



## Replication of “The Perception of Rational, Goal-Directed Action in Nonhuman Primates”

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### **This PDF file includes:**

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Notes for supplementary movie

### **Other Supporting Online Material for this correction includes the following:**

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Movie S1

# Replication of ‘The perception of rational, goal-directed action in nonhuman primates’

**Justin N. Wood<sup>1</sup> and Marc D. Hauser<sup>2,3</sup>**

## **1. Abstract**

Wood et al. (*1*) reported experiments on action perception with cotton-top tamarins, rhesus macaques and chimpanzees. All of the research materials are available to support the findings from the tamarin and chimpanzee experiments. However, there are only summary data, as opposed to raw data, for the rhesus monkey experiments because the researcher who performed the experiments inadvertently failed to archive the original field notes. Upon realizing that the notes were unavailable, Wood and Hauser reran all of the rhesus experiments, using the same design and test population. Each trial was videotaped and coded blind to the experimental condition. We found the same pattern of results: Rhesus showed statistically significant choice responses after observing the intentional hand grasp and hand-occupied elbow touch actions, and responded at chance levels after observing the accidental hand flop and hand-empty elbow touch actions. The direct replication of the originally reported results on rhesus monkeys in Wood et al. (*1*), including the raw data, is available below, and stored at [www.sciencemag.org/cgi/content/full/317/5843/1402/DC2](http://www.sciencemag.org/cgi/content/full/317/5843/1402/DC2).

## **2. Goals**

Our primary goal was to replicate the four experimental conditions with rhesus monkeys reported in Wood et al. (*1*), while adding more rigorous methods. Specifically, we replicated the intentional hand grasp and accidental hand flop conditions, as well as the hand-occupied elbow touch and hand-empty elbow touch conditions. We videotaped each trial, thereby allowing the subject’s response to be blind coded and tested for inter-observer reliability.

## **3. Methods**

From January 3-13, 2008, we tested the same population of free-ranging rhesus macaques (*Macaca mulatta*) on the island of Cayo Santiago, Puerto Rico. The general method was the same as in Wood et al. (*1*) with two exceptions. First, in order to make the procedure more comparable to the tamarin and chimpanzee experiments, we used containers rather than coconut shells; despite the change from coconut shells to containers, both presented a situation in which there were two potential food locations and the subject could choose between these locations by using the experimenter’s action as a cue to find food. This method of using containers has been successfully implemented in several studies with this population (*2,3*), including studies of action perception (*4, 5*). Consequently, rhesus readily associate these containers with food. Second, we videotaped all trials and then blind coded the trials using the procedure described in (*6*). The testing procedure was the same as in Wood et al. (*1*) except for the use of containers. For the intentional hand grasp and accidental hand flop actions, an experimenter searched for a subject who was not engaged in distracting activities. The experimenter approached to within 2-5

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meters of the subject, kneeled, and placed two white opaque containers (27 cm x 23 cm x 25 cm) on the ground between himself and the subject. Next, a foamcore occluder was placed between the subject and the containers. The experimenter then showed the subject a red apple approximately 30 cm above the top edge of the occluder, and then slowly lowered the apple into a hidden pouch between the two containers on the experimenter-side of the occluder. From the subject's perspective, it appeared as if the apple had been lowered into one of the two containers. After lowering the apple, the occluder was removed and placed behind the containers. The containers were then spread 2 meters apart and the experimenter performed an action toward one of the two containers, which was randomly selected before the start of the trial. After performing the action, the experimenter picked up the occluder and walked away, allowing the subject to approach. We defined a choice as the first container approached and inspected.

In contrast to the intentional hand grasp and accidental hand flop conditions, in which food was presented prior to the action, subjects were not shown food in the hand-occupied and hand-empty elbow touch conditions. Thus, in these two conditions, subjects had to use the experimenter's action to infer the existence of food in one of the containers; this condition was more similar to the coconut version presented in Wood et al. (1).

We aborted trials when (a) the test subject failed to attend to any part of the presentation, (b) the test subject failed to begin approaching one of the containers within 10 seconds, or (c) another monkey interfered with the trial during the presentation or choice period. We performed the conditions one at a time. Subjects were tested only once in a condition. We identified subjects from natural markings along with chest and leg tattoos and ear notches.

All trials were videotaped and then blind coded. Specifically, video clips of the trials were randomly intermixed with one another, and each was queued to start after the experimenter had performed the action. A coder then scored each trial, indicating whether the subject had made a choice, and if so on what side (right or left). The coder was therefore blind to both the condition and the container that the experimenter acted upon. To assess coding reliability, the primary coder (J.W.) randomly selected 20 trials coded as 'aborted' and 20 trials coded as 'successful.' A second individual (M.H), trained in coding rhesus monkey behavior, then coded these clips based on the criteria described in the main text, but blind to the primary coder's labeling. There was 100% agreement between the two coders for all 40 trials.

Trial-by-trial notes are presented in the Appendix. These notes include the time of the trial on the videotape, the subject number, whether the trial was included in the final analyses or excluded according to the abort criteria listed above (listed as "good" and "abort" trials, respectively), whether the subject did or did not inspect the container targeted by the action (listed as "1" and "0" trials, respectively), and comments specifying the reason for each aborted trial.

We also provide a comprehensive online supplementary video with accompanying notes. This video presents a collection of 24 trials: for each of the four conditions, we show four trials that were successful and two trials that were excluded based on our abort criteria.

#### **4. Results**

Rhesus selectively inspected the targeted container after observing the intentional hand grasp action (18/26 subjects; binomial probability:  $P = 0.04$ ) and the hand-occupied elbow touch action (14/17 subjects; binomial probability:  $P = 0.006$ ). In contrast, rhesus approached at chance after observing the accidental hand flop action (11/20 subjects; binomial probability:  $P = 0.41$ ) and the hand-empty elbow touch action (9/17 subjects; binomial probability:  $P = 0.50$ ).

## **5. Discussion**

This study replicates the pattern of responses reported in the original paper by Wood et al. (1) for rhesus monkeys (see Table 1 below) with comprehensive video records and blind coding. Specifically, as demonstrated by tamarins, rhesus and chimpanzees in our original report, this replication shows that rhesus monkeys reliably recognize an intentional hand grasp and a hand-occupied elbow touch as goal-directed actions.

*Table 1. Comparison of results from Wood et al. (1) and Wood & Hauser (replication).*

<b>Condition</b>	<b>Results</b>		<b>Binomial <i>p</i>-value</b>	
	<b>Wood et al. (1)</b>	<b>Wood &amp; Hauser (replication)</b>	<b>Wood et al. (1)</b>	<b>Wood &amp; Hauser (replication)</b>
Intentional hand grasp	17/20 subjects	18/26 subjects	.001	.04
Accidental hand flop	11/20 subjects	11/20 subjects	.41	.41
Hand-occupied elbow touch	28/32 subjects	14/17 subjects	.001	.006
Hand-empty elbow touch	16/32 subjects	9/17 subjects	.57	.50

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*Appendix*

Intentional Hand Grasp				
TAPE: "Hand Grasp Action; Jan. 08; Wood"				
TIME ON TAPE	SUBJECT #	GOOD TRIAL?	CORRECT?	COMMENTS
0:00	1	good	1	
0:37	2	good	1	
0:59	3	good	1	
1:34		abort		interference
1:58	4	good	1	
2:16	5	good	0	
2:44	6	good	1	
3:07		abort		failure to attend
3:32	7	good	1	
3:53		abort		experimenter error
4:23		abort		interference
4:48		abort		interference
5:40	8	good	1	
6:09		abort		interference
6:20		abort		interference
6:36	9	good	1	
7:01	10	good	0	
7:22	11	good	1	
8:30	12	good	1	
8:57		abort		interference
9:11		abort		interference
9:24	13	good	0	
9:59	14	good	0	
10:18	15	good	1	
10:51		abort		interference
11:12		abort		interference
11:43		abort		interference
12:05		abort		interference
12:21	16	good	0	
12:50		abort		no approach
13:15	17	good	0	subject made choice before interference; good trial
13:40		abort		interference
14:00	18	good	1	
14:30	19	good	1	
15:02	20	good	0	
15:47		abort		no approach
16:12		abort		interference
16:27	21	good	1	
17:00	22	good	1	
17:21	23	good	1	
17:51	24	good	0	
18:14	25	good	1	
18:28	26	good	1	

Aborts		Statistics		
Interference	13	# correct trials	18	
No approach	2	# good trials	26	
Failure to attend	1	Binomial (p-value)	0.04	SIGNIFICANT
Experimenter error	1			
<b>TOTAL</b>	<b>17</b>			

## Accidental Hand Flop

TAPE: "Hand Flop Action; Jan. 08; Wood"

TIME ON TAPE	SUBJECT #	GOOD TRIAL?	CORRECT?	COMMENTS
0:00	1	good	1	
0:36	2	good	0	
1:08	3	good	0	
1:41	4	good	1	
2:10		abort		Interference
2:28	5	good	1	
2:51	6	good	1	
3:20		abort		no approach
3:43		abort		failure to attend
3:56	7	good	1	
4:39		abort		failure to attend
4:58		abort		Interference
5:11		abort		no approach
5:35		abort		Interference
5:52		abort		experimenter error
6:22	8	good	1	
6:44	9	good	0	
7:35		abort		Interference
7:52		abort		no approach
8:22	10	good	0	
8:53	11	good	1	
9:15	12	good	0	
9:41		abort		Interference from truck
10:11	13	good	0	
10:43		abort		Interference
11:02	14	good	1	
11:34		abort		no approach
12:03		abort		Interference
12:25		abort		Interference
12:40	15	good	1	
13:04		abort		no approach
13:25		abort		no approach
13:50	16	good	0	
14:13		abort		Interference
14:25	17	good	0	
14:53		abort		no approach
15:16	18	good	1	
16:12	19	good	1	
16:25	20	good	0	

Aborts		Statistics		
Interference	9	# correct trials	11	<b>NON-SIGNIFICANT</b>
No approach	7	# good trials	20	
Failure to attend	2	Binomial (p-value)	0.41	
Exp. error	1			
<b>TOTAL</b>	<b>19</b>			

## Hand-Occupied Elbow Touch

TAPE: "Hand-Occupied Elbow Action; Jan. 06; Wood"

TIME ON TAPE	SUBJECT #	GOOD TRIAL?	CORRECT?	COMMENTS
0:00		abort		no approach: longer than 10 sec. to approach
0:47	1	good	1	
1:15	2	good	1	
1:38		abort		no approach
2:08	3	good	1	
2:28		abort		interference
3:15		abort		failure to attend
3:46	4	good	1	
4:18		abort		interference
4:38		abort		interference
5:11		abort		no approach
5:34		abort		no approach
6:04		abort		interference
6:21	5	good	1	
6:59		abort		no approach
7:25	6	good	1	
7:50		abort		no approach
8:40		abort		interference
9:05	7	good	1	
9:41	8	good	0	
10:36	9	good	1	
11:03	10	good	0	
11:44		abort		interference
12:12		abort		no approach: longer than 10 sec. to approach
12:42		abort		no approach
13:21		abort		no approach
14:16		abort		interference
15:12	11	good	1	
16:29	12	good	1	
16:58	13	good	1	
17:21	14	good	1	
17:54		abort		no approach
18:21	15	good	1	
18:49	16	good	1	
19:26		abort		no approach
19:52	17	abort	0	

Aborts		Statistics		
Interference	7	# correct trials	14	<b>SIGNIFICANT</b>
No approach	11	# good trials	17	
Failure to attend	1	Binomial (p-value)	0.006	
Exp. error	0			
<b>TOTAL</b>	<b>19</b>			

## Hand-Empty Elbow Touch

TAPE: "Hand-Empty Elbow Action; Jan. 08; Wood"

TIME ON TAPE	SUBJECT #	GOOD TRIAL?	CORRECT?	COMMENTS
0:00		abort		
0:44	1	good	0	no approach: longer than 10 sec. to approach
1:07		abort		no approach
1:48	2	good	1	
2:25	3	good	1	
2:44	4	good	1	
3:14	5	good	0	
3:38	6	good	0	
4:11	7	good	1	
4:33	8	good	1	
4:55	9	good	1	
5:27	10	good	0	
5:52	11	good	0	
6:09		abort		interference
6:35	12	good	0	
7:09	13	good	0	
7:32	14	good	0	
7:55	15	good	1	
8:18	16	good	1	
8:56	17	good	1	

Aborts		Statistics	
Interference	1	# correct trials	9
No approach	2	# good trials	17
Failure to attend	0	Binomial (p-value)	0.5
Exp. error	0		
<b>TOTAL</b>	<b>3</b>		<b>NON-SIGNIFICANT</b>

**Notes for supplementary video: Replication of ‘The perception of rational, goal-directed action in nonhuman primates.’**

All comments below are from the camera’s perspective, aimed at the subject.

<b>Condition</b>	<b>Trial #</b>	<b>Comments</b>
Intentional Hand Grasp: Good Trials	1	Subject is in front of the experimenter on the ground, to the right of the tree; subject approaches container on the left.
	2	Subject is in front of the experimenter, sitting on a fallen tree branch; there is another individual behind and to the left of the target subject; subject approaches container on the right.
	3	Subject is in front of the experimenter on the ground, next to the back tire of the truck; subject approaches container on the left.
	4	Subject is in front of the experimenter on the ground; subject approaches container on the right.
Intentional Hand Grasp: Aborted Trials	1	Subject is in front of the experimenter on the ground, within the bush; subject fails to approach.
	2	Subject is in front of the experimenter on the ground (with a tree behind the subject); as subject approaches, another individual also approaches.
Accidental Hand Flop: Good Trials	1	Subject is on the ground, in front of the tree, body facing to the right; subject approaches the container on the right.
	2	Subject is on the ground, under some of the bush, in front of the experimenter; subject approaches container on the right.
	3	Subject is in front of the experimenter on the ground; subject approaches container on the right.
	4	Subject is in front of the experimenter on the ground; there is another individual off to the right and back, near the tree; subject approaches container on the left.
Accidental Hand Flop: Aborted Trials	1	Subject is in front of the experimenter, to the right of dead tree trunk; subject fails to approach.
	2	Subject is in front of the experimenter on the ground; as subject approaches container on the left, another subject approaches from the right.
Hand-Occupied Elbow Touch: Good Trials	1	Subject is in front of the experimenter, sitting in front of the nearest tree; subject approaches container on the left.
	2	Subject is in front of the experimenter on the ground; subject approaches container on the left.
	3	Subject sitting on top of a water dispenser in front of experimenter; though another individual approaches from behind, the subject did not see this other individual and approached the container on the right.
	4	Subject is in front of the experimenter on the ground; subject approaches container on the right.
Hand-Occupied Elbow Touch: Aborted Trials	1	Subject is in front of the experimenter on the ground; subject fails to approach within 10 seconds.
	2	Subject is in front of the experimenter on a fallen log; another individual runs in from the right side.
Hand Empty Elbow Touch: Good Trials	1	Subject is in front of the experimenter on a log; subject approaches container on the right.

	2	Subject is in front of the experimenter on a fallen branch; subject approaches container on the left.
	3	Subject is in front of the experimenter on the ground; subject approaches container on the left.
	4	Subject is in front of the experimenter on the ground; subject approaches container on the right.
Hand Empty Elbow Touch: Aborted Trials	1	Subject is in front of the experimenter to the left of the nearest tree; subject fails to approach.
	2	Subject is in front of the experimenter on the ground; subject fails to approach and another individual approaches from the left.