each condition had one session with 20 trials instead of two ten-session trials.

Results and interpretation

When the number of drawer matches and the number of location matches were combined for each experiment the subjects in experiment II did not match the conspecific model at a level that was greater than chance (t(11)= -1.01, P= .335) and there was no difference between the conspecific condition for experiment I and II (F(1)= .137, P= .119). Additionally, the subjects in experiment II did not match at a level above chance when only their rewarded drawer or location was analyzed (t(11)= 1.56, P= .146. This is interpreted to mean that the presence of a food reward for the subjects in experiment II did not influence the subject to attend more to the model than it did in experiment I and therefore the absence of a food reward in experiment I was not the reason that the test subjects did not match the actions of a model. This conflicts with the findings of Bonnie and de Waal (2007) as the test subjects matched the conspecific model more when both model and subject were rewarded than when only the model was rewarded. Because our test subjects first went through experiment I where they were not rewarded, they may have learned not to attend to the actions of the model influencing the results of experiment II. Interestingly, three monkeys in the no model condition where location was rewarded had extremely high levels of success (85%, 85% and 95% with chance at 33%) whereas two had very low levels (.5% and 15%). This could indicate that location is a more salient factor for some subjects than following a social model or this condition could be illuminating the ease with which capuchins form a location bias.

Appendix III: Experiment III

Methods

In order to further explore the potential location and drawer bias that some subjects exhibited in experiment I, a third experiment was conducted. This experiment was the same as experiment II but here the subjects were rewarded for their non-biased strategy for both the conspecific model condition and the no model condition. If a subject, for example, showed a bias towards matching the location of the drawer that the model pulled in experiment I, they were then rewarded for matching the location in experiment II but were rewarded for pulling the same unique drawer in experiment III.

Results and interpretation

In this experiment the subjects matched the monkey model in the conspecific condition at a level that was equal to chance (t(11)= 1.10, P= .295) and gained a reward in the no-model condition at a level equal to chance (t(11)= -.608, P=.556). These results could indicate that the capuchin subjects did form a bias towards their preferred matching style but because experiment II and III were not counterbalanced between subjects an order effect could have influenced the data so as a result unambiguous conclusions cannot be drawn.

Appendix IV: Further Statistical Analysis

Analysis by Group

In addition to the reported analyses we analyzed our subjects by group A and group B as well as by sex. When we analyzed the pooled drawer and location matches for group A we found that the test subjects did not match any condition at a level that was significantly above chance (conspecific t(5)= -1.37, P=.227; human t(5)= -2.43, P=.060; ghost t(5)= 1.337, P=.239). When we repeated this analysis for group B we found that the test subjects did not match the model at a level above chance for any condition (conspecific t(5)= 1.022, P=.353; human t(5)= -.063, P=.952; ghost t(5)= .210, P=.842).

Analysis by Sex

When the drawer and location matches were pooled and the subjects were analyzed by sex we found that neither the females (n=9) or the males (n=3) matched the model above chance in any of the test conditions (Females: conspecific t(8)= -.415, P=.689; human t(8)= -.094, P=.927; ghost t(8)=.486, P=.640) (Males: conspecific t(2)= .693, P=.560; human t(8)= -1.21, P=.350; ghost t(8)= -.378, P=.742).

Matching across trials

In order to determine whether or not the degree of matching in experiment I was influenced by trial number we graphed the number of subjects who matched the models drawer or location during each of their 60 trials (see figure 1). This gave an interesting pattern that showed a steady increase in matching up to trial 5 with a dramatic decrease at trial 6. From this point on there was no evidence of a pattern within the graph. This graph gave evidence that the subjects may have been attending to the model in the first 5 trials but due to lack of reinforcement or some other factor, this behavior was not sustained. This finding matches that of Hopper et al. (2008) who found that chimpanzees matched the first trial of a ghost model to a degree that was higher than chance but that this matching declined after the first trial. In order to further explore this, we divided the first session by condition and grouped each condition by 5-trial increments (see figure 2). We found that, on average the subjects matched 77% of the trials and that human was matched in 90% of trials while the ghost condition was matched on 85% and conspecific on 57%. If there was an influence of number of trials over all conditions, though, we would expect to see a consistent rise or fall in matching across over the course of the session, and if there was an interaction between one social model and the amount of time each subject spent with the apparatus, we would expect to see a difference in that condition over time. Overall the patterns between trials were un-interpretable and we can conclude that trial number did not systematically influence the results of each condition.

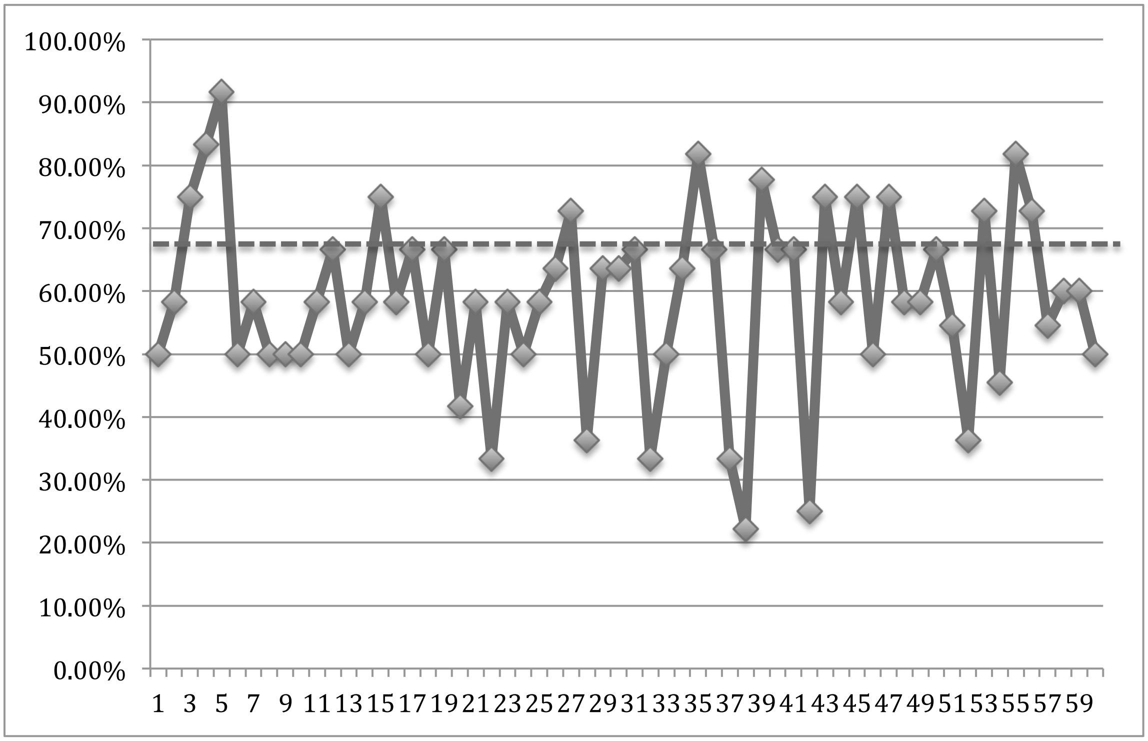

Figure 1. The percentage of individuals who matched the model in each trial.

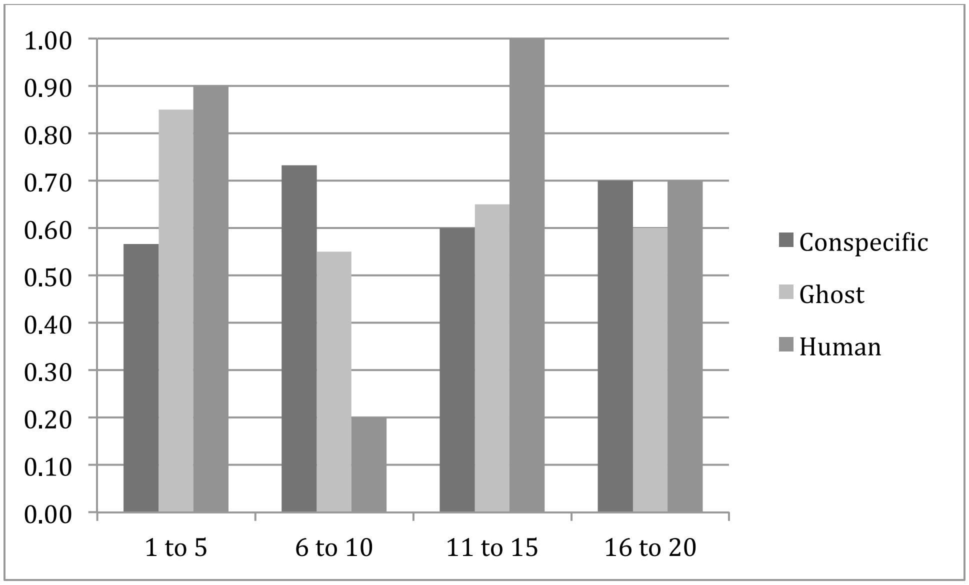

Figure 2. The proportion that each subject matched the model on drawer/location in trials 1-5, 6-10, 11-15 and 16-20 of the first session.

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