# Attentional Differences Toward Natural Kinds Categories by Cotton Top Tamarins (*Saguinus oedipus*): An Examination of Preferential Looking at Different Levels of Category Inclusiveness

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## Full Description of Study and Conclusion

A familiarization/preference to novelty paradigm used frequently to tap into infants' categorical representations (Quinn, 2002) was employed to examine attentional allocation to novel types of animals at the subordinate, basic, and superordinate levels in 6 adult members of a new world monkey species, cotton top tamarins. It was established in a prior study from this lab on look rates to mirrors and other objects (Neiworth, Anders, & Parsons, 2001), and by an expectancy violation procedure (Uller, Hauser, & Carey, 2001) that tamarins look longer at an unexpected or novel event. It is clear from developmental work by Quinn's lab that infants react with increased attention to novel categories of natural kinds both at the basic (cat/dog) and superordinate (mammal/furniture) levels, and well before they can use labels to assist in marking the groupings or features. It is possible that the ability to parse out relevant information to separate categories which have considerable perceptual overlap is a primate-general ability, and in humans, is followed later by a configuration of classes with labels. If so, other monkey species unrelated to humans should show similar attentional effects to stratified natural kinds categories.

Five familiarization phases exposed subjects to pairs of pictures which represented categories in a stratified manner, starting with a subordinate level and ending with superordinate groupings. After each familiarization phase, a test paired novel pictures of animals from the familiarized set with a novel category, often representing another categorical level. Look rates for individual subjects were recorded toward each of the pair of pictures throughout familiarization and the tests. Preference to novelty scores were calculated per subject per session for each category type.

The results were that tamarins looked significantly longer at novel monkey species after being habituated to a single monkey species, which marked a subordinate level discrimination. However, the same tamarins showed a lack of interest toward novel monkey species after 4 species had been habituated (a basic level generalization). This change in attentional allocation indicated that the tamarins could notice differences between monkey types, but allocated attention more evenly once monkeys as a category had been habituated.

Tamarins looked significantly longer at pictures of nonprimate mammals as compared to novel pictures of primates or novel pictures of reptiles once those categories had been habituated, marking a superordinate level discrimination. A final test pitted dinosaurs, an unrealistic but highly diverse set of animals, against mammals, a similarly broad and diverse set. In this case, tamarins showed preferential looking toward the novel dinosaurs. It is clear from these results that novel examples from a more diverse set of animals (typically superordinate) draw attention. In contrast, if exposed to a more narrowly defined set (subordinate level, as in a single monkey species), tamarins find that a subtle switch to a novel species of monkey draws their attention. Exposure at the basic level (i.e., monkeys more broadly) generated a lack of attention to the introduction of novel monkey and ape species, a condition that had previously peaked interest with a more narrowly defined familiarized set. Still, the tamarins found mammals more interesting than the broad primate class.

The evidence implies that categorical representation in lesser evolved New World monkeys, and possibly in all primates including human infants, is effected largely by the structure of the stimulus classes and the intra-and inter-category variability. If the variance within a category is very small (i.e., different pictures of one monkey species), then a feature change which marks a new category (i.e., a different monkey species) may force attention to it. At this level, elemental feature change is probably the basis of categorical formation. If the variance within a category is larger (i.e., different monkey species as a basic level grouping), then a set of correlated features is the most likely operative for categorical formation. Because correlational models generate a looser standard for membership, discriminated examples are treated as similar (i.e., other monkeys are of the same kind, and apes are of the same kind). A new problem in categorical representation occurs at the superordinate level, where the distance between classes is very large and thus confusability between classes is less likely (i.e., mammals vs. reptiles, and mammals vs. dinosaurs) but the classes maintain high intra-class diversity. In this case, tamarins readily attended to a novel superordinate set, and so noted important inter-class variation despite high intra-class variation. Human infants seem ready to note these differences as well, and thus primates more generally may be prepared to consider inter- and intra-class variability and note novelty relative to immediate exposure.

References:

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Quinn, P. (2002). Category representation in young infants. **Current Directions of Psychological Science, 11**, 66- 70.

Uller, C., Hauser, M.D., & Carey, S. (2001). Spontaneous representation of number in cotton-top tamarins. **Journal of Comparative Psychology 115**: 248-257.

Same Species, Monkey


Novel Same Species // Novel Species, Monkey


Four Species, Monkey


Ape    //    Monkey


Primate  //  Nonprimate mammal

## Method

**Stimuli**
The stimuli were a set of 212 14 cm X 10.5 cm digitized color pictures of animals obtained from several web sites of zoos (i.e., the National Zoo), research organizations (i.e., the Wisconsin Regional Primate Research Centers), or data bases of pictures (i.e., Corbis.com). The relative luminosity of the stimuli was controlled by presenting each picture in digitized form on the same television monitor. Pictures were chosen to represent a wide variety of positions of animals, numbers and ages of animals, background types, and relative sizes. In most pictures, a frontal face orientation was displayed.

**Apparatus**
The digitized pictures were presented in pairs in a Power Point slide show (Microsoft application) on a G3 Power Macintosh through a Focus Enhancements L-TV portable pro scan converter to a 27" Sony Trinitron television, placed 1 m in height above the floor on a Wilson mobile television cart.

**Procedure**
There were 6 30 - 40 minute sessions per familiarization phase, followed by a preference test conducted in two sessions. In ever phase, each trial lasted 70 seconds, and began with an 8-s presentation of a "green" screen, or the screen fully filled with a green color, followed by a 2-s presentation of a "blue" screen, and then a 60-s presentation of a pair of pictures.

**Subordinate Level.** A total of 40 unique pictures of golden lion tamarins were set up as 20 pairs , and 17 of these 20 were shown per session in the familiarization phase (1 on Figure 1). Within each session, the pairs were shown twice for a total of 34 trials, once in reverse so that the location of each picture was counterbalanced across each session. The preference test consisted of the 20 pairs of pictures used in the familiarization set, and 6 presentations each of three other test trials mixed in with the familiarization set, for a total of 38 trials. The critical test type paired a novel picture of a new species, the pygmy marmoset, with a novel picture of the familiarized species, the golden lion tamarin and was the NOVEL MONKEY test.

**Basic Level.** A total of 18 pairs of pictures of monkeys comprised the basic level, and they included 9 pictures each of golden lion tamarins , pygmy marmosets, capuchin monkeys and goeldi tamarins. The pairs were repeated twice per session such that the locations of the pictures were counterbalanced. The familiarization sessions were comprised of 36 trials (2 on Figure 1).
The preference test included the 18 pairs from the familiarization set, and a total of 5 other trial types, tested 4 times each, for a total of 38 unique trials. The MAMMAL test consisted of pairing a picture of a novel species of nonprimate mammal (either a dog or a squirrel) with a novel picture of a monkey species. The APE test consisted of pairing a picture of a novel ape species (either chimpanzee or human) with a novel picture of a monkey species.

**Superordinate Level.** The familiarization set included 18 pictures of primates, and 18 pictures of nonprimate mammals, including lions, squirrels, dogs, and rabbits (3, on Figure 1). One preference test consisted of pairing pictures of reptiles with novel mammal types (in this case, cows , elephants, gorilla or mandrill), called REPTILE .
Following the reptile superordinate level test, a familiarization phase was conducted to determine if the tamarins could habituate to reptile slides (4, on Figure 1). Next was a familiarization phase of dinosaur slides for 6 sessions (5, on Figure 1). Finally, a preference test at the superordinate level of novel mammals paired with novel dinosaurs was conducted in 2 sessions, and preference is labeled DINOSAUR and MAMMAL.

**Look Rates Coded**
Two researchers were positioned behind the television monitor to code the look direction and look duration of individual animals in each trial. A piece of corrugated cardboard equal to the size of the television screen was attached to the rear of the television facing the coders. A vertical line bisected the cardboard and two boxes were drawn on it, corresponding to the size and the position of the pictures displayed on the television screen.
Direction of looking was coded as either left, right, or "general". Looking to the left or right picture was coded if any one of the following was true: a) the animal's head and eyes were observed to be in line with the appropriate box drawn on the cardboard, b) the white portion of the eye opposite to the appropriate picture could be seen, or c) the apex of the animal's eye lens was pointed toward the appropriate box. The "general" behavior category included looks to the center of the television screen, and looks that could not be determined to fit the definition of a left- or right-oriented look.
Interjudge reliability was measured for looks during two familiarization sessions at each phase (subordinate, basic, superordinate), for a total of 6 sessions of reliability assessment. A Pearson correlational analysis yielded a positive correlation of r=+0.867, significant at p<0.001, for the two judges for looks per trial per subject. Exact interobserver agreement of look durations and total looks varied from 67% to 88% across the 6 sessions.
A preference to novelty score was calculated for each subject for each preference test by dividing the total duration of looks to a category picture by the sum of the duration of looks at it and its pair.


Nonprimate Mammal    //    Primate


Mammal    //    Reptile


Mammal    //    Dinosaur

## Results

Figure 1 depicts total look rates per session averaged across the 6 subjects per familiarization phase (single monkey, basic monkey, mammal, reptile, and dinosaur). A repeated measures ANOVA revealed a significant main effect of session (F (1,125) = 8.93, p < 0.001), indicating that in all phases, look rates decreased systematically across sessions.

There was no significant phase effect, but there was a significant interaction of Session X Phase (F (20, 125) = 2.59, p = 0.001). Specifically, the interaction was accounted for by significant differences between the habituation rates to MAMMALS as compared to REPTILES (Tukey HSD = 13.51, p=0.04) and between habituation rates to MAMMALS as compared to DINOSAURS (Tukey HSD = 13.62, p = 0.039). For both reptiles and dinosaurs, look rates increased across the first few sessions and then decreased, but at a slower rate than look rates to the other categories.





Note: * = significantly different from 50%, Wilcoxon One Sample Tests, p < 0.05
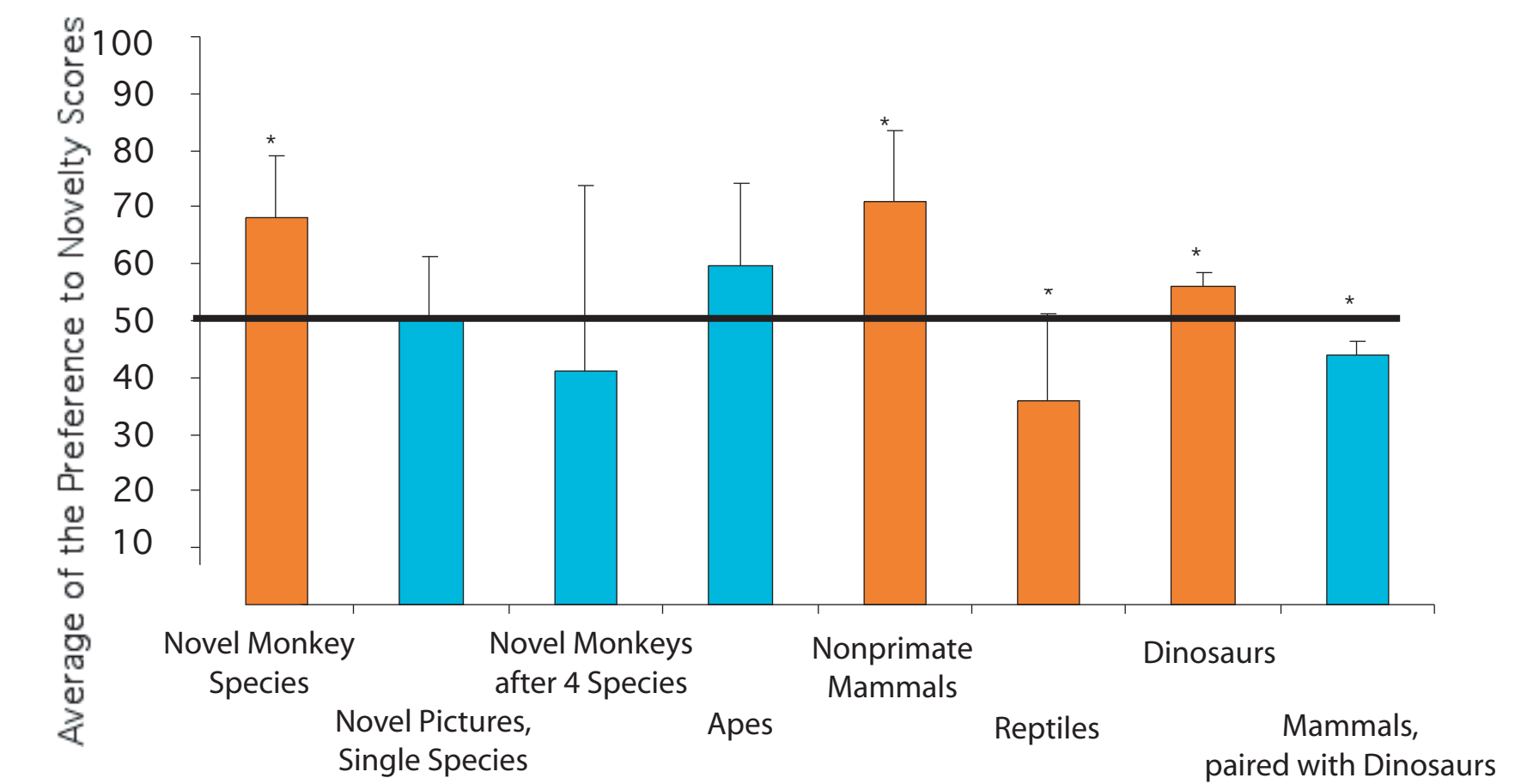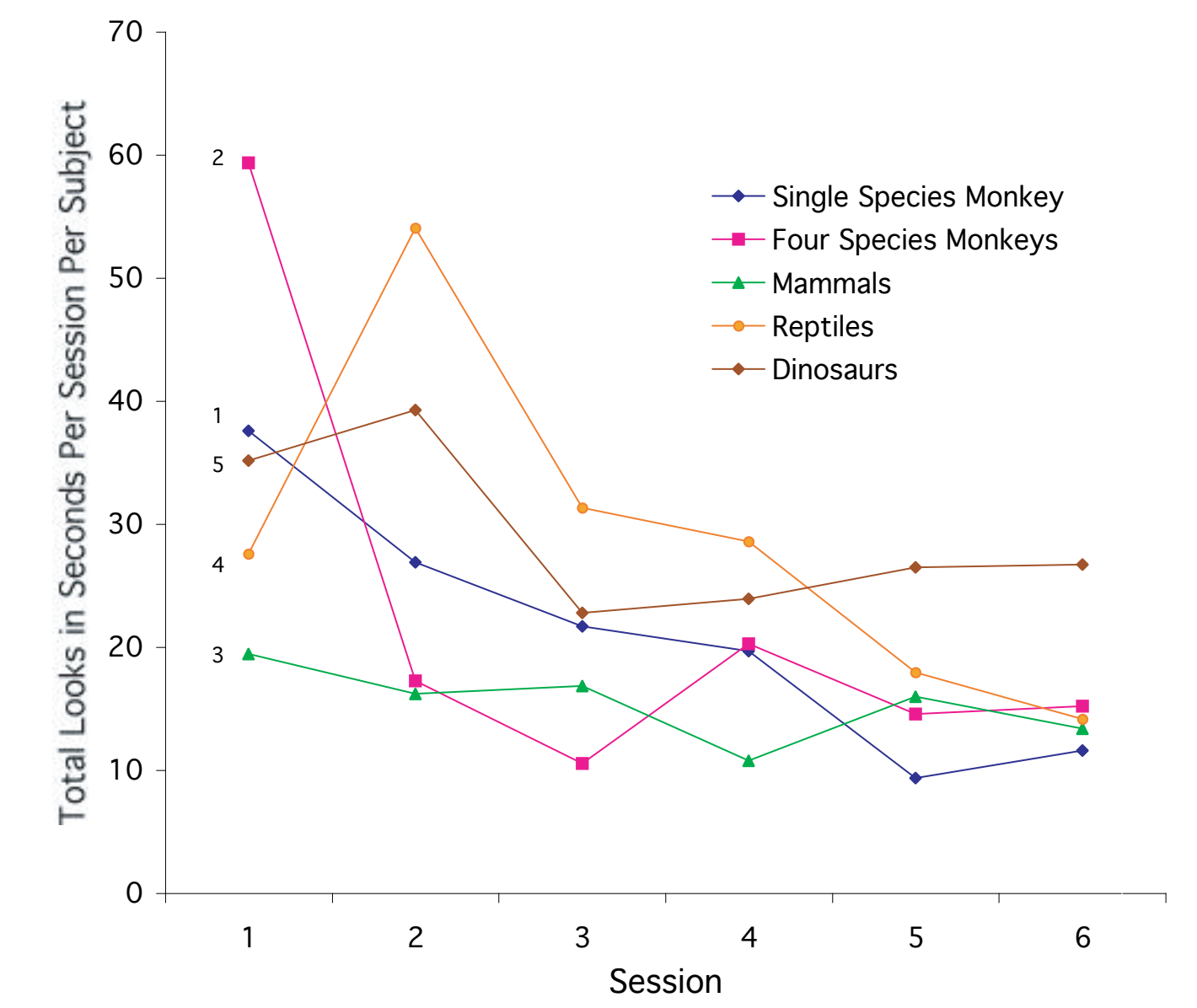
Figure 2 shows the preference to novelty scores averaged across the 6 subjects for each category test. Preferential looking that occurred to a novel category and was significantly higher than 50%, or equivalent preference, is denoted by an orange bar.

After habituating to a single monkey species, the tamarin subjects showed a signficant preference to look at novel species of monkeys over novel pictures of the habituated species (Wilcoxon One Sample test, estimated Z = -2.20, p=0.03). Conversely, after habituating to 4 species of monkeys, the tamarins did NOT show a preference to look at apes or at novel species of monkeys over novel photographs of the habituated species of monkeys. They did show a significant preference to look at novel species of nonprimate mammals over novel species of monkeys however (Wilcoxon One Sample test, estimated Z= -2.02, p=0.04).

After habituating to mammals, the tamarin subjects showed a preference to avoid looking at reptiles, a novel class of animals, but by a trend (Wilcoxon One Sample test, estimated Z= - 1.78, p = 0.07). This could be explained by an avoidance to look at reptiles, or a preference to continue to look at novel examples of mammals, a finding demonstrated when mammals were first introduced.

Finally, after habituating to reptiles and to dinosaurs, the tamarin subjects showed a significant preference to look at novel pictures of dinosaurs over novel pictures of mammals (Wilcoxon One Sample test, estimated Z = 2.20, p = 0.03). This finding demonstrates that mammals are not always preferred over another category, although they drew more attention as compared to primates, and as compared to reptiles. When pitted against an equally diverse set of animals that was relatively newer to them (Dinosaurs), the tamarins showed significant preference to look at dinosaurs. The results are interpreted in the FULL DESCRIPTION section.