Use of Experimenter-Given Cues in Visual Co-Orienting and in an Object-Choice Task by a New World Monkey Species, Cotton Top Tamarins (Saguinus oedipus)

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Abstract

Two different methods assessed the use of experimenter-given directional cues by cotton top tamarins. Experiment One used experimenter-given cues to elicit visual co-orienting toward distal objects. Experiment Two used experimenter-given cues to generate accurate choices in an object choice task. Visual co-orienting occurred at a very low frequency to distal objects. However, pointing cues generated more visual co-orienting than did eye gaze. Accurate choice of baited cups occurred with point/tap cues, and look cues, where looks involved head and body orientation. The results highlight the importance of head/body orientation to induce co-orientation in cotton top tamarins, both in a task that involved food-getting and a task that did not.

Introduction

A contemporary empirical question is the extent to which primates understand that there is informational value in following another animal's direction of gaze. In humans, the cognitive precursors to learning human language include following the spatial signaling function of a gaze, directing attention toward postures of the head and the hand of another, and finally, associating a symbol to label the object of gaze or gesture. The ability to look where someone else is looking, called joint visual attention in developmental literature (Butterworth, 1995), occurs in human infants at 2 months of age (Scafe & Bruner, 1975).

The most conservative statement one could make about primates is that most primates can follow signals consisting of changes in head and body orientation (i.e., Anderson & Mitchell, 1999; Tomasello, Call & Hare, 1998). But, there are some critical differences:

- Prosimians, specifically lemurs, cannot reliably follow the eye gaze of an experimenter, and thus fail to visually co-orient (Anderson & Mitchell, 1999).
- Some old world monkeys (i.e., macaques) reliably follow the eye gaze of an experimenter (Anderson & Mitchell, 1999).
- The only new world monkey species tested, the capuchin, was able to be trained to use experimenter-given cues of head and eye gaze, but could not follow eye gaze alone (Itakura and Anderson, 1996; Vick & Anderson, 2000).
- Apes including chimpanzees, orangutans, and humans (Itakura & Tanaka, 1998) attend to a location that is indicated by eye gaze with head orientation, an eye glance without corresponding head orientation, or the hand pointing of an experimenter, and they do so without training.

The current set of studies tested a new world monkey species, cotton top tamarins *(Saguinus oedipus*), and used two different methods in which eye gaze with head orientation, eye glance without head or without body orientation, and pointing, were assessed as informative directional cues. In Experiment One, various directional cues were used to test whether the subjects would visually co-orient toward distal objects indicated by experimenter-given cues. By this method, there is some information to be gained about a distal object, but food is not part of the motivation to direct gaze. In Experiment Two, the same directional cues, and tapping with pointing, were used to test whether the species could select accurately in an object-choice task. The goal was to test a different new world monkey species to add to the comparative evidence of primates' ability to understand naturally the information conveyed in a directional cue.

Results: Experiment One

Table 1. Absolute frequencies of the categories 'VCO' and 'no VCO' for tamarins from the current study, and from lemurs and macaques from Anderson & Mitchell, 1999

Species	VCO	No VCO	χ^2 (df=1)	p value
Lemurs[1]	30	117	51.49	<0.0001
Macaques[1]	133	22	79.49	<0.0001
Tamarins:	157	425	123.41	<0.0001
Tamarin Pairs Data:				
Mac and Oprah	61	180	58.76	<0.0001
Rolo and Yohoo	46	125	36.50	<0.0001
Fozzy and Zhivago	50	120	28.82	<0.0001

1: Data collapsed across subjects from Anderson & Mitchell. A total of 4 lemurs, and 5 macaques in prior study. A total of 6 tamarins in current study, analyzed as 3 pairs.

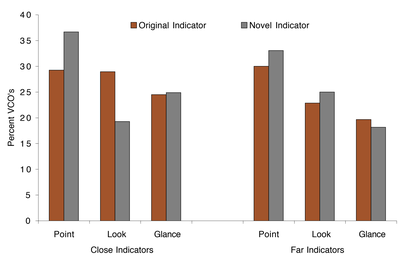


Table 1 presents the results of Anderson and Mitchell, as compared to ours with the tamarins. It is clear that while the macaques showed significantly higher VCO's than not, and the lemurs showed significantly lower VCO's from the prior study, the tamarins showed significantly lower VCO's in this current study. This pattern was evident in the tamarin data collapsed across all direction cue trials, and for each pair of subjects. These results suggest that tamarins appear not to visually co-orient, nor do lemurs from the prior study.

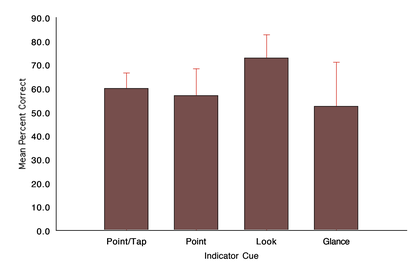
Since the current methodology employed pointing and glancing as well as a direct look by the experimenter and two distances were employed, it was important to determine if this species, while reluctant to co-orient at all, was more ready to co-orient with particular cues (**See the Figure to the left**).

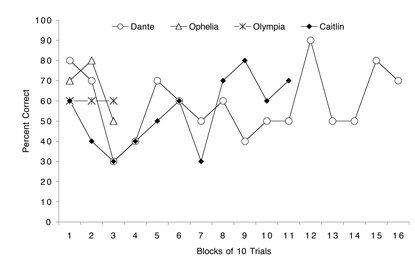
A Friedman's ANOVA resulted in a trend (χ^2 (5) =9.9048, p = 0.078) in the accuracy of looking between the 6 relevant trial types. Wilcoxon matched pairs signed-ranks tests were used to compare two variables overall: distance (close vs. far), and type of indicator (point, look, or glance). The comparison of accurate co-orienting between close cues and far cues was significant (p=0.05, estimated Z = 1.955), indicating that there was more co-orienting for close indicators (mean = 27.55%) than for far indicators (24.16%). Moreover, there was a significant difference between accurate co-orienting when pointing was used (mean = 29.61%) than when look indicators or glance indicators were used. A similar pattern of results occurred when a novel human was used to direct the subjects, although the effects were trends, and not significant.

Results: Experiment Two

Averaged percent correct scores for the participating subjects (a total of 4 of the original 6 in this study) for each of the four indicator cue trial types are presented in **the Figure to the right**. It was hypothesized that, if subjects used the information in the cues to make choices, their accuracy with those cues should be significantly greater than 50%. Two-tailed one-sample t- tests revealed that trials using **Point/Tap cues**, and trials using **Look cues** generated percent correct scores that were significantly higher than 50% or chance level accuracy (mean for point/tap = 59.96, t(3)=3.078, p = 0.05; mean for look = 72.76, t(3)=4.58, p = 0.02). Trials using pointing cues or glance cues did not generate accurate choices above 50% or chance level.

One concern about participation was that subjects might have learned by reinforcement to make particular kinds of choices with particular cues. The **bottom Figure to the right** shows the percent correct scores per subject per 10-trial block throughout the experiment. Two characteristics were clear in these data: 1) subjects varied in accuracies from the start of the experiment, with three subjects showing accurate performance from the first few blocks of 10 trials while the fourth showed chance level performance within the first few blocks of 10 trials, and 2) accuracies for most of the subjects did not steadily increase with exposure. A regression analysis found the best fitting line for Caitlin to be a linear increasing function (y=36.18 +2.91x; r^2 = 0.32). For Dante, Ophelia, and Olympia, the best fitting functions were either negative linear functions (Ophelia, y=1/(0.0099+0.0029x, r^2 = 0.53), a negative reciprocal function (Dante, y=55.44 +15.68 / x, r^2 =0.05) or a flat function (Olympia, y=60+0x, all variance accounted for).





Visual Co-Orienting Method

Participants

A group of 6 cotton top tamarins (*Saguinus oedipus*) served as participants. The animals were socially housed as 3 pairs, and studied as pairs in their home cages. There were a total of 2 females and 4 males in the study with adults and young adults/juveniles included.

Visual Co-Orienting Task

Various stimuli were placed in two different locations near each cage, and an experimenter attended to one of two stimuli using an indicator cue, either by: **Looking**, including head orientation and body leaning toward the stimulus, **Glancing** with the eyes, without head orientation toward the stimulus, or **Pointing**, with head orientation, body orientation, and a hand extended toward the stimulus. Frequency of visual co-orienting, or looking in the same direction as the experimenter, was measured in monkeys.

Object-Choice Task Method

Participants

A different group of 6 cotton top tamarins (*Saguinus oedipus*) served as participants. The animals were socially housed as 1 group of 4 and 1 group of 2, and studied in their home cages. There were a total of 4 females and 2 males in the study with adults and young adults/juveniles included.

Object-Choice Task

One of two cups was baited behind a screen, and then an experimenter indicated the "correct" cup with either a **point/tap** on the cup, **point** to the cup, **looking** at the cup with head orientation, or **glancing** at the cup. Subjects were allowed to choose one cup to obtain food rewards, and choices were coded as percent correct scores. **Catch trials** were included in which 1) **Reinforcement was not provided** under either cup and a look cue to one cup was used, or 2) **Reinforcement was provided under both cups** and a look cue was used. Correct responses on these trials were when subjects followed the look cue, despite the fact that the look cue did not increase reinforcement availability for them in either case.

Discussion:

The goal of the present set of experiments was to determine, without explicit training, whether eye gaze could direct a cotton top tamarin's attention to a novel object (Experiment One), or to a baited object (Experiment Two), and whether the use of various directional cues (i.e., pointing, gaze, or glance) were differentially used by the species in the different tasks.

Cotton top tamarins did not reliably visually co-orient to a novel object (Experiment One), but their rate of visual co-orienting was significantly increased by pointing cues as compared to a "look" cue that consisted of head, eyes, and body oriented toward the stimulus, and to a "glance" cue that consisted of head and eyes oriented toward the stimulus.

It was clear that tamarins made accurate choices at rates significantly higher than chance when a point/tap cue and when a "look" cue involving head, eye, and body orientation were used to indicate the "correct" baited cup in Experiment Two. As in Experiment One, a spatial relationship between a cue (finger) and an object produced accurate responding, especially when touching coincided with the visual cue.

A hand gesture like pointing may be a more effective cue to follow, especially when the reason for looking remains elusive. Social primates who do not actively share food, such as most old world and new world monkeys,(see Tomasello & Call, 1997) may use eye/head orientation and hand pointing to both avoid battle and to learn locations of food. For these purposes, cotton top tamarins may attend to eye/head cues and pointing/touching particularly when a location for food is indicated by such cues. The data from these two studies support such speculation, for with distal objects, body proximity was the more effective attention-getting cue, while for food locations, both head/eye cues and body proximty by way of touching were the prominently used cues.

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