

THE PENNSYLVANIA STATE UNIVERSITY  
SCHREYER HONORS COLLEGE

DEPARTMENT OF PSYCHOLOGY

BEHAVIORAL RESPONSES OF COTTON-TOP TAMARINS (*SAGUINUS OEDIPUS*)  
TO VIDEO RECORDINGS OF THE SELF AND CONSPECIFICS

RICKY DAVID GRONER II  
SPRING 2013

A thesis  
submitted in partial fulfillment  
of the requirements  
for a baccalaureate degree  
in Psychology  
with honors in Psychology

Reviewed and approved\* by the following:

Daniel Weiss  
Associate Professor of Psychology and Linguistics  
Thesis Supervisor

Kenneth Levy  
Associate Professor of Psychology  
Honors Advisor

\* Signatures are on file in the Schreyer Honors College.

## **ABSTRACT**

The present study involved a series of experimental approaches investigating how long and how frequently cotton-top tamarins (*Saguinus oedipus*), a species of New World monkeys, look towards real-time video recordings of themselves as compared to past video recordings of unfamiliar individuals. These results may speak to whether the tamarins possess a capacity for kinesthetic-visual matching, which may be an important underlying component of mirror self-recognition.

## TABLE OF CONTENTS

List of Figures .....	iii
List of Tables .....	iv
Acknowledgements.....	v
Chapter 1 Introduction .....	1
Conceptual Differences between Mirror-Guided Self Recognition and Self Awareness .....	2
The Kinesthetic-Visual Matching Model .....	4
A Phylogenetic Gradient of Self-Awareness.....	7
Previous Research on Self-Recognition in Cotton-Top Tamarins .....	9
Present Study .....	10
Chapter 2 Experiment 1 .....	12
Method.....	12
Subjects.....	12
Apparatus and Stimuli .....	12
Procedure .....	13
Analysis .....	14
Results.....	14
Chapter 3 Experiment 2 .....	19
Method.....	19
Subjects.....	19
Apparatus.....	19
Procedure .....	20
Analysis .....	20
Results.....	20
Chapter 4 General Discussion.....	25
REFERENCES .....	32

**LIST OF FIGURES**

Figure 2-1. Average Look Duration per Session for Experiment 1.....	15
Figure 2-2. Average Look Duration per Session by Sex for Experiment 1.....	15
Figure 2-3. Average Frequency of Looks per Session for Experiment 1 .....	16
Figure 2-4. Average Frequency of Looks per Session by Sex for Experiment 1. ....	17
Figure 3-1. Average Look Duration per Session for Experiment 2.....	21
Figure 3-2. Average Look Duration per Session by Sex for Experiment 2.....	22
Figure 3-3. Average Frequency of Looks per Session for Experiment 2. ....	23
Figure 3-4. Average Frequency of Looks per Session by Sex for Experiment 2. ....	23

**LIST OF TABLES**

Table 1. Individual Data for Experiment 1 .....	14
Table 2. Individual Data for Experiment 2 .....	20

## **ACKNOWLEDGEMENTS**

This honors thesis was funded in part by a generous Pennsylvania State University Office of Undergraduate Education Summer Discovery Grant, which allowed me to spend the summer of 2012 in the lab to collect data and work towards the completion of this project. I would like to thank Dr. Daniel Weiss for his invaluable guidance in the development and progression of the ideas and methodologies presented in this thesis, and I would like to thank Dr. Kenneth Levy for his valuable input as well. I would also like to thank the members of the Comparative Communication Laboratory at the Pennsylvania State University for their continuous miscellaneous assistance in data collection and procedural setup.

## Chapter 1

### Introduction

The scientific literature investigating primate self-awareness is an extensive collection spanning over 40 years of work. The first modern attempt to identify such a cognitive capacity in primates was documented by Gallup (1970), in the common chimpanzee (*Pan troglodytes*). Gallup exposed several chimpanzees individually to mirrors and observed their behaviors in response over the period of a few days (Gallup 1970). He observed that social behaviors (interacting with the mirror image as if it were another conspecific) were common towards their reflections initially, but these behaviors decreased over time. He also noticed that self-directed behaviors towards their reflections increased as time and exposure increased (Gallup, 1970). In the same report, he developed a mirror “test” where chimpanzees were marked with an odorless dye near the eyebrow (under anesthesia) and were placed in front of a mirror to observe their reaction to the dye. Chimpanzees with previous exposure to a mirror had noticed the mark on their face and used their hands to touch the mark, and they even observed and smelled their fingers after touching the mark (Gallup, 1970). Chimpanzees with no prior exposure to a mirror did not investigate the mark. Gallup also tested two other primate species: the stump-tailed macaque (*Macaca arctoides*) and the rhesus macaque (*Macaca mulatta*; Gallup, 1970). It was found that even through prolonged exposure to mirrors in both species, the monkeys did not show any apparent decrease in social behaviors, nor did they exhibit any evidence of self-directed behaviors while using the mirror. Not only

did this preliminary study produce the first results of a non-human primate species possessing the capacity for self-recognition, but it also suggested that this capacity may be unique only to humans and great-apes. Gallup provided an innovative way to observe whether a species had the capacity to demonstrate mirror-guided self-recognition (MSR).

Since Gallup's (1970) research on chimpanzees, other Great Ape species have been shown to pass the mark test. These species include the bonobo (*Pan paniscus*; Westergaard & Hyatt, 1994; Walraven, Elsacker, & Van Heyen, 1995; Inoue-Nakamura, 1997), and the orangutan (*Pongo pygmaeus*; Lethmate & Dücker, 1973). Gorillas (*Gorilla gorilla*), however, have historically had difficulty in demonstrating success with the mark test (Suarez & Gallup, 1981; Ledbetter & Basen, 1982). A common explanation for their failure is that gorillas often avert eye gaze from conspecifics, as this is seen as a threat in the wild, and therefore observing a reflection in the mirror can be stressful and elicit aversive behavior (Posada & Colell, 2007). However, with extensive experience in captivity, gorillas have been shown to pass the mark test (Patterson & Cohn, 1994; Posada & Colell, 2007). Interestingly, more distally related primate species have little or no support for mirror self-recognition (Suddendorf & Collier-Baker, 2009). The literature tends to support what could be called a 'phylogenetic barrier' between the Great Apes (including humans), and the rest of the primate evolutionary tree.

### **Conceptual Differences between Mirror-Guided Self Recognition and Self Awareness**

The mark test has become an important methodology in determining whether an organism is capable of demonstrating MSR. However, the relationship between MSR



and self-awareness is controversial (De Veer & van den Bos, 1999; Schilhab, 2004).

Gallup (1982) has staunchly postulated that MSR-capability in a species is evidence of self-awareness. To elaborate on this viewpoint, Morin (2011) summarizes that exhibiting mirror-guided self-directed behaviors is apparently indicative of the ability to make oneself the “object of [their] own attention” (pg. 369), and that this ability is evidence of self-knowledge, and therefore self-awareness. It is important to note, however, that MSR and self-awareness are not equally defined terms (Morin, 2011). Morin (2006; 2011) defines self-awareness as “a state in which one actively identifies, processes, and stores information about the self” (pg. 369), and that it involves emotional processes, autobiographical retrieval, a sense of agency, and personality traits, as well as self-esteem, self-regulation, death awareness, and self-conscious emotions. Is MSR indicative of all these characteristics?

Early attempts to debate Gallup’s conclusions about the indicative properties of MSR include a study by Epstein, Lanza, and Skinner (1981). The researchers applied blue dots to non-observable parts of the body of three pigeons that were trained to peck at these dots. The pigeons pecked at the dot through the use of the mirror, but not when the mirror was covered (Epstein, Lanza & Skinner, 1981). This showed that pigeons could be trained to use a mirror to touch unobservable parts of the body, without the presence of a self-concept.

Morin (2011) also provides a set of research studies (described below) that suggest MSR is not only non-indicative of self-awareness, but that MSR is not even required for self-awareness to exist. A study conducted by Cunningham & Glenn (2004), observed MSR in Down syndrome patients, and although 57% of the participants were

aware of their disability, a surprising 96% were able to demonstrate MSR. Another study by Ramachandran (2007) reported that patients who thought their mirror images were of someone other than themselves, are also capable of MSR. Similarly, there have been patients reported who are capable of shaving in the mirror, yet through dementia have lost their ability to recognize themselves in a mirror (Sugiura et al., 2006). There have even been reports of a prosopagnosia patient who cannot recognize their own face, yet they have self-knowledge of personal traits (Klein, Gabriel, Gandi, and Robertson, 2008). These studies, according to Morin (2011), suggest that “MSR can be exhibited in the presence of important self-awareness deficits, and MSR can be impaired despite intact self-knowledge” (pg. 370). Therefore, the role of MSR in the expression of self-awareness, at least in humans, is not as clear as previously thought.

### **The Kinesthetic-Visual Matching Model**

In further efforts to delineate MSR from genuine self-awareness, Mitchell (1993; 1997a; 1997b; 2002a; 2002b) has proposed the kinesthetic-visual matching model as a more appropriate explanation for MSR. The model suggests that an individual is capable of demonstrating MSR if they can cognize the match between the perception of their movement in space with the contingent motion occurring in a reflective medium (Mitchell, 1997). Operationally defining MSR in this way suggests that a fully-functioning self-awareness is not needed to demonstrate a capacity for MSR. This definition does not conflict with the clinical studies presented by Morin (2011), described above. Furthermore, the model has been validated in a study where a robot used a

Bayesian kinesthetic-visual matching algorithm to successfully distinguish its own motion in a mirror from other animate agents in the environment (Gold & Scassellati, 2007).

Kinesthetic-visual matching may also suggest that species which do not pass the mark test may still possess a capacity for MSR. Possible evidence for this model in non-humans may be expressed in an organism's preference for external agents that imitate their actions. For example, it has been found that the pigtailed macaque (*Macaca nemestrina*), a monkey species that has been demonstrated to fail the mark test (Macellini, Ferrari, Bonini, Fogassi & Paukner, 2011), will prefer to attend to human experimenters who imitate their actions compared to those who do not (Paukner, Anderson, Borelli, Visalberghi, and Ferrari, 2005). The authors themselves provide kinesthetic-visual matching as a possible explanation for the observed results, while also noting that visual-visual matching (matching what is seen by the agent with what is seen by the imitator) may be at play as well (Paukner et al., 2005).

If pigtailed macaques can recognize imitation through kinesthetic-visual matching capabilities, then it is likely that they have the cognitive prerequisites to at least implicitly recognize their mirror image as unique to the self. Whether or not this is true remains to be seen. One way to build on this argument could be to demonstrate that pigtailed macaques can distinguish between their mirror image from a live and present conspecific. Although such an experiment has not been conducted with pigtailed macaques, such an experiment has been conducted with capuchin monkeys.

An article by de Waal and colleagues (2005) examined capuchin monkeys' (*Cebus apella*) responses to mirrors, compared to both familiar and unfamiliar

individuals. The capuchin is a New World Monkey that is well-known for its ability to use tools in the wild, including the use of large rocks to crack open nuts (Fragaszy, Visalberghi, & Fedigan, 2004), yet nevertheless does not exhibit self-directed behaviors through exposure to mirrors (Anderson & Roeder, 1989; Paukner, Anderson & Fujita, 2004), and has empirically failed the mark test (Roma et al., 2007). Interestingly, de Waal and his colleagues (2005) found that capuchins generally respond to their mirror images more positively compared to a conspecific stranger of the same sex, as well as a familiar same-sex conspecific belonging to the same colony. Positive behaviors included the “bunny sit”, curling up, and squealing for males, and lip-smacking and friendly swaying for females. The most significant behavior found to be exhibited towards the mirror was the amount of eye contact made for both males and females. Furthermore, more negative behaviors were exhibited toward the stranger compared to the other conditions. These behaviors included the raise of the eyebrow and threat displays for males, as well as avoiding eye contact and quick glances for females. Although the differences between the total positive and negative behaviors described are significant for both genders, the effect seemed to be more prevalent for females.

De Waal and colleagues (2005) demonstrated that another monkey species, thought to not possess MSR, can distinguish between its mirror image and a conspecific stranger. These results led the authors to assert the idea that self-awareness may be more of a gradual concept, spanning varying levels across many species. It remains to be seen where the capuchin monkey lies on this suggested ‘gradient,’ but the idea warrants further research and intellectual pursuit.

## **A Phylogenetic Gradient of Self-Awareness**

The proposition that self-awareness may be reflected as a phylogenetic gradient comes from developmental research with humans. It has been postulated that self-awareness in humans develops in contrasted stages, or levels (Rochat, 2003). Rochat has presented six separate levels of self-awareness. On this scale, Level 0 describes an individual's complete obliviousness to their reflection in a mirror. At birth, infants have already surpassed this level, and therefore never express it. Level 1 describes an individual's preliminary perception of a difference between reflections in the mirror from the physical environment, and that there is something unique about the contingency between the movements of the individual and the motion in the mirror perceived by the individual. Infants express Level 1 at birth (Rochat, 2003).

Level 2 goes beyond the intrigue of contingency, and describes an individual's awareness that the contingent image in the mirror is unique to the self. Infants typically express this level by two months of age (Rochat, 2003). Rochat provides evidence that implies infants by this age are expressing Level 2 through indirect means. For example, Rochat and Strianno (1999) found that two month-old infants can differentiate between analog and non-analog pitch variations produced by oral pressure applied to a pacifier. In the analog condition, the pitch of a sound played back to the infant increased or decreased with respect to the increase or decrease of pressure applied to the pacifier by the infant. In the non-analog condition, the pitch variations were random and therefore not contingent with the infants sucking behavior. Interestingly, in a separate investigation, newborns were not found to differentiate between the two conditions (Rochat, 2003).

According to Rochat, these findings suggest that infants by two months of age are capable of “exploring and contemplating the consequences of their own actions in the environment” (pg. 724), and therefore are supportive evidence of a Level 2 status of self-awareness. Also, Meltzoff and Moore (1992) found that 6 month-old infants are capable of imitating the directionality of tongue pulls by an adult model. In other words, these infants were able to stick their tongues out and pull them in the same direction as an adult who had stuck out and pulled their tongue to either the left or right, compared to a straight midline posture (Meltzoff & Moore, 1992). The infants also appeared to begin at a midline posture, while slowly pulling their tongues until it matched the direction of the adult model, suggesting that these infants were ‘exploring’ their tongue-pulling options (Meltzoff & Moore, 1992). To Rochat (2003), these findings are evidence of both differentiation and situation from the adult model, and therefore are supportive of a Level 2 status of self-awareness.

In an attempt to map onto this developmental scale, the capuchins in de Waal and colleagues’ (2005) study seem to be expressing something between a Level 0 and Level 1 status of self-awareness, in that they are able to *differentiate* between their mirror image from a live and present conspecific, yet they still exhibit species-typical social behaviors (as well as high anxiety and aversive behaviors in males) towards the mirror. Nonetheless, if the phylogenetic gradient of self-awareness is anything like Rochat’s (2003) developmental stages, than it can be hypothesized that capuchins fall somewhere on the line between all (genuine self-awareness) and none (complete obliviousness to the self). Research on other monkey species, notably the cotton-top tamarin (*Saguinus oedipus*), may indicate that capuchins are not alone on this gradient.

### **Previous Research on Self-Recognition in Cotton-Top Tamarins**

The cotton-top tamarin, a New World monkey like the capuchin, is another primate species that has been investigated with regards to MSR (Hauser, Kralik, Botto, Garrett & Oser, 1995; Hauser, Miller, Liu & Gupta, 2001; Neiworth, Anders & Parsons, 2001). A preliminary investigation by Hauser et al. (1995) actually reported unusual findings compared to the rest of the literature, in that the data provided supposed evidence of mirror-guided self-exploration in the cotton-top tamarin through the employment of the mark test. However, a critique by Anderson and Gallup (1997) questioned the validity of the results, which forced an additional investigation by Hauser and colleagues (2001). They later conducted a follow-up experiment that employed a traditional mark test, as well as an additional mark test experiment that examined the effects of prolonged exposure to mirrors. They found that these cotton-top tamarins did not produce mirror-guided self-exploratory behaviors this time around.

Cotton-top tamarins have also been investigated utilizing an alternative methodology to the mark test: using video monitors. Neiworth and colleagues (2001) exposed cotton-top tamarins to mirrors, real-time and past video recordings of themselves, as well as past recordings of unfamiliar conspecifics. They measured the frequencies of a number of behaviors that occurred frequently throughout all conditions (Neiworth et al., 2001). These behaviors included nonaggressive looking, peeking, manipulation of the apparatus, and contingency testing, which Neiworth et al. (2001) describes as “the testing of one’s movement against the image’s movement [in a reflective medium]” (pg. 432). The authors found that the mirror condition elicited the

highest frequency of events for these behaviors, except for contingency testing, which was actually elicited more by the real-time self-condition, and was not elicited at all by the previously recorded conditions. However, the only behavior that happened to show a possible significant trend was nonaggressive looking (Neiworth et al., 2001).

Contingency testing is a particularly important behavior to observe because it may involve some capacity for kinesthetic-visual matching. If additional evidence can be provided that suggests cotton-top tamarins do indeed acknowledge the contingent properties of a reflective medium, then it may suggest that cotton-top tamarins possess some capacity for kinesthetic-visual matching. Moreover, the result that cotton-top tamarins prefer to test contingency with a live recording of the self, compared to their image in a mirror, deserves further investigation.

### **Present Study**

The present study was concerned with further investigating the behavior of cotton-top tamarins in response to video recordings of the self and conspecifics. The study employed a 2x2 within subjects design. The main independent variable measured in Experiment 1 was a percentage of motion contingency displayed through a video monitor. Contingency was modulated by either using a real-time video recording of the subject (100% motion contingency between the viewer and stimulus), or a past recording of another individual subject (0% contingency between the viewer and stimulus). The dependent variables included measures of look duration and frequency. Look duration was measured as the total duration in which the subject's head was facing toward the



monitor for one session. Look frequency was measured as the total amount of looks the subject exhibited for one session, defined as two or more seconds. Due to apparent issues with the methodology of the first experiment (described later), we ran a second similar experiment that addressed these issues.

If cotton-top tamarins possess the capacity for kinesthetic-visual matching, then we predicted that the tamarins would exhibit a significant difference in the duration and frequency of looks between a live video recording of the self and a past video recording of other conspecifics. If this prediction were to be supported by the data, it would suggest that cotton-top tamarins can differentiate between stimuli that produce contingent and non-contingent (random) motion in a reflective medium, an important component of the kinesthetic-visual matching model. It may also provide preliminary, but not complete, evidence that cotton-top tamarins, like capuchins, may fall somewhere between all and none on a phylogenetic gradient model of self-awareness.

## **Chapter 2**

### **Experiment 1**

#### **Method**

##### **Subjects**

Ten adult cotton-top tamarins were the subjects of this study (5 females and 5 males). Subjects were housed in the Centralized Biological Laboratory at the Pennsylvania State University. All subjects were housed in pairs. Home cages were separated by opaque dividers hanging between each cage. The monkeys were supported by full-time staff and were fed a regular diet of fruits, nuts, mealworms, and chow.

##### **Apparatus and Stimuli**

Subjects were run in their colony room within their home cages. A mobile cart was used to display the stimuli and record the video files for coding. The cart was fitted with a Mac Mini computer, an Apple Thunderbolt monitor (27 inch screen), and a Logitech 910 HD webcam, as well as a Dell monitor (17 inch screen) which was used for terminal access. The Thunderbolt monitor was used to display the stimuli for each condition. All conditions were initiated by and all video data was stored on the Mac Mini. The webcam was used to record individual sessions. It was also used to provide the input

for the real-time conditions, so that they could be displayed on the monitor. A Canon HD Vixia HG20 camcorder was positioned on a tripod behind the cart to record subjects for coding purposes. Three software packages were used to run, record, and import video during various trial sessions for the experiment. CamTwist, a live video effects software package, was used to display the real-time video recordings. iShowU HD, desktop recording software, was used to record the real-time video recordings as they were displayed during a particular session.

## **Procedure**

Before a session was conducted, the experimenter confirmed that the mobile apparatus was placed precisely against the home cage such that the video display monitor was centered and clearly viewable from inside the transport box chamber. The transport chamber (31x30.5x24 cm) protruded from the home cage, and sat roughly 82 cm from the ground. The monitor was positioned 5 cm from the face of the transport chamber that was directly across from chamber entrance.

The transport box door was closed to prevent subjects from entering the chamber until the session commenced. Once the stimulus was ready, the experimenter simultaneously opened the transport box door and started the stimulus, which was displayed on the monitor resting against the chamber. The subject pair was then given ten minutes to enter the chamber freely and observe the stimulus. In the online-self condition, the stimulus was a live recording of the subjects, while in the offline-other condition, the stimulus was a past recording of a pair of subjects in their own transport box chamber.

Once the ten-minute session expired, the experimenter stopped the stimulus and closed the transport chamber door, after both subjects had re-entered the home cage. Upon removing the mobile apparatus, the chamber door was reopened.

## Analysis

Windows Movie Maker was used to code the videos. Coded data was inputted into a Microsoft Excel spreadsheet, and data analyses were conducted using both Microsoft Excel and SPSS. We ran a series of paired t-tests, as well as several non-parametric Wilcoxon Signed Ranked tests when appropriate.

## Results

For Experiment 1, we analyzed two dependent variables: total look duration and total look frequency per session. For both variables we performed analyses for the sample as a whole, as well as a division of the sample based on sex. Since the sample size was small, we tested for outliers in the data, but none were found.

**Table 1. Individual Data for Experiment 1.**

	<i>Dolores (F)</i>	<i>Lisa (F)</i>	<i>Susan (F)</i>	<i>Mulva (F)</i>	<i>Maggie (F)</i>	<i>Newman (M)</i>	<i>Bart (M)</i>	<i>George (M)</i>	<i>Kramer (M)</i>	<i>Milhouse (M)</i>
<b>Duration</b>										
Online-Self	3.53	45.73	99.3	68.86	35.03	77.53	146.83	127.02	53.3	51.24
Offline-Other	61.07	53.43	110.26	55.94	84.96	12.57	68.77	152.22	8.5	9.23
<b>Frequency</b>										
Online-Self	1	6	17	16	7	21	31	26	12	11
Offline-Other	13	13	23	17	14	4	22	34	2	2

**Duration values are in seconds. (F) = Female, (M) = Male.**

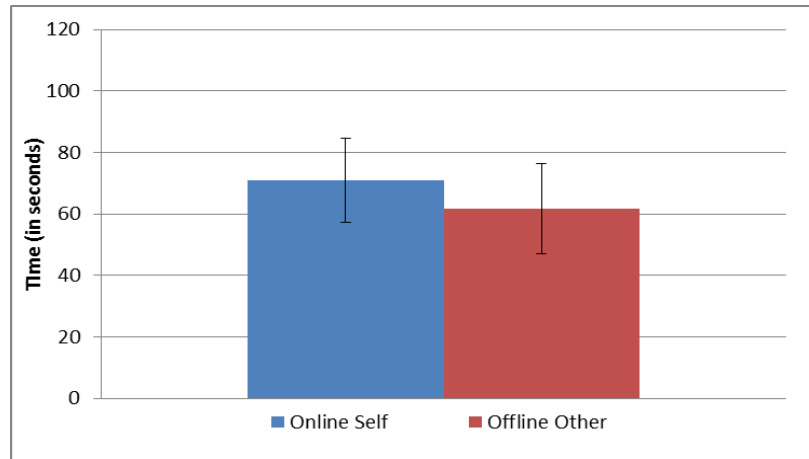


Figure 2-1. Average Look Duration per Session for Experiment 1.

For total duration of looks per session, we performed a paired t-test to assess the difference in the means of the online-self ( $M = 70.84$ ,  $SD = 43.36$ ,  $N = 10$ ) and the offline-other ( $M = 61.70$ ,  $SD = 46.24$ ,  $N = 10$ ) conditions, for the entire sample. It was found that the means of these two conditions were not statistically different,  $t(9) = 0.613$ ,  $p = 0.555$ .

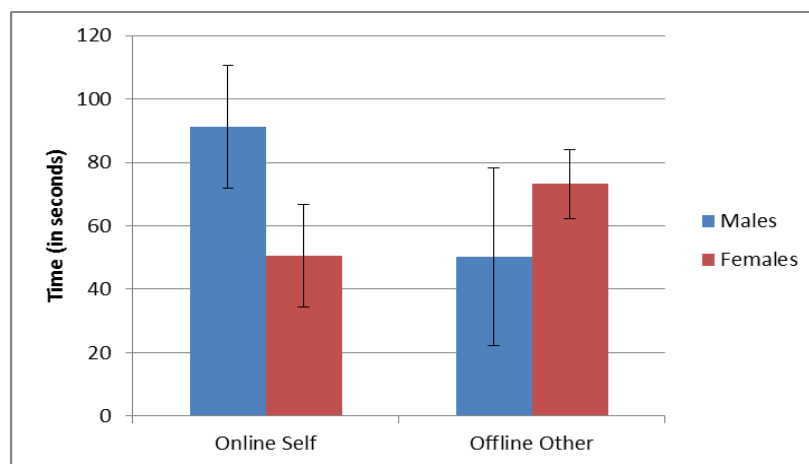


Figure 2-2. Average Look Duration per Session by Sex for Experiment 1.

We also ran four paired t-tests comparing sex differences in the total duration of looks across these two conditions. For the online-self condition, total look duration in males ( $M = 91.18$ ,  $SD = 43.58$ ,  $N=5$ ) was not found to be significantly different from total look duration in females ( $M = 50.49$ ,  $SD = 36.01$ ,  $N = 5$ ),  $t(4) = 1.952$ ,  $p = 0.123$ . There was also no significant difference in the means found for the offline-other condition between males ( $M = 50.26$ ,  $SD = 62.42$ ,  $N = 5$ ) and females ( $M = 73.13$ ,  $SD = 24.23$ ,  $N = 5$ ),  $t(4) = -1.038$ ,  $p = 0.358$ . For males across both the online-self ( $M = 91.18$ ,  $SD = 43.58$ ,  $N=5$ ) and the offline-other ( $M = 50.26$ ,  $SD = 62.42$ ,  $N = 5$ ) conditions, we found a marginally significant difference in the means,  $t(4) = 2.298$ ,  $p = 0.083$ . Additionally, a non-parametric Wilcoxon Signed Ranks test showed that there was also a marginally significant difference between the two conditions,  $z = -1.753$ ,  $p = 0.080$ . For females across both the online-self ( $M = 43.51$ ,  $SD = 33.76$ ,  $N = 5$ ) and offline-other ( $M = 43.286$ ,  $SD = 16.22$ ,  $N = 5$ ) conditions, we did not find a significant difference in the means,  $t(4) = -1.691$ ,  $p = 0.166$ .

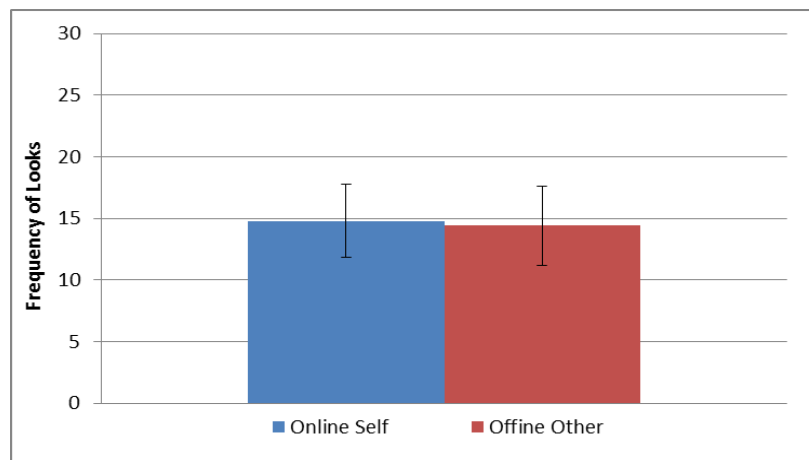
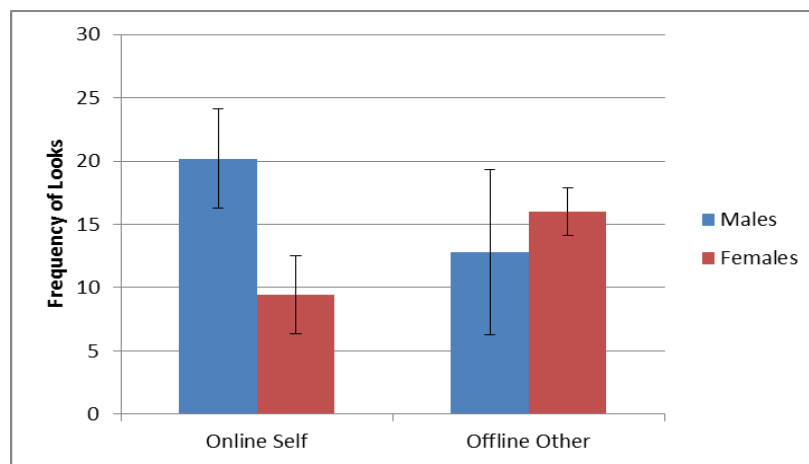


Figure 2-3. Average Frequency of Looks per Session for Experiment 1

For total frequency of looks per session, we also performed a paired t-test to assess the differences in the means of the online-self ( $M = 14.8$ ,  $SD = 9.33$ ,  $N = 10$ ) and offline-other ( $M = 14.4$ ,  $SD = 10.23$ ,  $N = 10$ ) conditions for the sample as a whole. It was found that the means of these two conditions were not significantly different,  $t(9) = 0.127$ ,  $p = 0.902$ .



**Figure 2-4. Average Frequency of Looks per Session by Sex for Experiment 1.**

We also ran four paired t-tests comparing sex differences in the total frequency of looks across the two conditions. For the online-self condition, total frequency of looks for males ( $M = 20.2$ ,  $SD = 8.70$ ,  $N = 5$ ) was not found to be significantly different from the females ( $M = 9.4$ ,  $SD = 6.88$ ,  $N = 5$ ),  $t(4) = -2.051$ ,  $p = 0.110$ . For the offline-other condition, total frequency of looks for males ( $M = 12.8$ ,  $SD = 14.53$ ,  $N = 5$ ) was also not found to be significantly different from the females ( $M = 16$ ,  $SD = 4.24$ ,  $N=5$ ),  $t(4) = -0.584$ ,  $p = 0.591$ . For males across both the online-self ( $M = 20.2$ ,  $SD = 8.70$ ,  $N = 5$ ) and offline-other ( $M = 12.8$ ,  $SD = 14.53$ ,  $N = 5$ ) conditions, we did not find a significant

difference in the means,  $t(4) = 1.792$ ,  $p = 0.148$ . However, for females across both the online-self ( $M = 9.4$ ,  $SD = 6.88$ ,  $N = 5$ ) and the offline-other condition ( $M = 16$ ,  $SD = 4.24$ ,  $N=5$ ), we did find a significant difference in the means,  $t(4) = -3.773$ ,  $p = 0.020$ . Additionally, a nonparametric Wilcoxon Signed Ranks test showed a significant difference across the two conditions,  $z = -2.032$ ,  $p = 0.042$ .



## **Chapter 3**

### **Experiment 2**

#### **Method**

##### **Subjects**

The same subjects from Experiment 1 participated in Experiment 2.

##### **Apparatus**

Slight changes were made to the apparatus design described for Experiment 1. In the previous design, the cart was positioned so that the display monitor was centered on the transport box face directly opposite to the entrance the subjects used to move freely in and out of the box. For the design in Experiment 2, the cart was repositioned so that the display monitor was centered on the face directly to the left of the subject's entrance. The position of the display was changed because the previous face used was a metal mesh that could have potentially obstructed the subject's view of the display. The side face was made of Plexiglas, which provided no visual obstruction between the subjects and the display. Also, the Thunderbolt monitor was replaced by the Dell monitor which was previously being used as the terminal monitor. We had to switch the monitor because the Thunderbolt Display was simply too large to fit centered against the Plexiglas face. The

Dell monitor was turned on its side to provide an adequate centered view for the subjects. Identical to Experiment 1, the monitor sat 5 cm from the face of the transport chamber.

## Procedure

The procedure used for Experiment 2 was the same described for Experiment 1.

## Analysis

Coding and analysis procedures were identical to those described for Experiment 1.

## Results

For Experiment 2, we analyzed two dependent variables: total look duration and total look frequency per session. For both variables we performed analyses for the sample as a whole, as well as a division of the sample based on sex.

**Table 2. Individual Data for Experiment 2.**

	<i>Dolores (F)</i>	<i>Lisa (F)</i>	<i>Susan (F)</i>	<i>Mulva (F)</i>	<i>Maggie (F)</i>	<i>Newman (M)</i>	<i>Bart (M)</i>	<i>George (M)</i>	<i>Kramer (M)</i>	<i>Milhouse (M)</i>
Duration										
Online-Self	27.43	6.23	87.21	26.51	70.17	33.17	38.57	16.5	26.51	46.28
Offline-Other	34.77	27.66	52.68	34.24	67.08	30.6	45.88	45.87	44.19	61.03
Frequency										
Online-Self	5	2	22	8	15	9	11	5	6	12
Offline-Other	7	7	13	8	16	8	12	12	9	19

**Duration values are in seconds. (F) = Female, (M) = Male**

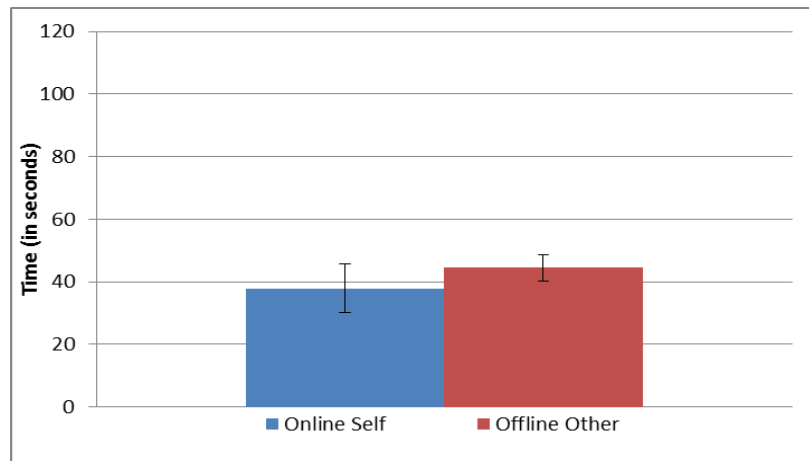


Figure 3-1. Average Look Duration per Session for Experiment 2.

For total duration of looks per session, we performed a dependent t-test to assess the difference in the means of the online-self ( $M = 37.86$ ,  $SD = 24.49$ ,  $N = 10$ ) and the offline-other ( $M = 44.40$ ,  $SD = 13.04$ ,  $N = 10$ ) conditions, for the entire sample. It was found that the means of these two conditions were not statistically different,  $t(9) = -1.173$ ,  $p = 0.271$ . We also ran four dependent t-tests comparing sex differences in the total duration of looks across these two conditions. For the online-self condition, total look duration in males ( $M = 32.21$ ,  $SD = 11.39$ ,  $N=5$ ) was not found to be significantly different from total look duration in females ( $M = 43.51$ ,  $SD = 33.76$ ,  $N = 5$ ),  $t(4) = -0.652$ ,  $p = 0.550$ .

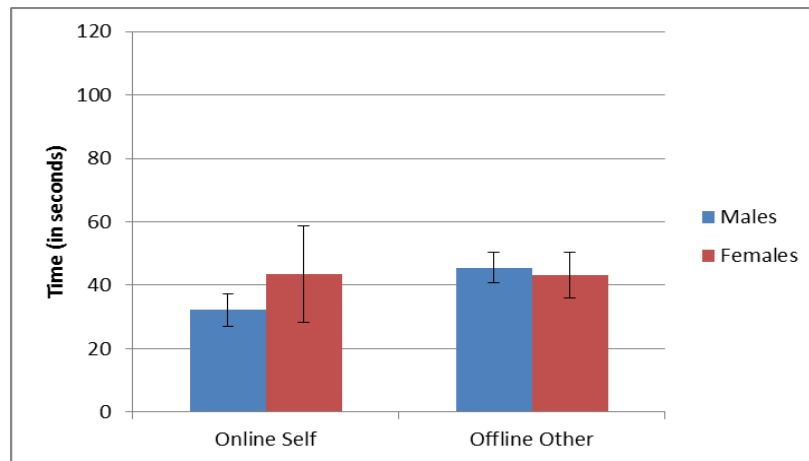


Figure 3-2. Average Look Duration per Session by Sex for Experiment 2.

There was also no significant difference in the means found for the offline-other condition between males ( $M = 45.51$ ,  $SD = 10.78$ ,  $N = 5$ ) and females ( $M = 43.29$ ,  $SD = 16.22$ ,  $N = 5$ ),  $t(4) = 0.443$ ,  $p = 0.681$ . For males across both the online-self ( $M = 32.21$ ,  $SD = 11.39$ ,  $N = 5$ ) and the offline-other ( $M = 45.51$ ,  $SD = 10.78$ ,  $N = 5$ ) conditions, we found a marginally significant difference in the means,  $t(4) = -2.499$ ,  $p = 0.067$ .

Additionally, a non-parametric Wilcoxon Signed Ranks test showed a marginal difference between the two conditions,  $z = -1.753$ ,  $p = 0.080$ . However, for the females across both the online-self ( $M = 43.51$ ,  $SD = 33.76$ ,  $N = 5$ ) and offline-other ( $M = 43.286$ ,  $SD = 16.22$ ,  $N = 5$ ) conditions, we did not find a significant difference in the means,  $t(4) = 0.024$ ,  $p = 0.982$ .

For total frequency of looks per session, we also performed a dependent t-test to assess the differences in the means of the online-self ( $M = 9.5$ ,  $SD = 5.84$ ,  $N = 10$ ) and offline-other ( $M = 11.10$ ,  $SD = 4.07$ ,  $N = 10$ ) conditions for the sample as a whole. It was found that the means of these two conditions were not significantly different,  $t(9) = -$

1.089,  $p = 0.305$ . We also ran four dependent t-tests comparing sex differences in the total frequency of looks across the two

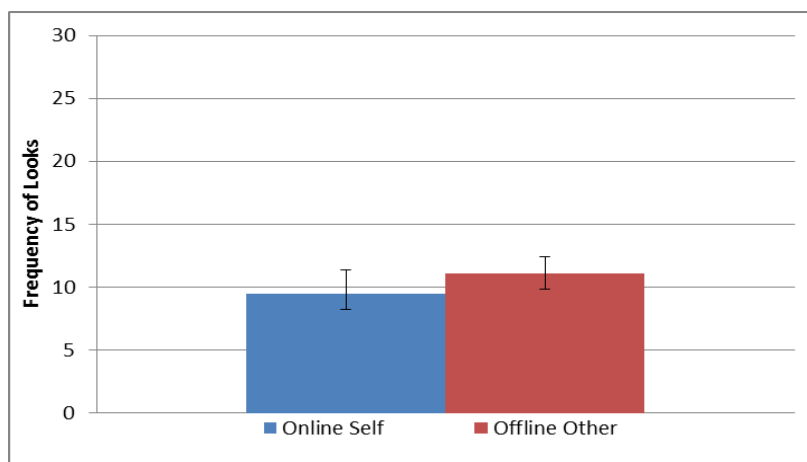


Figure 3-3. Average Frequency of Looks per Session for Experiment 2.

conditions. For the online-self condition, total frequency of looks for males ( $M = 8.60$ ,  $SD = 3.05$ ,  $N = 5$ ) was not found to be significantly different from the females ( $M = 10.4$ ,  $SD = 8.08$ ,  $N = 5$ ),  $t(4) = -0.411$ ,  $p = 0.702$ . Additionally, for the offline-other condition, total frequency of looks for males ( $M = 12$ ,  $SD = 4.30$ ,  $N = 5$ ) was not found to be

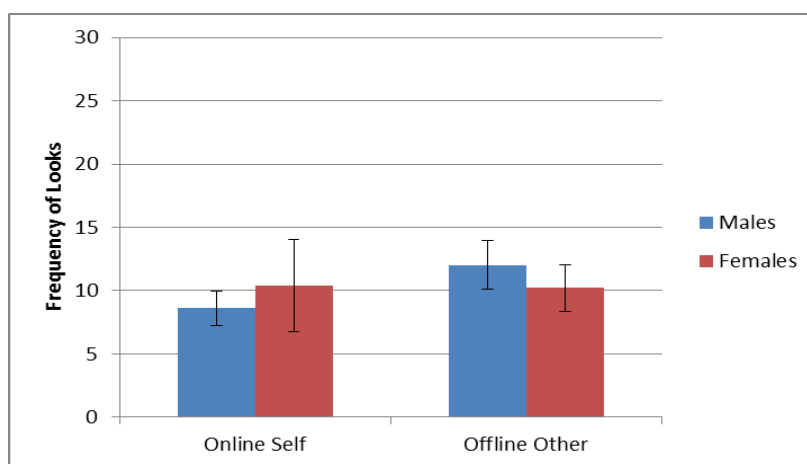


Figure 3-4. Average Frequency of Looks per Session by Sex for Experiment 2.

significantly different from the females ( $M = 10.2$ ,  $SD = 4.09$ ,  $N = 5$ ),  $t(4) = 1.765$ ,  $p = 0.152$ . For males across both the online-self ( $M = 8.60$ ,  $SD = 3.05$ ,  $N = 5$ ) and offline-other ( $M = 12$ ,  $SD = 4.30$ ,  $N = 5$ ) conditions, we did find a slightly marginal difference in the means,  $t(4) = -2.125$ ,  $p = 0.101$ . A non-parametric Wilcoxon Signed Ranks test showed a similar marginal difference between the two conditions,  $z = -1.633$ ,  $p = 0.102$ . For females across both the online-self ( $M = 10.4$ ,  $SD = 8.08$ ,  $N = 5$ ) and the offline-other condition ( $M = 10.2$ ,  $SD = 4.09$ ,  $N = 5$ ), we also did not find a significant difference in the means,  $t(4) = 0.085$ ,  $p = 0.936$ .

## Chapter 4

### General Discussion

The analysis of the data from Experiment 1 and Experiment 2 do not provide supporting evidence for the hypothesis that cotton-top tamarins possess an intermediate form of self-recognition as gauged by the mirror task. Across both experiments the tamarins did not exhibit a preference for either self or conspecific stimuli presented through a video display medium. We found that in both experiments cotton-top tamarins did not display a significant preference for either condition for measures of look duration and frequency when observed as a sample as a whole. Furthermore, across both experiments, when sex differences in preference for specific conditions were observed, we found no statistically significant differences between sexes for either measure of duration or frequency.

Any significant or marginally significant differences found in Experiment 1 were contrasted with opposing results in Experiment 2, severely complicating any potential conclusions. For example, in Experiment 1 it was found that females look more often at a video of a conspecific compared to a live recording of themselves. However, in Experiment 2 the trend was opposite: females tended to look more often at a live recording of themselves compared to a video of another conspecific. Additionally, the marginal differences in preference for look duration across conditions for males trended in the opposite direction between experiments as well: in Experiment 1 males looked longer at themselves, but in Experiment 2 they looked longer at the conspecific condition.

There were no differences found between conditions for the sample as a whole for look duration or frequency, and we found no sex differences across individual conditions (males and females do not differ in their preference for a single condition). Therefore, it cannot be concluded as to whether cotton-top tamarins possess a capacity for kinesthetic-visual matching when viewing stimuli through a video monitor.

The findings from Neiwirth et al. (2001) reported that cotton-top tamarins looked non-aggressively more often overall (in regard to absolute frequencies) at videos of familiar and unfamiliar individuals compared to the online recording of the self. However, these frequencies are rather small and are not significantly different from one another. These non-significant differences are compliant with the results we found with our subjects. Interestingly, their subjects on average looked 2.17 times toward the online-self condition during a three-hour session, whereas our subjects on average looked 14.8 times towards the same condition during a ten minute session. There seems to be considerable individual differences among individuals of this species when it comes to attentiveness towards video monitors. Individual differences have been found in all primate species that have been exposed to the mark test, in that not all members of any species pass the test. In humans, this can be due to cognitive deficits or clinical conditions, but in primates it is hard to identify individual-specific reasons for passing or failing the mark test. Several explanations may be related to age or pre-exposure. Nonetheless, individual differences can influence conclusions drawn by researchers studying self-recognition, especially if the reasons for these differences are not well understood.



There was no evidence of any behaviors indicative of contingency testing in the recordings of the subjects. Compared to the findings from Neiwirth et al. (2001), where few instances of contingency testing were exhibited by only a couple of subjects, it would seem that a capacity for demonstrating contingency testing is most likely absent in the cotton-top tamarin. One could argue that pre-exposure to reflective surfaces may influence the rate of self-oriented behaviors (like contingency testing) exhibited towards a mirror or a live video recording, which has been demonstrated by Gallup (1970) with chimpanzees. However, the prolonged method of exposure employed by Neiwirth and colleagues did not produce a significant amount of self-directed behaviors. The incredibly small amount of occurrences of contingency testing reported by Neiwirth and colleagues were only observed in two individuals (again, suggesting considerable individual differences). Additionally, the findings from Hauser et al. (2001), which described cotton-top tamarins as failing the mark test in both instances of immediate and prolonged exposure to mirrors, suggest that this species is not capable of explicitly demonstrating an understanding of the relationship between the self and their mirror image, regardless of the occurrence of pre-exposure.

From a qualitative perspective, the tamarins seemed genuinely uninterested in the video stimuli in general. This lack of interest ultimately led to the premature discontinuation of a planned experimental design. This experiment would have observed the tamarins responses to visually distorted video recordings of the self and conspecifics, singling out the contingency variable and potentially providing a more robust analysis of tamarins' sensitivity to kinesthetic-visual contingency. Since the tamarins showed very little interest in the stimuli presented in the experiments we ran, it was assumed that

making the stimuli even less ecologically valid would hinder their interest further.

Drawing from the experience of Neiwirth and colleagues (2001) that mirrors seem to be the strongest elicitor of behavioral responses in tamarins compared to other mediums, a distortion-based methodology using mirrors may be a more successful approach in examining sensitivity to kinesthetic-visual contingency. An example experimental proposal could involve a modified version of the apparatus used by de Waal and colleagues (2005), adding a distorted filter placed on the surface of the mirror, as well as the surface of the Plexiglas for the corresponding conspecific condition. Such an experiment is currently underway in the laboratory, examining behavioral responses of cotton-top tamarins to a mirror versus unfamiliar conspecifics housed in an adjacent chamber, borrowing from the methodology employed by de Waal and colleagues' (2005) study of capuchin monkeys.

The capuchins from de Waal et al. (2005) displayed a clear preference for looking towards their mirror image compared to a conspecific, a finding that was not found in the present study. As stated above, these behavioral differences may be due to the fact that the capuchins were shown mirrors and the cotton-top tamarins were shown video monitors. Indeed, capuchin males displayed aggressive behaviors in both conditions, whereas the cotton-top tamarins in this study were quite emotionally neutral towards the monitors in both conditions. However, there may also be species differences at play as well. Both species are New World monkeys, which are distantly related to humans through common ancestor which lived approximately 43.47 million years ago (Perelman et al., 2011). Capuchins and cotton-top tamarins share a common ancestor which lived approximately 19.25 million year ago. Despite their close relation in comparison to both

with humans, there seem to be clear cognitive differences between the two species. For example, as stated earlier, capuchins are known to use nut-cracking tools in the wild (Fragaszy et al., 2004), whereas cotton-top tamarins are not known to use any tools in the wild. Interestingly, with the exception of capuchin monkeys, tool-use in primates seems to be restricted to the Great Apes (Breuer, Ndoundou-Hockemba & Fishlock, 2005; Byrne, 2007; Call & Tomasello, 1994; Schick et al. 1999). It has been proposed by Parker and Gibson (1977) that tool-use in primates requires a developed tertiary sensorimotor intelligence, a capacity that may not be well developed in cotton-top tamarins. It is not yet clear what the cognitive similarities are between tool use and self-recognition, but the topic warrants further investigation.

Age has also been reported to affect the rate at which individuals pass the mark test in species that have been demonstrated to do so. An article by de Veer and colleagues (2003) reported that younger chimpanzees were more likely to pass the mark test than older individuals, suggesting that age of exposure indeed plays a role. The cotton-top tamarins in the present study were all adults. It would be interesting to see how adolescent cotton-top tamarins behave toward their mirror image or a live video recording of the self.

There were some inherent issues with both experiments regarding control. During an experimental session, the tamarin subjects were allowed to freely enter and exit the transport chamber where the videos were being displayed. This ultimately resulted in loose experimental control. Initially, in the planning stages of the Experiment 1, we intended on running the tamarins individually in a separate testing chamber. However, many of the tamarins needed to collect an adequate set of data were becoming

increasingly difficult to catch. Consequently, we decided to create a mobile apparatus and run sessions in the colony room to render catching unnecessary. Here, we did have the option of running subjects individually by setting up the apparatus and closing the transport chamber door when a tamarin would enter. However, this method proved difficult because when the experimenter would open the transport chamber door after setup, both subjects would often charge in to investigate, making it difficult to isolate the subject of interest. Running the experiments in the colony room also denied other lab members access to the room, limiting the amount of time to run sessions. Waiting for an opportunity to isolate subjects of interest created an inefficient use of valuable experimental time, and therefore was ultimately impractical. Furthermore, closing in subjects would have also potentially resulted in a decreased probability of returning to the chamber in subsequent sessions, reintroducing the original issue of catch-ability. In future endeavors, running subjects individually would be most ideal, provided that subjects are easily catchable and time is not an issue.

Additionally, the present study contains limitations regarding sample size. A small number of cotton-top tamarins were available to investigate for this study, and therefore we were forced to run the same individuals in both experiments across both conditions. A larger population allowing a between-subjects design would provide a more robust set of results and a stronger conclusion.

In a recent article by Anderson and Gallup (2011), the authors conclude that from the literature on non-human mirror self-recognition, mirror self-recognition remains unique to humans and Great Apes. The present study lends further evidence supporting this claim. With respect to Rochat's (2003) stages of self-awareness development, it is

inconclusive whether cotton-top tamarins display anything greater than a Level 0 status, which corresponds to a complete obliviousness to the self. If a phylogenetic gradient of self-awareness does indeed exist, it would seem that cotton-top tamarins fall not too far from a designation of self-obliviousness. With further studies employing multiple reflective mediums and clever experimental designs with numerous primate species, we may soon begin to visualize this gradient.

## REFERENCES

- Anderson, J. R. & Gallup, G. G. Jr. (1997). Self-recognition in *Saguinus*? A critical essay. *Animal Behaviour*, 54(6), 1563-1567.
- Anderson, J. R. & Gallup, G. G. Jr. (2011). Which primates recognize themselves in mirrors? *PLoS Biology*, 9(3), e1001024.
- Anderson, J. R. & Roeder, J. (1989). Responses of capuchin monkeys (*cebus apella*) to different conditions of mirror-image stimulation. *Primates*, 30(4), 581-587.
- Breuer, T., Ndoundou-Hockemba, M. & Fishlock, V. (2005). First observation of tool use in wild gorillas. *PLoS Biology*, 3(11), e380.
- Byrne, R. W. (2007). Animal cognition: Bring me a spear. *Current Biology*, 17(5), 164-165.
- Call, J. & Tomasello, M. (1994). The social learning of tool use by orangutans (*Pongo pygmaeus*). *Human Evolution*, 9(4), 297-313.
- Cunningham, C., & Glenn, S. (2004). Self-awareness in young adults with Down syndrome: I. Awareness of Down syndrome and disability. *International Journal of Disability, Development and Education*, 51(4), 335-361.
- De Veer, M. W., Gallup, G. G. Jr., Theall, L. A., Van den Bos, R. & Povinelli, D. J. (2003). An 8-year longitudinal study of mirror self-recognition in chimpanzees (*Pan troglodytes*). *Neuropsychologia*, 4, 229-234.

- De Veer, M. W., & Van den Bos, R. (1999). A critical review of methodology and interpretation of mirror self-recognition research in nonhuman primates. *Animal Behaviour*, 58(3), 459-468.
- De Waal, F. B. M., Dindo, M., Freeman, C. A., & Hall, M. J. (2005). The monkey in the mirror: Hardly a stranger. *Proceedings of the National Academy of Sciences*, 102(32), 11140-7.
- Duval, S., & Wicklund, R. A. (1972). A theory of objective self awareness. New York: Academic Press.
- Fragaszy, D. M., Visalberghi, E., & Fedigan, L. M. (2004). *The complete capuchin: The biology of the genus Cebus*. Cambridge University Press, Cambridge, U.K.
- Gallup, G. G. (1970). Chimpanzees: Self-recognition. *Science*, 167, 86-87.
- Gold, K., & Scassellati, B. (2007). A Bayesian robot that distinguishes “self” from “other”. In *Proceedings of the 29th Annual Meeting of the Cognitive Science Society (CogSci2007)*, Nashville, Tennessee.
- Hauser, M. D., Kralik, J., Botto-Mahan, C., Garrett, M., & Oser, J. (1995). Self-recognition in primates: phylogeny and the salience of species-typical features. *Proceedings of the National Academy of Sciences*, 92(23), 10811-10814.
- Hauser, M. D., Miller, C. T., Liu, K., & Gupta, R. (2001). Cotton-top tamarins (*Saguinus oedipus*) fail to show mirror-guided self-exploration. *American Journal of Primatology*, 53(3), 131-137.
- Inoue-Nakamura, N. (1997). Mirror self-recognition in non-human primates: A phylogenetic approach. *Jpn. Psychol. Res.* 39, 266-275.

- Klein, S. B., Gabriel, R. H., Gandi, C. E., & Robertson, T. E. (2008). Reflections on the self: A case study of a prosopagnosic patient. *Social Cognition, 26*(6), 766-777.
- Ledbetter, D. H. & Basen, J. A. (1982). Failure to demonstrate self-recognition in gorillas. *American Journal of Primatology, 2*, 307-310.
- Lethmate, J. & Dücker, G. (1973). Untersuchungen zum Selbsterkennen in Spiegel bei Orang-utans und einigen anderen affenarten. *Zeitschrift fuer Tierpsychologie, 33*, 248-269.
- Macellini, S., Ferrari, P. F., Bonini, L., Fogassi, L., & Paukner, A. (2010). A modified mark test for own-body recognition in pig-tailed macaques (*Macaca nemestrina*). *Animal Cognition, 13*(4), 631-639.
- Mead, G. H. (1934). *Mind, self and society*. Chicago: Chicago University Press.
- Meltzoff, A. N., & Moore, M. K. (1993). Early imitation within a functional framework: The importance of person identity, movement, and development. *Infant Behavior and Development, 15*(4), 479–505.
- Mitchell, R. W. (1993). Mental models of mirror-self-recognition: Two theories. *New Ideas in Psychology, 11*, 295-325.
- Mitchell, R. W. (1997a). Kinesthetic-visual matching and the self-concept as explanations of mirror-self-recognition. *Journal for the Theory of Social Behaviour, 27*(1), 17-39.
- Mitchell, R. W. (1997b). A comparison of the self-awareness and kinesthetic-visual matching theories of self-recognition: Autistic children and others. *Annals of the New York Academy of Sciences, 818*, 3962.



- Mitchell, R. W. (2002a). *Subjectivity and self-recognition in animals*. In M. R. Leary & J. P. Tangney (Eds.), *Handbook of self and identity*, 315. New York: Guilford Press.
- Mitchell, R. W. (2002b). *Kinesthetic-visual matching, imitation, and self-recognition*. In M. Bekoff, C. Allen, & G. Burghardt (Eds.), *The cognitive animal*, 345-351. Cambridge, MA: MIT Press.
- Morin, A. (2006). Levels of consciousness and self-awareness: A comparison and integration of various neurocognitive views. *Consciousness and cognition*, 15(2), 358-371.
- Morin, A. (2011). Self-recognition, theory-of-mind, and self-awareness: What side are you on?. *Laterality*, 16(3), 367-383.
- Neiwirth, J. J., Anders, S. L., & Parsons, R. R. (2001). Tracking responses related to self-recognition: A frequency comparison of responses to mirrors, photographs, and videotapes by cotton-top tamarins (*Saguinus oedipus*). *Journal of Comparative Psychology*, 115(4), 432-8.
- Parker, S. T. & Gibson, K. R. (1977). Object manipulation, tool use and sensorimotor intelligence as feeding adaptations in Cebus monkeys and Great Apes. *Journal of Human Evolution*, 6, 623-641.
- Patterson, F. G. P., & Cohn, R. H. (1994). Self-recognition and self-awareness in lowland gorillas. In S. T. Parker, R. W. Mitchell & M. L. Boccia (Eds.), *Self-awareness in animals and humans* (pp. 273-290). Cambridge, UK: Cambridge University Press.
- Paukner, A., Anderson, J. R., Borelli, E., Visalberghi, E., & Ferrari, P. F. (2005). Macaques (*Macaca nemestrina*) recognize when they are being imitated. *Biology Letters*, 1(2), 219-222.

- Paukner, A., Anderson, J. R., & Fujita, K. (2004). Reactions of capuchin monkeys (*Cebus apella*) to multiple mirrors. *Behavioral Processes*, 66, 1–6.
- Perelman, P., Johnson, W. E., Roos, C., Seuanez, H. N., Horvath, J. E., Moreira, M. A. M., Kessing, B., Pontius, J., Roelke, M., Rumpler, Y., Schneider, M. P. C., Silva, A., O'Brien, S. J. & Pecon-Slattery, J. (2011). A molecular phylogeny of living primates. *PLoS Genetics*, 7(3), e1001342.
- Posada, S., & Colell, M. (2007). Another gorilla (*Gorilla gorilla gorilla*) recognizes himself in a mirror. *American Journal of Primatology*, 69(5), 576-583.
- Ramachandran, V. S. (2007). "The Neurology of Self-Awareness." *The Edge*.
- Rochat, P. (2003). Five levels of self-awareness as they unfold early in life. *Consciousness and Cognition: An International Journal*, 12(4), 717-731.
- Rochat, P., & Striano, T. (1999). Emerging self-exploration by 2 month-old infants. *Developmental Science*, 2(2), 206–218.
- Roma, P. G., Silberberg, A., Huntsberry, M. E., Christensen, C. J., Ruggiero, A. M., & Suomi, S. J. (2007). Mark Tests for mirror self-recognition in capuchin monkeys (*Cebus apella*) trained to touch marks. *American Journal of Primatology*, 69(9), 989-1000.
- Schick, K. D., Toth, N., Garufi, G., Savage-Rumbaugh, E. S., Rumbaugh, D. & Sevcik, R. (1999). Continuing investigations into the stone tool-making and tool-using capabilities of a bonobo (*Pan paniscus*). *Journal of Archaeological Science*, 26, 821-832.
- Schilhab, T. S. (2004). What mirror self-recognition in nonhumans can tell us about aspects of self. *Biology and Philosophy*, 19(1), 111-126.

- Suarez, S. D. & Gallup, G. G. (1981). Self-recognition in chimpanzees and orangutans, but not gorillas. *Journal of Human Evolution*, *10*, 175-188.
- Suddendorf, T. & Collier-Baker, E. (2009). The evolution of primate visual self-recognition: Evidence of absence in lesser apes. *Proceedings of the Royal Society B*, *276*(1662), 1671-1677.
- Sugiura, M., Sassa, Y., Jeong, H., Miura, N., Akitsuki, Y., Horie, K., Sato, S., & Kawashima, R. (2006). Multiple brain networks for visual self-recognition with different sensitivity for motion and body part. *Neuroimage*, *32*, 1905-1917.
- Walraven, V., Elsacker, L., & Van Heyen, R. (1995). Reactions of a group of pygmy chimpanzees (*Pan pansicus*) to their mirror image: Evidence of self-recognition. *Primates*, *36*, 145-150.
- Westergaard, G. C., & Hyatt, C. W. (1994). The responses of bonobos (*Pan paniscus*) to their mirror images: Evidence of self-recognition. *Human Evolution*, *9*(4), 273-279.

**ACADEMIC VITAE**  
**Ricky David Groner II**

129 S. New Street  
Nazareth, PA 18064

(484) 560-2067  
rdg5070@psu.edu

**EDUCATION**

---

**Bachelor of Science, Psychology (in progress)**

December 2012

*Pennsylvania State University, University Park, PA*

Honors in Psychology

Biological and Evolutionary Sciences Option

**RESEARCH EXPERIENCE**

---

**Senior Honors Thesis**

September 2011 – November 2012

*Pennsylvania State University, University Park, PA*

- Conducted research in the Comparative Communications Laboratory under the supervision of Dr. Daniel Weiss, in fulfillment of requirements put forth by the university honors college.
- Investigated behavioral responses of cotton-top tamarins to various kinds of video recordings, including live recordings of themselves and past recordings of other tamarin individuals.
- Research and the production of a manuscript are currently in progress.

**Ronald E. McNair Summer Research Program**

May 2011 – July 2011

*Pennsylvania State University, University Park, PA*

- Spent nine weeks working on a project in Dr. Rick Gilmore's laboratory examining the influence of crawling experience on the development of communicative behaviors in infancy.
- Conducted extensive literature review and data analyses including ANOVAs and linear regressions.
- Analyzed data with R statistical analysis software.
- Wrote manuscript; currently preparing for submission.
- Oral Presentation at the 2011 Ronald E. McNair Summer Research Conference at the Pennsylvania State University – University Park Campus

## **LABORATORY AND WORK EXPERIENCE**

---

### **Peer Assistant**

January 2013 – July 2013

*Ronald E. McNair Postbaccalaureate Achievement Program, Pennsylvania State University, University Park, PA*

- Provided peer assistance to fellow scholars in the program.
- Assisted with multiple program workshops as a discussion leader and presenter, as also assisted with pre-workshop design and preparation.
- Performed various clerical duties including the copying of documents, designing the student showcase billboard, and maintaining the program student library.

### **Research Assistant**

September 2011 – December 2012

*Comparative Communications Laboratory, Pennsylvania State University, University Park, PA*

- Performed regulatory feeding and medication procedures and ran various trial sessions with cotton-top tamarins.
- Performed and recorded behavioral observations in the tamarins' home dwellings.
- Attended regular lab meetings and discussed relevant publications and current studies in the lab, as well as ideas for future studies.

### **Research Assistant**

September 2010 – May 2012

*Brain Development Laboratory, Pennsylvania State University, University Park, PA*

- Ran low- and high-density EEG sessions on infant, child, and adult participants.
- Specific activities included obtaining participant consent and database entry, running pre-trial vision screens, assisted in placing electrodes on participants' scalps, running and correcting impedance, running block trials, and post-trial data processing.
- Familiar with PowerDiva and NetStation EEG software programs.

### **Staff Assistant**

September 2011 – December 2012

*Social, Life, and Engineering Imaging Center, Pennsylvania State University, University Park, PA*

- Performed various database-oriented tasks for the center, including update maintenance and project billing reconciliation, as well as checking and filing subject consent and IRB paperwork.
- Updated and maintained the SLEIC website, posting news articles and current research projects affiliated with the center.
- Performed regular conductivity tests on the inventory of EEG nets in the facility using NetStation EEG software.
- Gained experience with E-Prime Experimental Design software.

## **GRANTS AND AWARDS**

---

- 2012 Penn State Discovery Summer Grant (2012)
  - Amount: \$3000.00
- 1<sup>st</sup> Place Award for Poster Presentation in the Social and Behavioral Sciences category at the 2011 Penn State Undergraduate Research Exhibition (2011)
- Chaiken Trustee Scholarship (2012)
- Gary and Ralphine Gentzler Trustee Scholarship (2012)
- Bunton Waller Scholarship (2011 – 2012)
- Class of 1922 Memorial Scholarship (2010 – 2011)
- Boscov Academic Excellence Award (2009 – 2010)

## **HONORS**

---

- Schreyer Honors College of the Pennsylvania State University (2010 – 2012)
- Ronald E. McNair Post-Baccalaureate Achievement Scholars Program (2010 – 2012)
- Psi Chi National Honors Society in Psychology (2010 – Present)
- Berks College Honors Program (2009 – 2010)
- University Dean's List (2008 – 2010, 2012)

## **RELEVANT COURSEWORK**

---

- **Psychological Science:** Introduction to Psychology, Psychology as a Science and Profession, Introduction to Developmental Psychology, Neurological Bases of Human Behavior, Introduction to Psychology of Learning, Evolutionary Psychology, Physiological Psychology, Language and Thought, Animal Minds
- **Biological and Evolutionary Sciences:** Biology: Basic Concepts and Biodiversity, Introduction to Anthropology, Humans as Primates, Introductory Physiology, Function and Development of Organisms, Neurobiology
- **Research and Statistics:** Animal Research Practicum, Introductory Statistics, Basic Research Methods in Psychology, Research Projects, Independent Study, Senior Thesis

## **PUBLICATIONS**

---

Groner, R. D. (in-press). Does travel broaden the communicative mind? The influence of crawling on the development of communication in the first year of life. *The Pennsylvania State University McNair Scholars Journal*, 19

## **PROFESSIONAL PRESENTATIONS**

---

Groner, R. D. & Weiss, D. J. (2012, October). *Behavioral responses of cotton-top tamarins (Saguinus oedipus) to video recordings of themselves and conspecifics*. Poster session presented at the 1<sup>st</sup> Annual Ivy Plus STEM Symposium and Workshops for Diverse Scholars at the University of Pennsylvania, Philadelphia, PA.

Groner, R. D., Thomas, A., Miller, C., & Gilmore, R. O. (2012, April). *The impact of crawling on the development of communicative behavior during infancy*. Poster session presented at the 21<sup>st</sup> Annual Undergraduate Research Exhibition at the Pennsylvania State University, University Park, PA.

Groner, R. D. (2012, April). *Behavioral responses of Saguinus oedipus to video recordings of the self and conspecifics*. Poster session presented at the 2012 Pennsylvania State University Psi Chi Undergraduate Research Conference, University Park, PA.

Groner, R. D. & Weiss, D. J. (2012, February). *Research proposal: Behavioral responses of Saguinus oedipus to video recordings of the self and conspecifics*. Oral presentation delivered at the Office of Graduate Educational Equity Programs February Research Brown Bag Session at the Pennsylvania State University, University Park, PA.

Groner, R. D., Miller, C., & Gilmore, R. O. (2011, July). *Does travel broaden the communicative mind? The influence of crawling on the development of communication in the first year of life*. Oral presentation delivered at the 19<sup>th</sup> annual Ronald E. McNair Summer Research Conference at the Pennsylvania State University, University Park, PA.

Groner, R. D., Mancino, A., Vadek, S., Fesi, J., & Gilmore, R. O. (2011, April). *The tuning of adult brain responses to optic flow*. Poster session presented at the 20<sup>th</sup> Annual Undergraduate Research Exhibition at the Pennsylvania State University, University Park, PA.

Groner, R. D., & Garner, J. K. (2010, April). *Executive functions and prospective memory*. Poster session presented at the 11<sup>th</sup> annual Undergraduate Research and Creativity Conference at Albright College, Reading, PA.