

## Supplemental Data

S1

## Selective Imitation in Domestic Dogs

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## Supplemental Experimental Procedures

## Subjects

Dogs (*Canis familiaris*;  $n = 54$ ) and their owners were recruited from various dog training schools in Austria and Hungary. Participation in the tests was voluntary. Owners were instructed on what to do and what to say during the test. We only included dogs in the analyses if their owner acted in line with our instructions. Dogs were assigned randomly to the experimental and control groups. Each dog was tested in one group only.

Only dogs older than 1 year were tested (mean age: 4.23 years, range: 1–12 years), and various breeds were included. The overall sex ratio of dogs was balanced (male to female: 28 to 26). The majority of dogs had extensive training as agility, rescue, service, or dancing dogs. Experiments were executed in an environment familiar to the dog.

## Procedures

The experiment was carried out between March and November 2006. For the pretest and, if needed, short training phase, we used a ring of twisted cotton (24 cm in diameter) commonly used as dog toys. We covered the ring with gray tape. It was held by the experimenter for all but 14 dogs in the experimental groups (see below for “Clever Hans Control”). First, all dogs including the control dogs were pretested to pull the ring with their mouth and push it down with their paw. The owners were allowed to use any method they liked to achieve this goal including giving a food reward to the dog. Each method had to be used correctly five times by each dog. The sequence of the training (paw-mouth or mouth-paw) was counterbalanced within groups.

After the training, the test was conducted spatially distinct from the training place with the novel test apparatus. The dogs in the mouth-free and mouth-occupied group received ten demonstrations from a model dog. The model dog was placed at a distance of 3–4 m from the apparatus, whereas the observer was placed approximately 2 m from the apparatus so that it could easily observe the demonstrated action. The experimenter showed the observer dog a piece of food that was then visibly placed into the food container. Then the experimenter returned to the model dog and sent the model to manipulate the wooden rod with the command “ring.” In both, the mouth-free and mouth-occupied conditions, the model went to the apparatus, pushed the wooden rod down with its paw, and returned to the starting position where it received a food reward. The reward that was released from the food container during the demonstration was retrieved by the observer dog after each demonstration. The same procedure was repeated ten times. During the demonstration, the owners were instructed to direct the attention

of their dog toward the model dog but were not allowed to use any commands or words such as paw, pull, etc. Additional ostensive cues were given by the model who gazed at the observer dog at the beginning of the demonstrations. Once the observers had received ten demonstrations, the model dog was taken away and the observer was put in the starting position. The experimenter again showed the observer dog a piece of food and then placed it into the food container. Now the observer dog was released by the owner and instructed to “get the reward” without any indication of which method to use. Initially, the owner stayed back at the starting point ( $n = 21$ ), but most dogs needed the help of the owner to direct them toward the wooden rod at least in the first trial ( $n = 34$ ). In these circumstances, the owners were not allowed to touch the rod but could approach as close as 1.5 m and point toward the rod, thus encouraging their dogs without giving any clear instructions. If the dog successfully retrieved the food reward, the dog was led back to the starting position and the procedure was repeated. Each dog received a total of eight trials.

The control dogs received no demonstration by the model, but otherwise the procedure was identical. Importantly, however, the owners of the control dog did witness the demonstration of the model dog to make sure that dogs in all conditions received the same social cues from their owners. All owners were kept uninformed of the goal of the study (e.g., they were told that we want to see whether their dogs can obtain the food reward from the food container by manipulating the wooden rod). The experiments were filmed with a digital JVC video camera.

In order to test whether the paw use as well as the selectivity was influenced by social cues given by the owners, we tested 14 of the 54 dogs (MF:  $n = 7$ ; MO:  $n = 7$ ) under stricter conditions. First, the pretest or, if necessary, training, was carried out by someone not involved in the real study. If the dogs showed separation anxiety ( $n = 2$ ), owners were allowed to stay in the same room during the pretest but had their eyes covered and listened to music from a headset. Second, during the demonstrations in the test phase, the owners had their eyes covered and thus did not observe the behavior of the model dog. Keeping the owners blind to the experimental conditions neither influenced the adoption of the paw method nor the selectivity (see Table S3).

## Coding

In line with the infant studies (Meltzoff and Gergely et al. [S1]), all clear attempts of the dogs to get the food reward via manipulating the wooden rod were coded. A paw action was noted if the dog touched the rod with its paw or approached it (within 10 cm) with his paw horizontally lifted. A mouth action was recorded if the dog grabbed the rod with open jaws or showed an attempt to do so in touching the rod while holding the mouth open and when it moved the rod by poking it with its nose. If the action resulted in producing the food reward, it was said to be successful.

## Statistics

Statistical analyses were performed with Instat 3. All tests were two tailed, and  $\alpha$  was set at 0.05. When multiple comparisons were conducted, probabilities were corrected by the Bonferroni procedure.

## Supplemental References

S1. Gergely, G., Bekkering, H., and Kiraly, I. (2002). Rational imitation in preverbal infants. *Nature* 415, 755.

Table S1. Number of All Actions across the Eight Test Trials

Trial	# of Actions			p
	C	MO	MF	
1	2 (1; 7)	3 (2; 5)	3 (1.25; 6.75)	0.605
2	2 (1; 2)	1 (1; 2)	2 (1; 3)	0.456
3	2 (1; 2.75)	2 (1; 3)	1 (1; 4)	0.768
4	3 (2; 5)	1 (1; 4)	2 (1; 2.25)	0.394
5	1 (1; 3)	1 (1; 3)	2 (1; 3)	0.798
6	3 (2; 4)	3 (1.75; 3.25)	3 (2; 4)	0.645
7	3 (1; 7)	2 (1; 3.25)	2 (2; 4)	0.612
8	2 (1; 3)	2 (1.75; 4)	2 (1; 4)	0.699

Depicted are the medians (first quartile, third quartile) of actions used to receive a reward for all eight test trials in the three groups and the results of the Kruskal-Wallis test (p).

Table S2. Percentage of Paw Use across All Eight Trials

Trial	Median % of Paw Use				Dunn's Multiple-Comparisons Test		
	C	MO	MF	p	C-MO	C-MF	MO-MF
1	0 (0; 0)	0 (0; 0)	35.38 (13.57; 91.67)	0.0002	p > 0.05	p < 0.01	p < 0.01
2	0 (0; 0)	20 (0; 50)	50 (0; 100)	0.0095	p < 0.05	p < 0.05	p > 0.05
3	0 (0; 0)	0 (0; 50)	38 (0; 100)	0.046	p > 0.05	p < 0.05	p > 0.05
4	0 (0; 0)	50 (0; 56)	29 (0; 100)	0.03	p > 0.05	p < 0.05	p > 0.05
5	0 (0; 0)	0 (0; 100)	57 (0; 100)	0.1254	p > 0.05	p > 0.05	p > 0.05
6	0 (0; 0)	33 (0; 100)	50 (17; 75)	0.0365	p > 0.05	p < 0.05	p > 0.05
7	0 (0; 0)	25 (0; 50)	100 (67; 100)	0.0027	p > 0.05	p < 0.01	p > 0.05
8	0 (0; 0)	0 (0; 43)	63 (25; 100)	0.0064	p > 0.05	p < 0.01	p > 0.05

Depicted are the medians (first quartile, third quartile) of the percentage of paw use across all eight test trials in the three groups (C = Control; MO = Mouth-Occupied; MF = Mouth-Free), the results of the Kruskal-Wallis test (p) and the Dunn's multiple comparison test.

Table S3. Successful Action for Each Dog in All Eight Trials

Group	Dog	Trial							
		1	2	3	4	5	6	7	8
C	Angie	M	M	M	M	M	M	M	M
C	Balfi	P							
C	Boss	M	M	M	M	M	M	M	M
C	Clipper	(M)							
C	Gina	M	M	M	M	M	M	M	M
C	Gomba	M	M	M	M	M	M	M	M
C	Guru	M	M	M	M	M	M	M	M
C	Happy	(M)							
C	Hiszti	M	M	M	M	P	M		
C	Mazsola	P	M	P	P	P	P	M	M
C	Nikita	(M)							
C	Rozi	M	M	M	M	M	M	M	M
C	Speck	M	M	M	M	M	M	M	M
MF	Apollo	P	M	M	P	M	M	M	M
MF	Benji	P	P	M	P	P	P	P	P
MF	Benny	P	P	P	P	P	P	P	P
MF	Dana	M	M	M	M	P	P	M	M
MF	Duke	P	M	P	P	P	P	P	P
MF	Flint	P	M	M	M	M			
MF	Heck	P	P	P	P	P	P	P	P
MF	Joy	M	M	M	M	M	M	M	M
MF	Kira	P	M	M					
MF	Magic	P	P	P	P	P	P	P	P
MF	Taube	M	M	M	M	M	M	M	M
MF	Maggie*	P	P	P	P	P	P	P	P
MF	Tiny*	(P)							
MF	Bonny*	P	M	M	P	M	P	P	P
MF	Finn*	P	P	P	P	P	P	P	P
MF	Bounty*	P	P	P	P	P	P	P	P
MF	Lokri*	(P)							
MF	Chip*	P	P	P	M	P			
MO	Arnould	M	P	M	M	M	M	M	M
MO	Cooly	M	P	P	P	P	P	P	P
MO	Crisscross	M	M	M	M	M	M	M	M
MO	Doc	M	M	M	P	M	M	M	M
MO	Filip	M	M	M	P	P	P	P	P
MO	Blackie	M	P	P	P	P	P	P	P
MO	Ikarus	M	P	P	P	P	P	P	P
MO	Jamil	P	P	M	P	M	M	P	M
MO	Nell	M	M	M	M	M	M	M	M
MO	Quincy	P	P	P	P	P	P	M	M
MO	Sanchez	M	M	M	M	M	M	M	M
MO	Tracy	M	P	P	P	P	M	M	M
MO	Happy*	M	M	M	M	M	M	M	M
MO	Kyra*	(M)							
MO	Celine*	M	M	P	M	P	P	P	M
MO	Sweety*	P	P	P	P	P	P	P	P
MO	Maya*	M	P	P	P	P	P	P	M
MO	Maluna*	(P)							
MO	Merlin*	M	M	M	M	M	M	M	M

The following abbreviations were used: C, control group; MF, mouth-free group; MO, mouth-occupied group; P, paw; M, mouth; (M), dogs that manipulated the rod with their mouth but that were not successful in producing a reward; and (P), dogs that manipulated the rod with their mouth and also their paw but that were not successful in producing a reward. Asterisks indicate the dogs that were tested with their owners blindfolded.