

Department of Interdisciplinary Life Sciences

University of Veterinary Medicine Vienna

Comparative Cognition Unit, Messerli Research Institute

Head: Univ.-Prof. Dr.rer.nat. Ludwig Huber

A Breed-Comparative Analysis of Canine Responses to Human Knowledge States in an Auditory False Belief Study

Diploma thesis

Submitted by

Gina Risch

Vienna, May 2025

Betreuer: Univ.-Prof. Dr.rer.nat. Ludwig Huber
Vergleichende Kognitionsforschung, Messerli Forschungsinstitut
Department für Interdisziplinäre Lebenswissenschaften
Veterinärmedizinische Universität Wien

Lucrezia Lonardo, PhD
Vergleichende Kognitionsforschung, Messerli Forschungsinstitut
Department für Interdisziplinäre Lebenswissenschaften
Veterinärmedizinische Universität Wien

Gutachterin: Priv.-Doz. Sarah Marshall-Pescini, PhD
Domestication Lab, Konrad-Lorenz-Institut für Vergleichende
Verhaltensforschung
Department für Interdisziplinäre Lebenswissenschaften
Veterinärmedizinische Universität Wien

Eigenständigkeitserklärung

Hiermit erkläre ich, dass ich die vorgelegte Arbeit selbstständig verfasst und keine anderen als die angegebenen Quellen und Hilfsmittel benutzt habe. Alle übernommenen Textstellen aus fremden Quellen wurden kenntlich gemacht.

Ich habe die entscheidenden Arbeiten selbst durchgeführt und alle zuarbeitend Tätigen mit ihrem Beitrag zur Arbeit angeführt.

Die vorliegende Arbeit wurde nicht an anderer Stelle eingereicht oder veröffentlicht.

Wien, den 31.05.2025

Gina Risch

Table of contents

1. Introduction 1

2. Material and methods 4

2.1. Subjects 4

2.2. Setup 5

2.3. Procedure..... 8

2.4. Analyses..... 11

3. Results 12

4. Discussion..... 18

5. References..... 22

6. Tables and Figures 25

7. Appendix 27

Zusammenfassung

Das Verständnis der kognitiven Fähigkeiten von Haushunden (*Canis familiaris*) liefert neue Einblicke in die Evolution sozialer Intelligenz. In diesem Forschungsfeld legen einige Theorien nahe, dass die soziokognitiven Fähigkeiten von Hunden ein zufälliges Nebenprodukt des Domestikationsprozesses sind. Andere Theorien gehen hingegen davon aus, dass bestimmte Hunderassen speziell für den Umgang mit Menschen selektiert wurden. Frühere Studien haben Rasseunterschiede in Bereichen wie dem Verständnis menschlicher Kommunikationssignale, beispielsweise anhand von Gesten oder gerichteten Blicken beschrieben. Diese Ergebnisse deuten darauf hin, dass die Rasseauswahl für Aufgaben, die Kooperation versus Eigenständigkeit erfordern, eine bedeutende Rolle spielen kann.

Diese Diplomarbeit untersucht potenzielle Unterschiede zwischen Rassetypen bei der Einschätzung menschlicher Wissensstände in einer auf Gehör basierten Täuschung. Hauptziel war der Vergleich mit den Ergebnissen einer früheren Studie basierend auf visueller Täuschung mit ähnlicher Rassezusammensetzung. Mithilfe eines auditiven Täuschungsparadigmas zur Manipulation des Wissensstandes eines menschlichen Beobachters über den Ausgang eines Futterversteckvorgangs wurde eine Stichprobe von 206 Hunden getestet. Die Hunde wurden basierend auf ihrem Arbeitsstil in kooperative (N=183) und eigenständige (N=23) Rassetypen eingeteilt. Alle getesteten Hunde durchliefen die notwendigen Eingewöhnungsphasen und zeigten somit ein ausreichendes Aufgabenverständnis.

Die Ergebnisse zeigen keinen statistisch signifikanten Unterschied in der Tendenz kooperativer und eigenständiger Hunderassetypen, irreführenden Hinweisen eines Menschen zu folgen. Dieses Ergebnis steht im Gegensatz zu früheren Studien und könnte darauf hindeuten, dass für die Interpretation menschlicher Wissensstände die sensorische Modalität der Hinweise eine zentrale Rolle spielt.

Abstract

Understanding the cognitive abilities of domestic dogs (*Canis familiaris*) continues to provide new insights into the evolution of social intelligence. Within this field, some theories suggest socio-cognitive abilities of dogs are an incidental by-product of the broader domestication process, while others imply certain dog breeds were directly selected for interaction with humans. Previous studies have highlighted breed differences in areas such as comprehension of human communicative signals (e.g. cue following) and human directed gazing or dependency. These findings suggest that breed selection for tasks requiring cooperation versus independence may play a significant role.

This thesis investigated potential breed type differences in canine responses to human knowledge states in an auditory false belief task. The primary objective was to replicate findings from a previous visual false belief task, aiming for a similar breed composition.

Utilising an auditory false belief paradigm to manipulate a human's knowledge state regarding an event's outcome, a sample of 206 dogs was tested.

Subjects were broadly categorised into breed types based on their working style, cooperative (N=183) and independent (N=23). All tested dogs completed necessary familiarisation phases, demonstrating task comprehension. The central finding of the current was the absence of a statistically significant overall difference in the tendency of cooperative and independent dog breed types to follow misleading human suggestions. This outcome, contrasting earlier studies, may suggest that for dogs' interpretation of human knowledge states the sensory modality of cues play a critical role.

Abbreviations

BLUPs	Best linear unbiased predictors
FB	False belief
FCI	Fédération Cynologique Internationale
GLMM	Generalised Linear Mixed Model
LRT	Likelihood ratio test
SC	Sound control
TB	True belief

1. Introduction

Understanding the cognitive abilities in domesticated dogs (*Canis familiaris*) continues to provide new insights into the evolution of social intelligence. Some theories suggest socio-cognitive abilities of dogs are an incidental by-product of domestication. Others imply certain dog breeds were directly selected to further develop the ability to understand human communicative gestures.

The presence of theory of mind, the ability to attribute mental states to others, has been well documented in human infants, with foundational abilities emerging in the first year of life using implicit false belief tasks. However a more complex understanding of false belief using explicit tasks involving language seems to begin appearing around the age of four (1). Performing the implicit false belief tasks, not involving language, on non-human primates has yielded mixed results. While some studies have suggested apes exhibit some complex theory of mind aspects such as perspective taking, i.e., being able to distinguish other's view from their own (2), they sometimes showed understanding of other's knowledge (3) but lacked comprehension of false belief (4). An ability that non-human primates seem not to possess is following cues, even iconic ones, in object-choice tasks consistently (5). Dogs on the other hand excel at these from as early as 6 weeks old, following human cues such as pointing gestures or a marker to successfully find hidden food (6). In another object-choice task study, utilising human gaze and pointing cues, results showed to be independent of the dog's breed (7), implying that the ability to follow human communicative cues developed as an early by-product of domestication. While dogs are generally adept at interpreting human communicative signals, it is plausible that breed-specific traits, shaped by centuries of selective breeding for various different roles, could significantly influence their behaviour of more complex social cognitive tasks (8).

Different breeds exhibit variations in their reliance on human cues, social learning strategies and overall responsiveness to human interaction. Studies comparing broad categories of breeds have found distinctions in their reliance on human signals. When classifying breeds based on their historical selection for either cooperative work, which demands close responsiveness to human signals, or independent work, where dogs require autonomy, one study indicates that breeds selected for cooperative tasks tend to exhibit higher levels of human-directed gazing when faced with difficult problems (9).

Breed differences are also apparent in situations involving potentially misleading human cues. In a food choice task focusing on the influence of breed groups and developmental stage on domestic dogs' sensitivity to human cues primitive, hunting/herding and mastiff-like breed groups were tested. When a human indicated a smaller food quantity despite a larger one being available, dogs from the hunting/herding group were significantly more likely to follow the human's misleading indication compared to mastiff-like dogs. Primitive dogs however chose at a chance level in this misleading cue scenario. This again suggests that breeds selected for cooperative work, such as the cooperative hunting and herding dogs tested, may be more sensitive to human social communicative cues, while breeds selected for independent work, like mastiff-types, are less influenced by humans. The study also found that sensitivity to human influence is present in puppies as young as 4 months, adult dogs however followed cues significantly more in some conditions, indicating the role of learning and development. Overall, the research reinforces that domestic dogs rely on human social communicative cues, and supports the theory that this reliance is shaped by breed specific selection and developmental factors (10)

Seeing that dogs exhibit these exceptional skills in interpreting human communication raises the question whether their social cognitive abilities extend to understanding human mental states. Exploring theory of mind in non-human species presents some methodological hurdles, having to rely on non-verbal paradigms that can reliably depict understanding of others' mental states while also controlling for simpler explanations that could be attributed to behaviour reading (11).

Building on the understanding that domestic dogs are highly responsive to human social cues and often display a dependence on humans in problem solving tasks, research further explores the extent of this influence, specifically whether dogs will follow a human's suggestion even when it is incorrect or leads to a disadvantageous outcome for the dog (10,12). In a task presenting dogs with a choice between a larger and a smaller quantity of food, some dogs were significantly influenced by a human indicating a clear preference for the smaller, less rewarding amount, choosing it over the larger one (10). Similarly, a study utilising human pointing or gazing have found instances where dogs follow these cues even when they do not accurately indicate the location of a hidden reward (12).

This tendency for dogs to follow misleading human cues appears to be influenced by factors such as breed and potentially their interpretation of the human's knowledge state. In the quantity discrimination task (10), dogs from hunting/herding breed groups were more prone to

follow the human's suggestion of the smaller amount than dogs from primitive or mastiff-like groups. In the change of location task (12), dogs' understanding of human's varying knowledge states (true and false belief) has been explored and revealed, dogs followed a human's misleading cue to an empty location more frequently when the human was unaware of the food's true location (false belief) compared to when the human knew about it (true belief). Notably, the opposite pattern was observed in terriers, the only breed group to follow the misleading suggestion more often when the human held a true belief about the food's location, aligning with findings in human infants and children (13,14) and non-human primates (15).

Less is known about responses to auditory false belief and whether functional breed classifications predict these responses. The current study aims to further investigate this implicit sensitivity to human beliefs in the auditory domain, focusing on differences in performance across different dog breed types and groups utilising a between-subjects non-verbal change of location task. After successfully completing a series of familiarisation phases, dogs will undergo one test trial in which a human observer assumes one of three knowledge states. Based on past findings in the field of animal and canine social cognition, dog breeds historically selected for cooperative work with humans are predicted to be more likely to follow human communicative signals and disregard their own observations when the communicator has an auditory false belief. Independent breeds, bred to make decisions more autonomously, on the other hand would potentially be more inclined to ignore a communicator's misleading suggestion, choosing to act based on their own information.

2. Material and methods

2.1. Subjects

In total 206 observations (one per dog) were collected from dogs of 57 different breeds in a completed test trial. An additional 109 dogs were invited but had to be excluded due to not meeting the inclusion criteria (62 in phase 1, 34 in phase 2, 8 in phase 3). 5 dogs did not start the familiarisation trials because of lack of interest or fear of the equipment. This is only a subsample of the total 240 dogs that are tested for the complete study due to time constraints of this thesis. Out of the 206 tested dogs, 183 were categorised as cooperative and 23 as independent.

All tested dogs completed all 3 familiarisation phases and therefore showed comprehension of the task. The sample was counterbalanced for sex, breed type, and age between test conditions (Table 1). Given that the primary objective of the current study was to compare the findings of a prior visual false belief task (12), efforts were made to achieve a breed composition closely resembling that of the previous study, despite the skewed sample distribution.

Table 1: Summary of tested subjects categorised by sex and breed group

	Female	Male	FCI 1	FCI 2	FCI 5	FCI 6	FCI 7	FCI 8	FCI 10	Avg. age in months
FB	36	33	26	6	4	2	5	24	2	60.58
SC	37	32	30	7	4	2	4	20	2	62.38
TB	37	31	27	8	3	2	4	22	2	58.19
TOTAL	110	96	83	21	11	6	13	66	6	60.39

In total 57 breeds were tested and grouped into their respective 7 breed groups according to the Fédération Cynologique Internationale (16). The breed types were further divided into independent (N=23) and cooperative (N=183) breed types according to previous studies' categorisation (17). Since not all of the 57 tested breeds were individually categorised, the classification (independent or cooperative) assigned to listed breeds was considered as

classification for the entire respective FCI breed group. According to this FCI groups 1 (Sheepdogs and Cattle dogs, except Swiss Cattle dogs), 2 (Pinscher and Schnauzer, Molossoid and Swiss Mountain and Cattle dogs), 7 (Pointing Dogs) and 8 (Retrievers, Flushing Dogs, Waterdogs) were considered cooperative and groups 5 (Spitz and primitive types), 6 (Scent hounds and related breeds) and 10 (Sighthounds) independent. This approach was taken to categorise breeds based on their original intended work purpose, aiming to investigate differences related to functional breed selection for cooperation or independence.

All subjects' experience in dog sport was recorded. Basic and at home training was considered as having no experience, training with a professional or competition experience were considered as having experience.

2.2. Setup

Each dog was always accompanied by its owner for the entire duration of their single approximately 20-minute-long session in a room as pictured in Figure 7 at the Clever Dog Lab, Vienna.



Figure 1: 20x20 cm lid with 10 bells (silent or noisy) attached

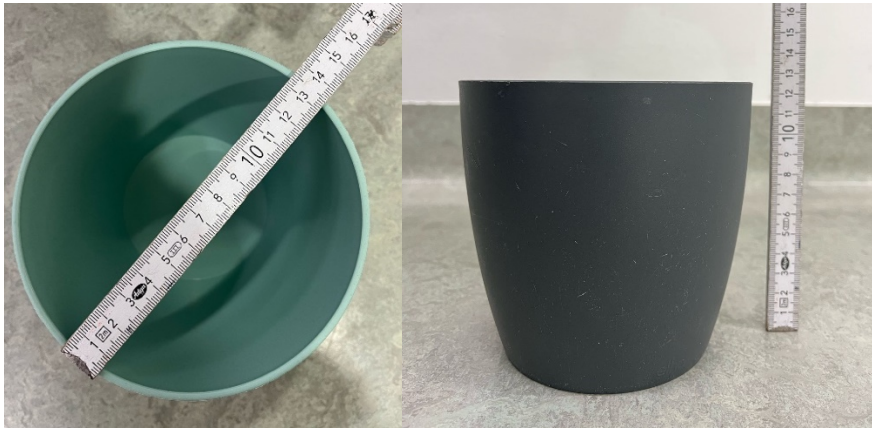


Figure 2: Regular buckets (grey and blue, opaque, 13.5 cm diameter, 12.5 cm height)



Figure 3: Small buckets (green and red, opaque, 12.0 cm diameter, 10.5 cm height)



Figure 4: Large buckets (red and blue, opaque, 18.0 cm diameter, 15.5 cm height)



Figure 5: Circular foam piece (9.5 cm diameter, 1.5 cm height)

Depending on the dog's size and preference a set of two differently coloured but equally sized buckets (Figure 2-4) was used. While the names of bucket A and B were counterbalanced across dogs (Table 7) but fixed within dog, the actual buckets' placement (left=regular grey, small green, large red; right=regular blue, small red, large blue; Figure 7) remained the same for all trials. Cardboard lids (Figure 1) were used to cover the buckets during familiarisation and testing phases according to 1.3 Procedure. A small piece of foam (Figure 5) was placed inside the bucket and used alongside a quiet lid during FB and SC test trials as described in 1.3 Procedure.

The dog was kept facing the buckets (Figure 2-4) when in position (Figure 7) in front of or next to the owner who for the duration of each trial wore a blindfold (Figure 6) and remained seated on the chair. The owner was instructed to hold onto their dog using a leash or simply grabbing their collar until an experimenter gave the "ok" to set them free. They were also allowed to use a verbal command (e.g. "free" or "search") if the dog did not move after being set free to make a choice. After a choice was made or the trial was deemed "no choice" the owner was allowed to remove the blindfold and retrieve their dog.



Figure 6: Blindfold

Dry kibble was used as food for all dogs, if motivation was deemed low the kibble was replaced with sausages. For 19 dogs the owner's food was used due to allergies or low food motivation.

Water was available *ad libitum*.

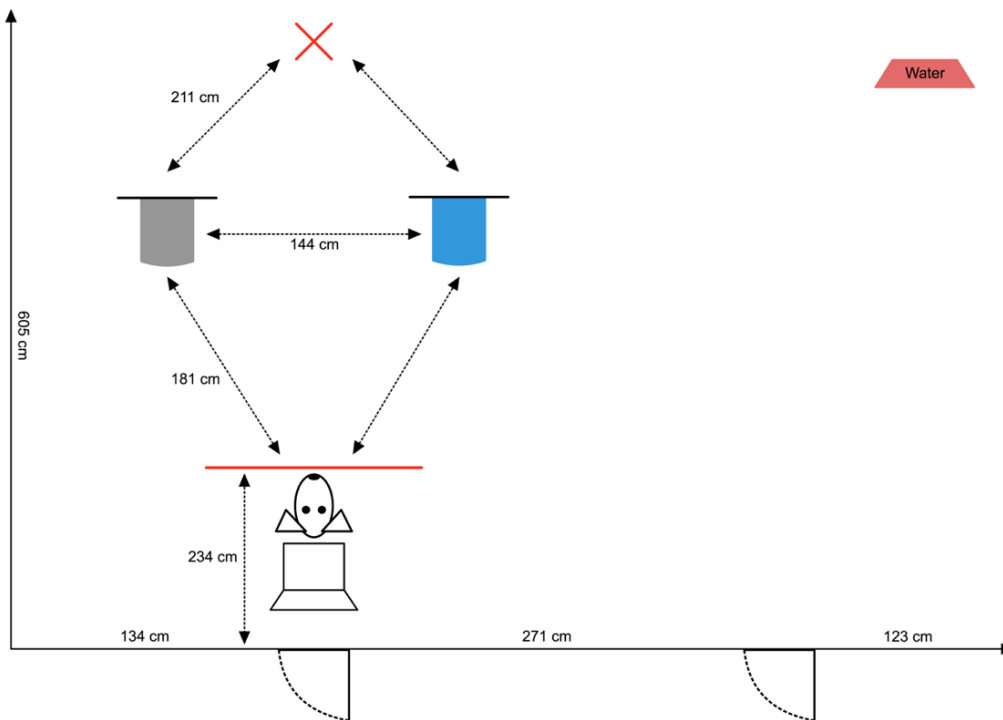


Figure 7: Experiment room setup

2.3. Procedure

Each dog was assigned 2 experimenters (Table 7), one assuming the role of the hider, the other the role of the communicator. Hider and communicator were always unfamiliar to the dog and the communicator did not handle any food around the dog, aiming to act as a neutral observer. The hider, being the experimenter handling the placement of food in further phases, was also tasked with carrying out familiarisation phase 0. To ensure dogs' success was independent of experimenter, each of the 4 experimenters resumed both roles an equal number of times.

In a short familiarisation phase 0 (2–15 mins.) all dogs were introduced to the testing room and equipment to minimise distraction and fear factors. For this phase, dogs were free to roam around the testing room while a piece of food was placed inside the open buckets one at a time. This was done to introduce the rule of only one piece of hidden food, discouraging dogs

from checking both buckets. Noisy lids were slowly added in, covering more of the buckets' opening each time. This was done in an effort to encourage dogs to retrieve the food inside even when the buckets were eventually covered by a noisy lid. Most dogs were confident in removing the noisy lids themselves and retrieving food from inside the bucket after around 2-10 minutes. Few still struggled with opening the buckets, only touching them or the lids, but in an effort to prevent frustration or disinterest, subjects advanced to familiarisation phase 1.

A choice was considered if the dog touched a bucket or lid, approaching without making contact was not considered a choice. If no bucket or lid was touched after 30 seconds, it was considered no choice and therefore a failed trial.

Each of the following 3 familiarisation phases was considered completed if the dog made the correct choice in 2 consecutive trials of the same phase for a maximum of 4 trials per phase. This was done to ensure dogs' comprehension of the newly introduced part of the task and minimise the chance of succeeding by choosing at random.

For all trials, each time food was dropped or placed into a bucket, the hider retracted her hand out of the bucket with a closed fist as to not visually indicate the absence of the food in their palm.

While manipulating a bucket, experimenters never obstructed the bucket from the dog's or communicator's view (marked X; Figure 7) and always tried to make eye contact with the dog, which has been shown to promote engagement (18).

The hider always entered the room, passing the dog on the side of bucket A and exited, passing on the side of the last manipulated bucket.

Familiarisation Phase 1: The owner and dog were instructed to be in their respective positions (Figure 7) while alone in the room. The hider then entered from the door behind the dog, visibly holding a piece of food. Each dog's first trial was always a "no displacement" trial.

In the "no displacement" trial the lid of bucket A was then audibly (purposefully shaking it and the attached noisy bells) opened, food audibly dropped into the bucket and the lid audibly closed again. The hider then exited the room, after which the dog was set free to make a choice.

In the "displacement" condition the lid of bucket A was audibly opened, food audibly dropped into the bucket and the lid audibly closed. The lid was then audibly opened again, food taken out of bucket A and the lid audibly closed. The food was then clearly shown to the dog and

moved over to bucket B, where it was placed inside the bucket the exact same way. The hider then exited the room and the dog was set free.

Familiarisation Phase 2: The dog started this phase by waiting outside the testing room. The hider and the communicator entered the room together. The communicator crouched down in their position (marked X; Figure 7) facing the wall. After placing food into one of the buckets, according to the counterbalancing (Table 7), the hider then exited the room, letting the dog back inside to take its position. The communicator then turned around, walked to the correct bucket containing food and made a suggestion to the dog by lifting the container and, in a friendly voice, saying “Look! This is good. This is very good.”. The bucket was then placed back, and the communicator resumed their position equidistant from both buckets, this time facing the buckets but averting their gaze. The dog was then let go of to make a choice.

Familiarisation Phase 3: The dog and communicator both started the trial in the testing room in their respective positions, with the communicator facing away from the buckets. The hider performed the hiding as described in *Familiarisation Phase 1*. Before the dog was released from the leash, the communicator made a correct suggestion as described in *Familiarisation Phase 2*.

Before the False Belief (FB) and Sound Control (SC) tests, the lid of bucket B was replaced with an identical looking one whose bells’ clappers had been removed, silencing the lid. Inside bucket B a piece of foam (Figure 5) to prevent the placement of food being noisy. Both buckets and lids remained the same for the True belief (TB) test.

Test: Each dog received only one test trial, in only one of three test conditions. In all three test conditions the hider performed the displacement of food from bucket A to bucket B after which the communicator suggested bucket A (misleading) to the dog. The three test conditions represented different belief states in the communicator; false belief (FB), true belief with sound control (SC) and true belief (TB).

False Belief (FB): The dog and communicator both started out in their respective positions. The hider then entered the room wearing no shoes and placed food inside bucket A as described above. The lid of bucket A was then opened again, this time carefully to avoid making noise, the food removed and the lid closed again, silently. The hider then moved the food over to bucket B, visible to the dog but making as little noise as possible. The lid of bucket B was carefully lifted, and the motion of placing food inside was performed, without actually leaving any in the bucket, to exclude the possibility of dogs’ choice being scent based. The lid

was then carefully closed again after which the hider exited the testing room, the food remaining in their closed fist. The removal of food from bucket A, its displacement and subsequent hiding in B was therefore not audible for the communicator, due to the silent lid on bucket B. The communicator then suggested, as described before, bucket A (unintentionally misleading). After the communicator returned to their position, facing the dog, the dog was set free.

Sound Control (SC): The procedure was performed identically to test condition FB, the only difference being the communicator's starting position. This time she started out facing the dog instead of the wall to watch the entire placement and displacement of food, after which bucket A was suggested to the dog.

True Belief (TB): The procedure was equivalent to *Familiarisation Phase 3*, with both noisy lids being used and the communicator facing the wall during the placement and displacement of food, which was also done loudly. After the hider exited the room, however, the communicator suggested bucket A.

Due to the communicator's knowledge state their suggestion of bucket A is unintentionally misleading in FB, since they are unaware of the displacement and therefore the food's true location in bucket B. In the two conditions where the communicator is knowledgeable about the displacement, visually in SC and auditory in TB, and therefore the food's true location in bucket B their misleading suggestion is intentional.

2.4. Analyses

Dogs' first choice was scored from video recordings, bucket A=1 and bucket B=2. All data was analysed using R version 4.2.2 (19). and a generalised linear mixed model with binomial error structure and logit link function was fitted with choice as the dependent variable, using the R function *glmer* of the package *lme4* (20) (version 1.1.31). As test predictor with fixed effect we included Condition (FB/SC/TB), breed type (cooperative/independent) and their interaction. As control predictors with fixed effect we used age (z-transformed), first baited box and sex. Additionally, random slopes of the interaction between condition and breed type, age (z-transformed), sex and first baited box (all factors manually dummy-coded and centred) were included within the random intercept of breed. A likelihood ratio test using the *drop1* function of the above-mentioned package in R was used to draw inference about the significance of the individual predictors with fixed effect. Checks of the Best Linear Unbiased Predictors (BLUPs) and residual distributions showed no obvious violation of our model assumptions.

3. Results

The dogs' first choice (bucket A = suggested; bucket = observed) was analysed in three test conditions, false belief (FB) and two conditions representing true belief: sound control (SC), and true belief (TB). The results presented in Table 2 provide the raw counts of choices for each FCI group across the three conditions, Table 7 depicts a list of all tested dogs' detailed information.

Table 2: Overview of number of choices of all tested FCI groups in the three test conditions

FCI Group	Total number of dogs	False Belief		Sound Control		True Belief	
		A	B	A	B	A	B
1	83	10	16	11	19	10	17
2	21	4	2	5	2	2	6
5	11	1	3	0	4	1	2
6	6	2	0	1	1	2	0
7	13	2	3	2	2	1	3
8	66	14	10	8	12	10	12
10	6	0	2	1	1	2	0

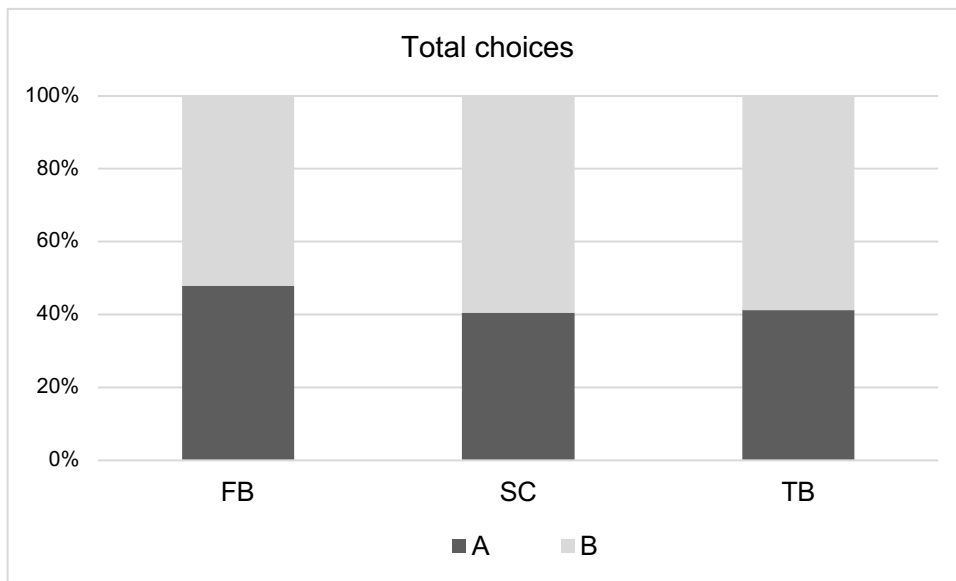


Figure 8: Choices of all dogs across all three test conditions (FB, TB, SC).

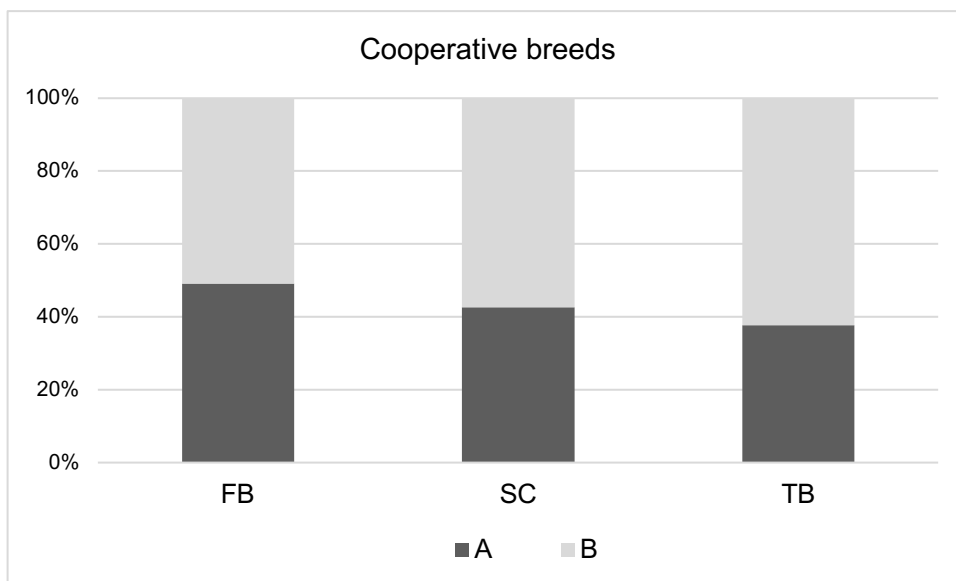


Figure 9: Summarised choices of breeds categorised as “cooperative” according to their respective FCI breed groups; 1 (Sheepdogs and Cattle dogs, except Swiss Cattle dogs), 2 (Pinscher and Schnauzer, Molossoid and Swiss Mountain and Cattle dogs), 7 (Pointing Dogs and 8 Retrievers, Flushing Dogs, Waterdogs).

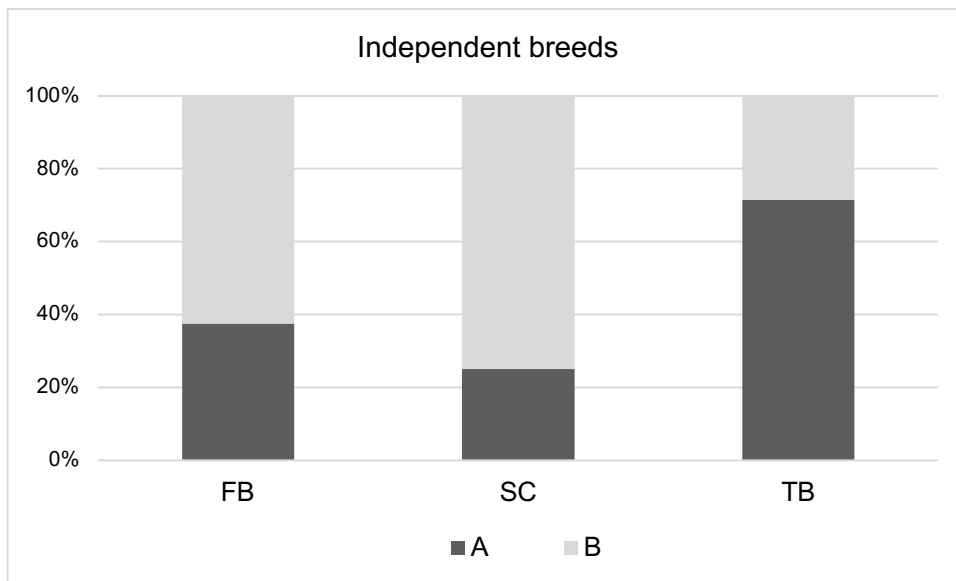


Figure 10: Choices of breeds categorised as “independent” according to their respective FCI breed groups; 5 (Spitz and primitive types), 6 (Scent hounds and related breeds) and 10 (Sighthounds).

Out of the 206 dogs tested, 52.17 % in FB, 59.42 % in SC and 58.82 % in TB did not follow the communicator’s misleading suggestion and instead chose bucket B (Figure 8). Divided into cooperative and independent dog types, out of the 183 cooperative dogs 50.82 % in FB, 57.38 % in SC and 62.30 % in TB chose bucket B (Figure 9). The choice of bucket B by the 23 independent dogs was recorded as 62.50 % in FB, 75.00 % in SC and 28.57 % in TB (Figure 10).

Although these numbers appear to display a great difference in cooperative (Figure 9) and independent (Figure 10) dogs’ behaviour and do resemble outcomes of the previous visual false belief study, the skewed distribution in sample size and lack of statistical significance needs to be acknowledged. To accurately display independent dogs’ choices a larger number of subjects would need to be tested in order to compare results to the 183 cooperative individuals.

To analyse these choices, shown in Table 2, a GLMM described above was fitted and Table 3 shows the likelihood ratio test (LRT) results for the interaction between breed type (independent/cooperative) and condition (FB/SC/TB). The LRT result for this interaction was not significant (LRT=3.072; npar=2; Pr(Chi)=0.215), thus indicating that dogs’ choices between conditions did not differ depending on their breed type (cooperative/independent).

Subsequently the breed-condition interaction was removed from the model, while keeping both variables as fixed effects.

Table 3: Significance of the main effects of the model including the breed-condition interaction

	npar	AIC	LRT	Pr(Chi)
z.age	1	304.60	0.001	0.981
Sex	1	305.97	0.242	0.242
First baited box	1	304.62	0.892	0.892
Condition-breed type interaction	2	305.67	3.072	0.215

Estimates for the main effects of condition, breed type, age and sex are shown in Table 4, after removal of condition*breed type interaction from the model. None of the observed main effects proved to be significant, as all values in column Pr(Chi) (Table 3) are >0.275 (Table 4). This supports the finding that as a main effect, breed type (LRT=3.072; npar=2; Pr(Chi)=0.969) did not significantly predict the dogs' choices in the experiment and neither did the experimental condition.

Table 4: Significance of main effects

	Estimate	Std Error	Z value	Pr(Chi)
Condition FB	-0.26	0.35	-0.75	0.727
Condition TB	-0.4	0.35	-0.12	0.781
Breed type independent	0.17	0.60	0.28	0.969
z.age	-0.01	0.15	-0.04	0.275
Sex m	0.32	0.29	1.09	0.954
First baited box grey	-0.02	0.29	-0.06	

Confidence intervals in Table 5 show with what degree of certainty observations of the experiment's sample reflect the true value of the general dog population. The broad confidence

interval for breed type independent $x=0.17$, 95 % CI [-1.11, 1.93] reflects the comparatively small sample size of the associated breed types.

Table 5: Confidence intervals

	Sample (orig)	Cmin (x2.5)	Cmax (x97.5)
	0.23	-0.43	0.93
Condition FB	-0.26	-1.08	0.52
Condition TB	-0.04	-0.81	0.74
Breed type independent	0.17	-1.11	1.93
z.age	-0.01	-0.34	0.34
Sex m	0.32	-0.26	0.97
First baited box grey	-0.02	-0.66	0.61

To check model stability, one at a time each level of breed was removed and the model fitted and its estimates calculated again to estimate the stability with regards to influence of each breed. This was done for all 57 breeds tested. The range of estimates, as seen in Table 6, is very minimal, meaning the effect of each single breed is not very pronounced and no outliers were recorded. This further suggests, results are independent of breed and do not support the initial hypothesis of expected breed differences in how dogs respond to false belief manipulation in this specific auditory task.

Table 6: Model stability

	orig	min	max
Condition FB	-0.26	-0.45	-0.05
Condition TB	-0.04	-0.17	0.10
Breed type independent	0.17	-0.39	0.68
z.age	-0.01	-0.06	0.08
Sex m	0.32	0.14	0.38
First baited box grey	-0.02	-0.11	0.13

4. Discussion

The central finding of the current study is that no statistically significant differences were found in the tendency of cooperative and independent dog breeds to follow misleading auditory suggestions in a change of location task, regardless of the communicator presumed belief state. This outcome stands in contrast to the initial hypothesis, which anticipated that cooperative breeds, historically selected to work closely with humans and attend to their cues, might be more inclined to follow the communicator's suggestions, even when misleading. Contrarily, independent breeds, bred to make decisions autonomously, were expected to rely more on their own observation of the food placement, thus ignoring the communicator's suggestion in the false belief condition.

The absence of significant breed differences in response to auditory false belief manipulation present an interesting contrast to findings from studies employing visual paradigms.

For instance, a previous study showed dogs (mostly belonging to cooperative breeds) chose the suggested container significantly more often when the communicator had a visual false belief compared to a true belief in a similar change of location task (12). These results deviate from what is typically observed in human infants (14,21) and primates (15) in similar tasks, where individuals tend to disregard the misleading cue from someone with a false belief, thus demonstrating comprehension of their counterpart's knowledge state. These findings suggest dogs might interpret the communicator's intention differently in true and false belief scenarios, potentially viewing a misleading cue from a knowledgeable communicator as deceptive. Given the previous study found dogs in FCI group 3 (Terriers), categorised as an independent breed, was the only breed group to deviate from the otherwise observed behavioural pattern, thus aligning with responses seen in human infants and non-human primates, it would be interesting to expand the current study to include this breed group as well. Although the current study's breed type-condition interaction was not statistically significant (Table 3), with the small sample of independent breed dogs there already seems to be a tendency of independent dogs to differentiate between the two true belief conditions ($A_{SC}=25.00\%$ and $A_{TB}=71.43\%$), especially when compared to cooperative dogs that seem to only slightly differentiate between the false belief and either true belief condition but almost not at all between the two true belief conditions ($A_{SC}=42.62\%$ and $A_{TB}=37.70\%$).

One potential explanation for the lack of significant results may be attributed to the modality of the cues employed in the current study. While dogs can discern human auditory attention (22)

the link between this and understanding false beliefs conveyed through auditory cues might be processed similarly across breeds. A study focusing on dogs' knowledge states about what a human can see and hear concluded reliance on their own perception as a way to assess the human's knowledge state (23). While selection for cooperation is thought to influence communication skills, this influence might not manifest uniformly across auditory tasks involving mental state attribution. The current study's sound control test condition is most comparable to the previous visual false belief study's true belief condition. While in both conditions the communicator had a visual true belief, the main notable difference of course being the current study's auditory aspect the test condition meant to control for, results were not entirely replicated. While 70 % of cooperative dogs chose to ignore the misleading suggestion by choosing bucket B previously (experiment 3 (24)), only 59.42 % of cooperative dogs in the current study displayed the same behaviour. Comparing independent dogs' behaviour in both studies suggests modality of employed cues is even more important. While independent dogs previously differentiated between false and true belief (experiment 3 (24): $A_{FB}=20\%$; $A_{TB}=50\%$), their behaviour in the current study's small sample size both replicates and contradicts previous results ($A_{FB}=37.50\%$; $A_{SC}=25.00\%$; $A_{TB}=71.43\%$). This large difference in tendency to follow a misleading suggestion in the two different true belief conditions poses the question whether the silent lid, only introduced to the dogs in the FB and SC conditions but not during any familiarisation phase, influences their behaviour of choosing the silent bucket B only because it is a newly introduced item and not because of the communicator's presumed knowledge state. To exclude this potentially disrupting factor an additional familiarisation phase would need to be added introducing the silent bucket alongside the familiarisation phase's reliable communicator.

Another potential explanation for the lack of significant results could be attributed to the study's sample size. While the final overall sample size was rather large and matched that of the preregistration, the uneven distribution of sample size between breed types likely impacted the significance of results. Perhaps the observed tendency of independent breed dogs does not accurately display the breed type's behaviour in the current auditory false belief task. Future studies would benefit from focusing on the current studies' underrepresented breed type as well as adding FCI group 3, terriers.

Breed differences in social cognition and responsiveness to human cues have also been documented in other contexts. One study, comparing the performance of adult dogs of different breeds, showed their genetic distance from wolves does not seem to have an impact on their

ability to follow different visual cues such as pointing, gazing and the use of markers (25). Dividing them into working (shepherds and huskies) and non-working (basenji and toy poodles) however yields a significant result, showing working breeds, especially working dogs on an individual level, display greater ability to use multiple human social cues to find hidden food, further supporting the role of selection for communicative ability.

Another study further investigated breed differences in dogs' attention to human perception in a task involving forbidden food with varying visual access for a human observer (8). Breed groups, categorised by both working style and genetic relatedness, differed in their attentiveness to the human's perspective. Results showed, when categorised by working style, independent and family workers appeared more attentive to the owner's perception compared to cooperative workers. Although earlier studies found cooperative working dogs tend to look at their owners more frequently during tasks (26), combining these seemingly opposing results may suggest that cooperative breeds' looking behaviour indicates the anticipation of a command or signal for help from their owner, rather than attempting to discern the owner's perception. Although these studies (8,25) suggest that different breeds have varying ability of understanding as well as responding to human gestures and attentional states, similar findings could not be observed during the current auditory false belief study.

The sensitivity to false beliefs in the auditory domain might also be a more fundamental cognitive ability, as is the case with following human experimenter's pointing gestures not only in dogs but even domesticated foxes (27,28). It may have been subject to less influence by specific selective pressures than what shaped responses to visual or cooperative clues.

Ultimately, the absence of similar effect in the auditory domain underlines the complexity of relating breed to specific cognitive skills and highlights that different functional groupings might be relevant for different cognitive domains and sensory modalities. Further research could compare responses across visual and auditory modalities to determine the influence breed has on social skills and sensitivity to human beliefs.

Given that the overall success rate of dogs successfully completing the 3 familiarisation phases was 61.1 %, it would be interesting to see if there was any correlation between breed type and exclusion phase. This would also affect the interpretation of test results, considering the ability to understand phase 1, understanding the location of hidden food and the act of food displacement, and phase 2, following an unfamiliar human's suggestion, has been linked to different variables such as age, breed type and dog sport/work experience (9,26,29).

In conclusion breed differences in social cognition involving mental state attribution appear complex and potentially influenced by cue modality, suggesting that breed-specific adaptations for human interaction may not manifest uniformly across all sensory contexts.

5. References

1. Grosse Wiesmann C, Friederici AD, Singer T, Steinbeis N. Implicit and explicit false belief development in preschool children. *Developmental Science*. 2017 Sep;20(5):e12445.
2. Krupenye C, Kano F, Hirata S, Call J, Tomasello M. Great apes anticipate that other individuals will act according to false beliefs. *Science*. 2016 Oct 7;354(6308):110–4.
3. Martcorena DCW, Ruiz AM, Mukerji C, Goddu A, Santos LR. Monkeys represent others' knowledge but not their beliefs: Monkeys represent knowledge but not beliefs. *Developmental Science*. 2011 Nov;14(6):1406–16.
4. Martin A, Santos LR. The origins of belief representation: Monkeys fail to automatically represent others' beliefs. *Cognition*. 2014 Mar;130(3):300–8.
5. Herrmann E, Melis AP, Tomasello M. Apes' use of iconic cues in the object-choice task. *Anim Cogn*. 2006 Apr;9(2):118–30.
6. Riedel J, Schumann K, Kaminski J, Call J, Tomasello M. The early ontogeny of human–dog communication. *Animal Behaviour*. 2008 Mar;75(3):1003–14.
7. Gácsi M, Kara E, Belényi B, Topál J, Miklósi Á. The effect of development and individual differences in pointing comprehension of dogs. *Anim Cogn*. 2009 May;12(3):471–9.
8. Heberlein MTE, Turner DC, Manser MB. Dogs' (*Canis familiaris*) attention to human perception: Influence of breed groups and life experiences. *Journal of Comparative Psychology*. 2017;131(1):19–29.
9. Pongrácz P, Lugosi CA. Cooperative but Dependent–Functional Breed Selection in Dogs Influences Human-Directed Gazing in a Difficult Object-Manipulation Task. *Animals*. 2024 Aug 14;14(16):2348.
10. Barnard S, Passalacqua C, Pelosi A, Valsecchi P, Prato-Previde E. Effects of breed group and development on dogs' willingness to follow a human misleading advice. *Anim Cogn*. 2019 Sep;22(5):757–68.
11. Lurz R, Krachun C. Experience-Projection Methods in Theory-of-Mind Research: Their Limits and Strengths. *Curr Dir Psychol Sci*. 2019 Oct;28(5):456–62.
12. Lonardo L, Völter CJ, Lamm C, Huber L. Dogs follow human misleading suggestions more often when the informant has a false belief. *Proc R Soc B*. 2021 Jul 28;288(1955):20210906.
13. Buttelmann D, Carpenter M, Tomasello M. Eighteen-month-old infants show false belief understanding in an active helping paradigm. *Cognition*. 2009 Aug;112(2):337–42.
14. Guran CNA, Lonardo L, Tünte M, Arzberger K, Völter CJ, Hoehl S, et al. Investigating belief understanding in children in a nonverbal ambiguous displacement and communication setting. *Journal of Experimental Child Psychology*. 2024 Apr;240:105830.

15. Buttelmann D, Buttelmann F, Carpenter M, Call J, Tomasello M. Great apes distinguish true from false beliefs in an interactive helping task. Kaminski J, editor. PLoS ONE. 2017 Apr 5;12(4):e0173793.
16. Fédération Cynologique Internationale [Internet]. Available from: <https://www.fci.be/>
17. Gácsi M, McGreevy P, Kara E, Miklósi Á. Effects of selection for cooperation and attention in dogs. Behav Brain Funct. 2009;5(1):31.
18. Bräuer J, Kaminski J, Riedel J, Call J, Tomasello M. Making inferences about the location of hidden food: Social dog, causal ape. Journal of Comparative Psychology. 2006;120(1):38–47.
19. R Core Team (2022). R: A language and environment for statistical computing. [Internet]. R Foundation for Statistical Computing, Vienna, Austria.; Available from: <https://www.R-project.org/>
20. Bates D, Mächler M, Bolker B, Walker S. Fitting Linear Mixed-Effects Models Using **lme4**. J Stat Soft [Internet]. 2015 [cited 2025 May 12];67(1). Available from: <http://www.jstatsoft.org/v67/i01/>
21. Onishi KH, Baillargeon R. Do 15-Month-Old Infants Understand False Beliefs? Science. 2005 Apr 8;308(5719):255–8.
22. Kündey SMA, De Los Reyes A, Taglang C, Allen R, Molina S, Royer E, et al. Domesticated dogs (*Canis familiaris*) react to what others can and cannot hear. Applied Animal Behaviour Science. 2010 Aug;126(1–2):45–50.
23. Bräuer J, Keckeisen M, Pitsch A, Kaminski J, Call J, Tomasello M. Domestic dogs conceal auditory but not visual information from others. Anim Cogn. 2013 May;16(3):351–9.
24. Lonardo L, Völter CJ, Lamm C, Huber L. Dogs follow human misleading suggestions more often when the informant has a false belief. Proc R Soc B. 2021 Jul 28;288(1955):20210906.
25. Wobber V, Hare B, Koler-Matznick J, Wrangham R, Tomasello M. Breed differences in domestic dogs' (*Canis familiaris*) comprehension of human communicative signals. IS. 2009 Jul 28;10(2):206–24.
26. Passalacqua C, Marshall-Pescini S, Barnard S, Lakatos G, Valsecchi P, Prato Previde E. Human-directed gazing behaviour in puppies and adult dogs, *Canis lupus familiaris*. Animal Behaviour. 2011 Nov;82(5):1043–50.
27. Virányi Z, Gácsi M, Kubinyi E, Topál J, Belényi B, Ujfalussy D, et al. Comprehension of human pointing gestures in young human-reared wolves (*Canis lupus*) and dogs (*Canis familiaris*). Anim Cogn. 2008 Jul;11(3):373–87.
28. Hare B, Plyusnina I, Ignacio N, Schepina O, Stepika A, Wrangham R, et al. Social Cognitive Evolution in Captive Foxes Is a Correlated By-Product of Experimental Domestication. Current Biology. 2005 Feb;15(3):226–30.

29. Junttila S, Valros A, Mäki K, Väättäjä H, Reunanen E, Tiira K. Breed differences in social cognition, inhibitory control, and spatial problem-solving ability in the domestic dog (*Canis familiaris*). *Sci Rep.* 2022 Dec 29;12(1):22529.

6. Tables and Figures

Tables

Table 1: Summary of tested subjects categorised by sex and breed group	4
Table 2: Overview of number of choices of all tested FCI groups in the three test conditions	12
Table 3: Significance of the main effects of the model including the breed-condition interaction	15
Table 4: Significance of main effects	15
Table 5: Confidence intervals	16
Table 6: Model stability	17
Table 7: Detailed overview of all tested subjects. (First baited bucket=bucket A; fam phase 2/3 first type=condition of first trial in the respective phase; bucket choice=bucket choice in test trial).....	27

Figures

Figure 1: 20x20 cm lid with 10 bells (silent or noisy) attached.....	5
Figure 2: Regular buckets (grey and blue, opaque, 13.5 cm diameter, 12.5 cm height) .	6
Figure 3: Small buckets (green and red, opaque, 12.0 cm diameter, 10.5 cm height)....	6
Figure 4: Large buckets (red and blue, opaque, 18.0 cm diameter, 15.5 cm height).....	6
Figure 5: Circular foam piece (9.5 cm diameter, 1.5 cm height)	7
Figure 6: Blindfold	7
Figure 7: Experiment room setup.....	8
Figure 8: Choices of all dogs across all three test conditions (FB, TB, SC).....	13
Figure 9: Summarised choices of breeds categorised as “cooperative” according to their respective FCI breed groups; 1 (Sheepdogs and Cattle dogs, except Swiss Cattle dogs), 2 (Pinscher and Schnauzer, Molossoid and Swiss Mountain and Cattle dogs), 7 (Pointing Dogs and 8 Retrievers, Flushing Dogs, Waterdogs).....	13

Figure 10: Choices of breeds categorised as “independent” according to their respective FCI breed groups; 5 (Spitz and primitive types), 6 (Scent hounds and related breeds) and 10 (Sighthounds)..... 14

7. Appendix

Table 7: Detailed overview of all tested subjects. (First baited bucket=bucket A; fam phase 2/3 first trial type=condition of first trial in the respective phase; Hider/Communicator=Initials of testing experiments; bucket choice=bucket choice in test trial)

Dog ID	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Dog Name	Ringo	Lina4	Benny7	EltonJohn4	Bucky	Bailey6	Terence	Woody2	Ellie	Kosmo	Mabel	Zita2	Quattro	Massimo	Ellia4
First baited bucket	grey	blue	blue	grey	grey	blue	grey	grey	grey	blue	grey	grey	grey	blue	blue
Fam phase 2 first trial type	no displ.	displ.	displ.	displ.	displ.	displ.	no displ.	no displ.	displ.	no displ.	no displ.	displ.	no displ.	displ.	no displ.
Fam phase 3 first trial type	displ.	displ.	displ.	no displ.	no displ.	displ.	displ.	displ.	no displ.	displ.	no displ.	no displ.	displ.	no displ.	no displ.
Test condition	SC	FB	FB	FB	TB	FB	FB	FB	SC	SC	FB	SC	SC	SC	SC
Dog breed	romagna water dog	shetland sheepdog	border collie	border collie	appenzell cattle dog	labrador retriever	welsh corgi pembroke	irish setter	welsh corgi	welsh corgi	border collie	belgian shepherd	border collie	hovawart	golden retriever
Sex	m	f	m	m	m	f	m	m	f	m	f	f	m	m	f
Castration	yes	yes	no	no	yes	yes	yes	no	yes	no	no	no	no	no	no
FCI group	8	1	1	1	2	8	1	7	1	1	1	1	1	2	8
Age in months	69	60	135	30	31	86	66	65	49	32	32	112	9	29	24
Dog sport exp.	no	yes	yes	yes	no	yes	yes	yes	no	no	yes	yes	yes	no	no
Hider	VB	VB	VB	VB	VB	VB	GR	VB	GR	VB	GR	GR	VB	GR	GR
Communicator	LL	LL	LL	LL	LL	CH	VB	LL	VB	VB	VB	CH	CH	VB	CH
Phase 1 trials	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
Phase 2 trials	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
Phase 3 trials	2	2	2	2	2	2	2	2	2	3	2	2	2	4	2
No choice trials	no	no	no	no	2 in phase 2	no	no	no	no	no	no	no	no	no	no
Total trials	6	8	8	6	7	6	6	6	7	9	8	7	6	10	6
Bucket choice	A	A	A	B	B	A	B	A	A	A	B	B	B	B	B

Dog ID		16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
Dog Name		Paddy	Allegro2	Saphira4	Loomis	Destino	Jaguar	Ivy-Infinity	Fortuna	Savvy	Daisys5	Loki5	Thor3	June3	Frida3	Emma12
First baited bucket		blue	blue	blue	blue	grey	grey	blue	blue	blue	blue	blue	blue	blue	blue	blue
Fam phase 2 first trial type		no displ.	no displ.	no displ.	displ.	no displ.	no displ.	displ.	no displ.	displ.	no displ.	no displ.	no displ.	displ.	no displ.	no displ.
Fam phase 3 first trial type		no displ.	displ.	no displ.	no displ.	no displ.	no displ.	displ.	no displ.	displ.	no displ.	displ.	no displ.	no displ.	no displ.	no displ.
Test condition		SC	TB	SC	SC	TB	TB	FB	FB	SC	TB	SC	TB	SC	TB	FB
Dog breed		irish setter	border collie	german shepherd	golden retriever	border collie	dutch shepherd	labrador retriever	labrador retriever	labrador retriever	golden retriever	golden retriever	welsh corgi pembroke	australian shepherd	australian shepherd	labrador retriever
Sex		m	m	f	m	m	m	f	f	f	f	f	m	f	f	f
Castration		no	no	yes	no	no	yes	yes	yes	yes	no	yes	yes	yes	no	no
FCI group		7	1	1	8	1	1	8	8	8	8	8	1	1	1	8
Age in months		91	136	37	49	56	118	53	89	114	53	64	35	45	43	72
Dog sport exp.		yes	yes	yes	yes	yes	no	yes	yes	no	no	yes	yes	yes	yes	yes
Hider		VB	VB	GR	GR	VB	GR	GR	GR	GR	GR	GR	GR	GR	GR	VB
Communicator		LL	CH	CH	VB	CH	VB	VB	CH	VB	VB	VB	VB	VB	VB	CH
Phase 1 trials		2	2	2	4	2	3	2	2	2	3	2	4	2	2	2
Phase 2 trials		2	2	2	2	2	2	2	3	2	2	2	2	2	4	2
Phase 3 trials		2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
No choice trials																
Total trials	A 6	no	no	no	no	no	no	no	no	no	no	no	no	no	no	no
Bucket choice	A 6			B 6	B 8	A 6	B 7	A 6	B 7	B 6	B 7	B 6	A 8	A 6	B 8	A 6

Dog ID		31	32	33	34	35	36	37	38	39	40	41	42	43	44	45
Dog Name		Willi2	Bonja	Trixi2	Cacho	Ivy6	Dali	Heidi6	Remus	Lotte6	Balou3	Questa	Scully3	Flynn3	Lotta	Chomsky
First baited bucket		grey	grey	blue	grey	blue	grey	blue	grey	blue	blue	grey	blue	blue	grey	grey
Fam phase 2 first trial type		displ.	displ.	no displ.	no displ.	displ.	no displ.	displ.	no displ.	displ.	no displ.	no displ.	displ.	no displ.	no displ.	displ.
Fam phase 3 first trial type		displ.	displ.	displ.	displ.	displ.	displ.	displ.	displ.	displ.	no displ.	no displ.	displ.	no displ.	displ.	no displ.
Test condition		FB	TB	FB	SC	TB	SC	TB	FB	SC	TB	SC	TB	FB	TB	FB
Dog breed		labrador retriever	schnauzer	schnauzer	flat coated retriever	australian shepherd	border collie	labrador retriever	weimaraner	portuguese water dog	brittany spaniel	deutsch langhaar	golden retriever	shetland sheepdog	romagna water dog	rottweiler
Sex		yes m	no f	yes f	yes m	yes f	no m	yes f	no m	no f	yes m	no f	no f	no m	yes f	yes m
Castration		yes	no	yes	yes	yes	no	yes	no	no	yes	no	no	no	yes	yes
FCI group		8	2	2	8	1	1	8	7	8	7	7	8	1	8	2
Age in months		24	103	128	77	40	60	24	9	33	104	30	19	6	72	105
Dog sport exp.		no	yes	no	yes	yes	yes	yes	yes	yes	no	yes	yes	no	no	no
Hider		GR	GR	GR	LL	VB	CH	GR	GR	VB	CH	CH	GR	CH	GR	VB
Communicator		VB	CH	VB	GR	CH	VB	VB	VB	CH	GR	VB	VB	VB	VB	CH
Phase 1 trials		2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
Phase 2 trials		2	2	2	3	2	2	2	2	2	2	2	2	2	2	2
Phase 3 trials		2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
No choice trials																
Total trials		6	6	6	7	8	6	6	8	6	6	6	7	6	6	6
Bucket choice		A	B	A	B	A	A	A	B	A	B	B	B	A	B	A

Dog ID	46
Dog Name	Jaimie
First baited bucket	grey
Fam phase 2 first trial type	no displ.
Fam phase 3 first trial type	no displ.
Test condition	TB
Dog breed	border collie
Sex	m
Castration	no
FCI group	1
Age in months	64
Dog sport exp.	yes
Hider	VB
Communicator	CH
Phase 1 trials	2
Phase 2 trials	2
Phase 3 trials	2
No choice trials	no
Total trials	6
Bucket choice	A
Dog ID	47
Dog Name	Finley
First baited bucket	blue
Fam phase 2 first trial type	displ.
Fam phase 3 first trial type	no displ.
Test condition	SC
Dog breed	shetland sheepdog
Sex	m
Castration	no
FCI group	1
Age in months	87
Dog sport exp.	yes
Hider	LL
Communicator	GR
Phase 1 trials	4
Phase 2 trials	2
Phase 3 trials	2
No choice trials	no
Total trials	8
Bucket choice	B
Dog ID	48
Dog Name	Ben2
First baited bucket	blue
Fam phase 2 first trial type	displ.
Fam phase 3 first trial type	displ.
Test condition	SC
Dog breed	english springer
Sex	m
Castration	yes
FCI group	8
Age in months	150
Dog sport exp.	yes
Hider	CH
Communicator	VB
Phase 1 trials	2
Phase 2 trials	2
Phase 3 trials	2
No choice trials	no
Total trials	6
Bucket choice	B
Dog ID	49
Dog Name	Zazou3
First baited bucket	grey
Fam phase 2 first trial type	displ.
Fam phase 3 first trial type	no displ.
Test condition	TB
Dog breed	labrador retriever
Sex	f
Castration	yes
FCI group	8
Age in months	63
Dog sport exp.	yes
Hider	VB
Communicator	LL
Phase 1 trials	2
Phase 2 trials	3
Phase 3 trials	2
No choice trials	no
Total trials	8
Bucket choice	A
Dog ID	50
Dog Name	Pinu'u
First baited bucket	grey
Fam phase 2 first trial type	displ.
Fam phase 3 first trial type	displ.
Test condition	TB
Dog breed	shetland sheepdog
Sex	m
Castration	no
FCI group	1
Age in months	14
Dog sport exp.	yes
Hider	LL
Communicator	GR
Phase 1 trials	2
Phase 2 trials	2
Phase 3 trials	2
No choice trials	no
Total trials	6
Bucket choice	B
Dog ID	51
Dog Name	Heidi7
First baited bucket	blue
Fam phase 2 first trial type	displ.
Fam phase 3 first trial type	displ.
Test condition	FB
Dog breed	portuguese water dog
Sex	f
Castration	yes
FCI group	8
Age in months	72
Dog sport exp.	yes
Hider	LL
Communicator	GR
Phase 1 trials	2
Phase 2 trials	2
Phase 3 trials	2
No choice trials	no
Total trials	6
Bucket choice	B
Dog ID	52
Dog Name	Arko2
First baited bucket	blue
Fam phase 2 first trial type	no displ.
Fam phase 3 first trial type	displ.
Test condition	TB
Dog breed	labrador retriever
Sex	m
Castration	yes
FCI group	8
Age in months	126
Dog sport exp.	no
Hider	CH
Communicator	LL
Phase 1 trials	2
Phase 2 trials	2
Phase 3 trials	2
No choice trials	no
Total trials	6
Bucket choice	B
Dog ID	53
Dog Name	Bud
First baited bucket	grey
Fam phase 2 first trial type	displ.
Fam phase 3 first trial type	displ.
Test condition	FB
Dog breed	welsh corgi pembroke
Sex	m
Castration	yes
FCI group	1
Age in months	7
Dog sport exp.	no
Hider	VB
Communicator	GR
Phase 1 trials	2
Phase 2 trials	2
Phase 3 trials	2
No choice trials	no
Total trials	6
Bucket choice	B
Dog ID	54
Dog Name	Buddy9
First baited bucket	grey
Fam phase 2 first trial type	no displ.
Fam phase 3 first trial type	displ.
Test condition	TB
Dog breed	german short haired pointer
Sex	m
Castration	yes
FCI group	7
Age in months	77
Dog sport exp.	yes
Hider	LL
Communicator	GR
Phase 1 trials	2
Phase 2 trials	2
Phase 3 trials	4
No choice trials	no
Total trials	8
Bucket choice	B
Dog ID	55
Dog Name	Leia3
First baited bucket	grey
Fam phase 2 first trial type	displ.
Fam phase 3 first trial type	displ.
Test condition	FB
Dog breed	welsh corgi pembroke
Sex	f
Castration	yes
FCI group	1
Age in months	40
Dog sport exp.	no
Hider	VB
Communicator	GR
Phase 1 trials	2
Phase 2 trials	2
Phase 3 trials	2
No choice trials	no
Total trials	6
Bucket choice	A
Dog ID	56
Dog Name	Adele
First baited bucket	blue
Fam phase 2 first trial type	no displ.
Fam phase 3 first trial type	displ.
Test condition	FB
Dog breed	romagna water dog
Sex	f
Castration	no
FCI group	8
Age in months	52
Dog sport exp.	yes
Hider	LL
Communicator	GR
Phase 1 trials	2
Phase 2 trials	2
Phase 3 trials	2
No choice trials	no
Total trials	6
Bucket choice	B
Dog ID	57
Dog Name	Curly2
First baited bucket	blue
Fam phase 2 first trial type	displ.
Fam phase 3 first trial type	no displ.
Test condition	FB
Dog breed	border collie
Sex	m
Castration	no
FCI group	1
Age in months	39
Dog sport exp.	yes
Hider	CH
Communicator	VB
Phase 1 trials	2
Phase 2 trials	2
Phase 3 trials	2
No choice trials	no
Total trials	6
Bucket choice	A
Dog ID	58
Dog Name	Arany
First baited bucket	blue
Fam phase 2 first trial type	no displ.
Fam phase 3 first trial type	displ.
Test condition	TB
Dog breed	welsh corgi cardigan
Sex	f
Castration	no
FCI group	1
Age in months	42
Dog sport exp.	yes
Hider	VB
Communicator	CH
Phase 1 trials	2
Phase 2 trials	2
Phase 3 trials	4
No choice trials	no
Total trials	8
Bucket choice	B
Dog ID	59
Dog Name	Phil
First baited bucket	grey
Fam phase 2 first trial type	displ.
Fam phase 3 first trial type	displ.
Test condition	SC
Dog breed	australian shepherd
Sex	m
Castration	no
FCI group	1
Age in months	23
Dog sport exp.	yes
Hider	VB
Communicator	CH
Phase 1 trials	2
Phase 2 trials	2
Phase 3 trials	2
No choice trials	no
Total trials	6
Bucket choice	B
Dog ID	60
Dog Name	Noomi2
First baited bucket	blue
Fam phase 2 first trial type	no displ.
Fam phase 3 first trial type	displ.
Test condition	FB
Dog breed	portuguese water dog
Sex	f
Castration	no
FCI group	8
Age in months	35
Dog sport exp.	yes
Hider	VB
Communicator	GR
Phase 1 trials	2
Phase 2 trials	2
Phase 3 trials	2
No choice trials	no
Total trials	6
Bucket choice	B

Dog ID	61
Dog Name	grey Gundi
First baited bucket	grey
Fam phase 2 first trial type	displ.
Fam phase 3 first trial type	no displ.
Test condition	SC
Dog breed	labrador retriever
Sex	f
Castration	no
FCI group	8
Age in months	28
Dog sport exp.	yes
Hider	VB
Communicator	GR
Phase 1 trials	2
Phase 2 trials	2
Phase 3 trials	2
No choice trials	no
Total trials	6
Bucket choice	A
Dog ID	62
Dog Name	blue Edhard
First baited bucket	blue
Fam phase 2 first trial type	no displ.
Fam phase 3 first trial type	no displ.
Test condition	SC
Dog breed	danish swedish
Sex	m
Castration	no
FCI group	2
Age in months	20
Dog sport exp.	no
Hider	VB
Communicator	GR
Phase 1 trials	2
Phase 2 trials	2
Phase 3 trials	2
No choice trials	no
Total trials	6
Bucket choice	A
Dog ID	63
Dog Name	grey Garou
First baited bucket	grey
Fam phase 2 first trial type	displ.
Fam phase 3 first trial type	displ.
Test condition	SC
Dog breed	german shepherd
Sex	m
Castration	no
FCI group	1
Age in months	8
Dog sport exp.	yes
Hider	VB
Communicator	GR
Phase 1 trials	5
Phase 2 trials	2
Phase 3 trials	2
No choice trials	no
Total trials	9
Bucket choice	B
Dog ID	64
Dog Name	blue Abby5
First baited bucket	blue
Fam phase 2 first trial type	displ.
Fam phase 3 first trial type	displ.
Test condition	SC
Dog breed	kleiner munsterlander
Sex	f
Castration	no
FCI group	7
Age in months	38
Dog sport exp.	yes
Hider	VB
Communicator	GR
Phase 1 trials	2
Phase 2 trials	2
Phase 3 trials	2
No choice trials	no
Total trials	6
Bucket choice	A
Dog ID	65
Dog Name	blue Kirsi
First baited bucket	blue
Fam phase 2 first trial type	displ.
Fam phase 3 first trial type	no displ.
Test condition	TB
Dog breed	portuguese water dog
Sex	f
Castration	no
FCI group	8
Age in months	17
Dog sport exp.	yes
Hider	VB
Communicator	GR
Phase 1 trials	2
Phase 2 trials	2
Phase 3 trials	2
No choice trials	no
Total trials	6
Bucket choice	A
Dog ID	66
Dog Name	blue Patack
First baited bucket	blue
Fam phase 2 first trial type	no displ.
Fam phase 3 first trial type	displ.
Test condition	TB
Dog breed	portuguese water dog
Sex	m
Castration	no
FCI group	8
Age in months	6
Dog sport exp.	no
Hider	VB
Communicator	GR
Phase 1 trials	2
Phase 2 trials	4
Phase 3 trials	3
No choice trials	no
Total trials	9
Bucket choice	A
Dog ID	67
Dog Name	grey Dora
First baited bucket	grey
Fam phase 2 first trial type	no displ.
Fam phase 3 first trial type	displ.
Test condition	TB
Dog breed	labrador retriever
Sex	f
Castration	no
FCI group	8
Age in months	113
Dog sport exp.	yes
Hider	VB
Communicator	GR
Phase 1 trials	2
Phase 2 trials	2
Phase 3 trials	2
No choice trials	no
Total trials	6
Bucket choice	B
Dog ID	68
Dog Name	grey Bo
First baited bucket	grey
Fam phase 2 first trial type	no displ.
Fam phase 3 first trial type	displ.
Test condition	FB
Dog breed	border collie
Sex	m
Castration	no
FCI group	1
Age in months	48
Dog sport exp.	yes
Hider	VB
Communicator	GR
Phase 1 trials	2
Phase 2 trials	2
Phase 3 trials	2
No choice trials	no
Total trials	6
Bucket choice	B
Dog ID	69
Dog Name	grey Moon2
First baited bucket	grey
Fam phase 2 first trial type	displ.
Fam phase 3 first trial type	no displ.
Test condition	SC
Dog breed	australian shepherd
Sex	f
Castration	no
FCI group	1
Age in months	36
Dog sport exp.	yes
Hider	LL
Communicator	VB
Phase 1 trials	3
Phase 2 trials	2
Phase 3 trials	2
No choice trials	no
Total trials	7
Bucket choice	B
Dog ID	70
Dog Name	grey Leia5
First baited bucket	grey
Fam phase 2 first trial type	displ.
Fam phase 3 first trial type	no displ.
Test condition	SC
Dog breed	labrador retriever
Sex	f
Castration	no
FCI group	8
Age in months	87
Dog sport exp.	yes
Hider	GR
Communicator	LL
Phase 1 trials	2
Phase 2 trials	2
Phase 3 trials	2
No choice trials	no
Total trials	6
Bucket choice	B
Dog ID	71
Dog Name	grey Gustl2
First baited bucket	grey
Fam phase 2 first trial type	no displ.
Fam phase 3 first trial type	no displ.
Test condition	TB
Dog breed	laekenois
Sex	m
Castration	no
FCI group	1
Age in months	48
Dog sport exp.	yes
Hider	VB
Communicator	GR
Phase 1 trials	2
Phase 2 trials	2
Phase 3 trials	2
No choice trials	no
Total trials	6
Bucket choice	A
Dog ID	72
Dog Name	grey Kira17
First baited bucket	grey
Fam phase 2 first trial type	displ.
Fam phase 3 first trial type	no displ.
Test condition	TB
Dog breed	mudi
Sex	f
Castration	yes
FCI group	1
Age in months	66
Dog sport exp.	yes
Hider	LL
Communicator	GR
Phase 1 trials	2
Phase 2 trials	2
Phase 3 trials	2
No choice trials	no
Total trials	6
Bucket choice	B
Dog ID	73
Dog Name	grey Thorin
First baited bucket	grey
Fam phase 2 first trial type	displ.
Fam phase 3 first trial type	no displ.
Test condition	FB
Dog breed	flat coated retriever
Sex	m
Castration	yes
FCI group	8
Age in months	56
Dog sport exp.	yes
Hider	VB
Communicator	GR
Phase 1 trials	4
Phase 2 trials	2
Phase 3 trials	2
No choice trials	no
Total trials	8
Bucket choice	B
Dog ID	74
Dog Name	blue Kunibert
First baited bucket	blue
Fam phase 2 first trial type	displ.
Fam phase 3 first trial type	no displ.
Test condition	TB
Dog breed	giant schnauzer
Sex	m
Castration	no
FCI group	2
Age in months	15
Dog sport exp.	yes
Hider	VB
Communicator	GR
Phase 1 trials	2
Phase 2 trials	2
Phase 3 trials	2
No choice trials	no
Total trials	6
Bucket choice	B
Dog ID	75
Dog Name	blue Lilly16
First baited bucket	blue
Fam phase 2 first trial type	displ.
Fam phase 3 first trial type	displ.
Test condition	SC
Dog breed	bernese mountain dog
Sex	f
Castration	no
FCI group	2
Age in months	9
Dog sport exp.	no
Hider	CH
Communicator	GR
Phase 1 trials	2
Phase 2 trials	2
Phase 3 trials	2
No choice trials	no
Total trials	6
Bucket choice	A

Dog ID	76	77	78	79	80	81	82	83	84	85	86	87	88	89	90
Dog Name	Rio	Grady	Cookie11	Fee	Onyx	Brandy2	Bonda	Maika	Ivan	Dasha	Mila4	Toni	Priya	Mickey3	Bugsy
First baited bucket	grey	grey	grey	blue	grey	grey	blue	blue	grey	blue	grey	grey	grey	blue	grey
Fam phase 2 first trial type	displ.	displ.	displ.	displ.	displ.	no displ.	displ.	no displ.	no displ.	no displ.	no displ.	no displ.	displ.	displ.	displ.
Fam phase 3 first trial type	displ.	displ.	no displ.	no displ.	no displ.	displ.	no displ.	no displ.	no displ.	displ.	no displ.	no displ.	displ.	no displ.	displ.
Test condition	TB	SC	FB	FB	FB	TB	TB	SC	FB	SC	FB	SC	FB	TB	SC
Dog breed	hungarian shorthaired pointer	border collie	kleiner munsterlander	french water dog	german shepherd	border collie	entlebucher mountain dog	austrian pinscher	beagle	bouvier des flandres	portuguese water dog	beagle	border collie	beagle	welsh corgi cardigan
Sex	f	m	f	f	m	m	f	f	m	f	f	f	f	f	m
Castration	no	no	yes	no	no	yes	no	no	no	yes	no	yes	no	yes	yes
FCI group	7	1	7	8	1	1	2	2	6	1	8	6	1	6	1
Age in months	43	68	78	22	77	54	63	101	42	91	36	90	39	117	57
Dog sport exp.	yes	yes	yes	no	yes	yes	yes	no	no	yes	yes	yes	yes	no	no
Hider	CH	CH	VB	LL	VB	CH	VB	GR	CH	LL	VB	CH	CH	VB	VB
Communicator	GR	VB	GR	VB	GR	VB	GR	LL	GR	CH	GR	LL	VB	GR	GR
Phase 1 trials	2	2	2	4	4	2	2	2	2	2	2	2	3	4	4
Phase 2 trials	2	3	2	2	2	2	2	2	2	2	2	2	2	2	3
Phase 3 trials	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
No choice trials	no	no	no	1 in phase 1	no	no	no	no	no	no	no	no	no	no	1 in phase 2
Total trials	6	7	6	8	8	6	6	6	6	6	6	6	7	8	9
Bucket choice	A	A	B	A	A	B	B	A	A	B	B	A	B	A	B

Dog ID	91
Dog Name	Nimo
First baited bucket	grey
Fam phase 2 first trial type	no displ.
Fam phase 3 first trial type	no displ.
Test condition	SC
Dog breed	border collie
Sex	m
Castration	yes
FCI group	1
Age in months	65
Dog sport exp.	yes
Hider	GR
Communicator	CH
Phase 1 trials	4
Phase 2 trials	4
Phase 3 trials	2
No choice trials	no
Total trials	10
Bucket choice	B
Dog ID	92
Dog Name	Woody4
First baited bucket	blue
Fam phase 2 first trial type	displ.
Fam phase 3 first trial type	displ.
Test condition	TB
Dog breed	flat coated retriever
Sex	m
Castration	no
FCI group	8
Age in months	52
Dog sport exp.	yes
Hider	LL
Communicator	VB
Phase 1 trials	2
Phase 2 trials	2
Phase 3 trials	2
No choice trials	no
Total trials	6
Bucket choice	B
Dog ID	93
Dog Name	Joey4
First baited bucket	blue
Fam phase 2 first trial type	no displ.
Fam phase 3 first trial type	displ.
Test condition	FB
Dog breed	border collie
Sex	m
Castration	yes
FCI group	1
Age in months	132
Dog sport exp.	yes
Hider	CH
Communicator	VB
Phase 1 trials	2
Phase 2 trials	3
Phase 3 trials	2
No choice trials	no
Total trials	7
Bucket choice	B
Dog ID	94
Dog Name	Naya2
First baited bucket	grey
Fam phase 2 first trial type	displ.
Fam phase 3 first trial type	displ.
Test condition	TB
Dog breed	golden retriever
Sex	f
Castration	no
FCI group	8
Age in months	30
Dog sport exp.	yes
Hider	LL
Communicator	VB
Phase 1 trials	2
Phase 2 trials	4
Phase 3 trials	2
No choice trials	no
Total trials	8
Bucket choice	B
Dog ID	95
Dog Name	Charly5
First baited bucket	blue
Fam phase 2 first trial type	displ.
Fam phase 3 first trial type	no displ.
Test condition	FB
Dog breed	spanish water dog
Sex	m
Castration	yes
FCI group	8
Age in months	98
Dog sport exp.	yes
Hider	CH
Communicator	LL
Phase 1 trials	2
Phase 2 trials	4
Phase 3 trials	2
No choice trials	no
Total trials	8
Bucket choice	A
Dog ID	96
Dog Name	Ulla
First baited bucket	grey
Fam phase 2 first trial type	no displ.
Fam phase 3 first trial type	displ.
Test condition	FB
Dog breed	labrador retriever
Sex	f
Castration	yes
FCI group	8
Age in months	93
Dog sport exp.	yes
Hider	LL
Communicator	CH
Phase 1 trials	2
Phase 2 trials	2
Phase 3 trials	2
No choice trials	no
Total trials	6
Bucket choice	A
Dog ID	97
Dog Name	Waleria
First baited bucket	blue
Fam phase 2 first trial type	no displ.
Fam phase 3 first trial type	no displ.
Test condition	FB
Dog breed	german pinscher
Sex	f
Castration	no
FCI group	2
Age in months	52
Dog sport exp.	yes
Hider	VB
Communicator	GR
Phase 1 trials	2
Phase 2 trials	2
Phase 3 trials	2
No choice trials	no
Total trials	6
Bucket choice	A
Dog ID	98
Dog Name	Toby2
First baited bucket	grey
Fam phase 2 first trial type	no displ.
Fam phase 3 first trial type	displ.
Test condition	TB
Dog breed	golden retriever
Sex	m
Castration	yes
FCI group	8
Age in months	137
Dog sport exp.	no
Hider	VB
Communicator	GR
Phase 1 trials	2
Phase 2 trials	2
Phase 3 trials	2
No choice trials	no
Total trials	6
Bucket choice	A
Dog ID	99
Dog Name	Gina10
First baited bucket	grey
Fam phase 2 first trial type	no displ.
Fam phase 3 first trial type	no displ.
Test condition	FB
Dog breed	silken windsprite
Sex	f
Castration	no
FCI group	10
Age in months	8
Dog sport exp.	no
Hider	GR
Communicator	CH
Phase 1 trials	2
Phase 2 trials	4
Phase 3 trials	2
No choice trials	no
Total trials	8
Bucket choice	B
Dog ID	100
Dog Name	Chester5
First baited bucket	grey
Fam phase 2 first trial type	displ.
Fam phase 3 first trial type	no displ.
Test condition	TB
Dog breed	border collie
Sex	m
Castration	no
FCI group	1
Age in months	35
Dog sport exp.	yes
Hider	VB
Communicator	GR
Phase 1 trials	4
Phase 2 trials	3
Phase 3 trials	4
No choice trials	no
Total trials	11
Bucket choice	B
Dog ID	101
Dog Name	Finch2
First baited bucket	blue
Fam phase 2 first trial type	no displ.
Fam phase 3 first trial type	displ.
Test condition	SC
Dog breed	labrador retriever
Sex	m
Castration	no
FCI group	8
Age in months	116
Dog sport exp.	yes
Hider	GR
Communicator	CH
Phase 1 trials	3
Phase 2 trials	4
Phase 3 trials	3
No choice trials	1 in phase 2 and 3
Total trials	10
Bucket choice	B
Dog ID	102
Dog Name	Timmy4
First baited bucket	grey
Fam phase 2 first trial type	no displ.
Fam phase 3 first trial type	displ.
Test condition	SC
Dog breed	portuguese water dog
Sex	m
Castration	yes
FCI group	8
Age in months	95
Dog sport exp.	yes
Hider	LL
Communicator	CH
Phase 1 trials	2
Phase 2 trials	3
Phase 3 trials	2
No choice trials	no
Total trials	7
Bucket choice	A
Dog ID	103
Dog Name	Suri5
First baited bucket	grey
Fam phase 2 first trial type	no displ.
Fam phase 3 first trial type	no displ.
Test condition	SC
Dog breed	malinois
Sex	f
Castration	no
FCI group	1
Age in months	155
Dog sport exp.	yes
Hider	CH
Communicator	LL
Phase 1 trials	2
Phase 2 trials	4
Phase 3 trials	2
No choice trials	no
Total trials	8
Bucket choice	A
Dog ID	104
Dog Name	Paulinche
First baited bucket	grey
Fam phase 2 first trial type	displ.
Fam phase 3 first trial type	no displ.
Test condition	TB
Dog breed	border collie
Sex	f
Castration	no
FCI group	1
Age in months	6
Dog sport exp.	yes
Hider	GR
Communicator	CH
Phase 1 trials	2
Phase 2 trials	2
Phase 3 trials	4
No choice trials	no
Total trials	8
Bucket choice	A

Dog ID	105	106	107	108	109	110	111	112	113	114	115	116	117	118	119
Dog Name	Linus3	Papaya	Tenya	Luna40	Oonagh	Loki6	Kiwi6	Ambiano	Pia3	Madoc	Lilly17	Juri	Lenny4	Holly10	NaNu
First baited bucket	blue	blue	blue	blue	grey	blue	blue	grey	grey	blue	grey	grey	grey	blue	grey
Fam phase 2 first trial type	displ.	displ.	no displ.	no displ.	no displ.	displ.	displ.	displ.	displ.	displ.	no displ.	no displ.	displ.	no displ.	no displ.
Fam phase 3 first trial type	no displ.	no displ.	displ.	no displ.	displ.	displ.	displ.	no displ.	no displ.	displ.	displ.	displ.	no displ.	displ.	no displ.
Test condition	FB	TB	TB	FB	SC	FB	FB	FB	TB	FB	FB	FB	SC	SC	FB
Dog breed	border collie	border collie	collie	labrador retriever	labrador retriever	great swiss mountain dog	labrador retriever	picardy spaniel	whippet	welsh corgi pembroke	welsh corgi pembroke	labrador retriever	canarian warrenhound	bernese mountain dog	hovawart
Sex	m	f	f	f	f	m	f	m	f	m	f	m	m	f	f
Castration	no	no	no	yes	no	yes	no	no	yes	yes	no	yes	yes	yes	no
FCI group	1	1	1	8	8	2	8	7	10	1	1	1	5	2	2
Age in months	111	6	104	35	49	112	15	91	96	121	42	39	124	66	40
Dog sport exp.	no	yes	yes	no	no	yes	yes	yes	yes	no	no	yes	yes	yes	yes
Hider	LL	GR	LL	GR	GR	CH	GR	CH	CH	GR	GR	GR	GR	CH	VB
Communicator	CH	CH	CH	LL	LL	GR	VB	GR	LL	VB	VB	VB	VB	VB	CH
Phase 1 trials	2	4	2	2	2	2	2	2	2	2	2	2	2	2	2
Phase 2 trials	2	4	2	2	2	2	2	2	4	4	3	2	2	2	2
Phase 3 trials	2	2	2	2	2	2	2	4	2	2	2	2	2	2	2
No choice trials	no	no	no	no	no	no	no	no	no	no	no	no	no	no	no
Total trials	6	10	8	6	6	8	8	8	8	8	7	6	6	6	6
Bucket choice	B	B	B	B	A	B	A	B	A	B	B	A	B	B	A

Dog ID	120	121	122	123	124	125	126	127	128	129	130	131	132	133	134
Dog Name	Pauli6	Happy6	Pumba	Yui	Loki2	Gandalf	Sofia2	Silva	Henri	Ginger9	Poppy4	Mia7	Veri	Lola9	Mogli2
First baited bucket	grey	grey	blue	blue	blue	blue	blue	blue	grey	grey	blue	blue	blue	blue	blue
Fam phase 2 first trial type	displ.	no displ.	displ.	no displ.	no displ.	no displ.	no displ.	displ.	no displ.	no displ.	displ.	no displ.	displ.	no displ.	no displ.
Fam phase 3 first trial type	no displ.	displ.	no displ.	no displ.	no displ.	displ.	no displ.	no displ.	no displ.	no displ.	displ.	no displ.	displ.	no displ.	displ.
Test condition	SC	SC	SC	SC	SC	TB	SC	SC	TB	TB	FB	FB	SC	TB	SC
Dog breed	labrador retriever	golden retriever	border collie	welsh corgi	australian shepherd	andalusian hound	welsh corgi pembroke	german shepherd	border collie	golden retriever	welsh corgi pembroke	golden retriever	whippet	golden retriever	border collie
Sex	m	f	m	f	m	m	f	f	m	f	f	f	f	f	m
Castration	yes	no	yes	yes	no	yes	no	yes	no	yes	no	no	no	yes	no
FCI group	8	8	1	1	1	5	1	2	1	8	1	8	10	8	1
Age in months	40	25	151	39	92	64	72	50	11	44	50	91	32	122	155
Dog sport exp.	yes	yes	no	yes	yes	yes	no	yes	yes	yes	yes	yes	no	yes	no
Hider	GR	VB	VB	GR	VB	GR	VB	CH	VB	VB	VB	VB	GR	VB	CH
Communicator	VB	GR	GR	LL	GR	VB	VB	VB	GR	GR	GR	GR	VB	GR	VB
Phase 1 trials	2	2	2	2	2	3	2	2	2	2	2	2	2	2	2
Phase 2 trials	2	4	2	2	2	4	2	3	2	2	3	2	3	2	2
Phase 3 trials	4	2	2	2	2	4	2	4	2	2	2	2	2	2	2
No choice trials	no	no	no	no	no	no	no	no	no	no	no	no	no	no	no
Total trials	8	8	6	7	6	11	6	9	6	6	7	6	7	8	8
Bucket choice	B	B	A	A	B	A	B	A	B	A	B	B	A	A	B

[illegible]

Dog ID		150	151	152	153	154	155	156	157	158	159	160	161	162	163	164
Dog Name		Pixie3	Kairi	Yuma	Cora2	Chilli7	Baloo2	Daphne3	Kapa	Abbey2	Milow5	Baghira2	Kali3	Phoebe7	Apple2	Nash3
First baited bucket		blue	blue	grey	grey	grey	blue	blue	grey	grey	blue	blue	grey	grey	grey	blue
Fam phase 2 first trial type		displ.	no displ.	no displ.	displ.	no displ.	displ.	displ.	displ.	displ.	displ.	no displ.	displ.	no displ.	displ.	no displ.
Fam phase 3 first trial type		displ.	no displ.	displ.	no displ.	no displ.	no displ.	displ.	no displ.	displ.	displ.	displ.	displ.	displ.	displ.	displ.
Test condition		TB	FB	TB	FB	TB	SC	SC	TB	TB	FB	TB	FB	TB	FB	FB
Dog breed		miniature american shepherd	siberian husky	white swiss shepherd	australian shepherd	flat coated retriever	labrador retriever	bobtail	australian shepherd	labrador retriever	labrador retriever	flat coated retriever	flat coated retriever	labrador retriever	golden retriever	white swiss shepherd
Sex		f	f	m	f	f	m	f	m	f	m	f	f	f	f	m
Castration		no	yes	no	no	no	no	no	no	yes	yes	no	yes	no	yes	no
FCI group		1	5	1	1	8	8	1	1	8	8	8	8	8	8	1
Age in months		9	89	91	49	81	62	53	29	146	57	7	60	46	110	138
Dog sport exp.		yes	no	yes	yes	yes	yes	no	yes	yes	yes	yes	yes	yes	yes	yes
Hider		VB	CH	CH LL	VB	CH	CH	CH LL	CH LL	CH	VB	CH	CH	CH	CH	CH LL
Communicator		CH	VB	CH LL	CH	VB	GR	CH	CH LL	LL	CH	VB	LL	VB	LL	CH LL
Phase 1 trials		2	2	2	2	2	4	2	2	2	2	2	2	2	2	3
Phase 2 trials		2	2	2	2	2	4	3	2	2	2	2	2	2	2	3
Phase 3 trials		3	2	2	2	2	2	2	2	2	2	2	2	2	2	2
No choice trials		no	no	no	no	no	no	in2	no	no	no	no	no	no	no	no
Total trials		7	7	6	6	6	10	7	6	6	6	6	8	6	6	8
Bucket choice		B	B	B	B	B	B	A	A	A	B	A	A	B	A	A

Dog ID	165
Dog Name	Billie
First baited bucket	blue
Fam phase 2 first trial type	displ.
Fam phase 3 first trial type	no displ.
Test condition	FB
Dog breed	golden retriever
Sex	f
Castration	no
FCI group	8
Age in months	26
Dog sport exp.	yes
Hider	CH
Communicator	LL
Phase 1 trials	2
Phase 2 trials	2
Phase 3 trials	2
No choice trials	no
Total trials	6
Bucket choice	A
Dog ID	166
Dog Name	Lori2
First baited bucket	blue
Fam phase 2 first trial type	no displ.
Fam phase 3 first trial type	displ.
Test condition	TB
Dog breed	beagle
Sex	m
Castration	no
FCI group	6
Age in months	8
Dog sport exp.	no
Hider	CH
Communicator	LL
Phase 1 trials	2
Phase 2 trials	2
Phase 3 trials	2
No choice trials	no
Total trials	6
Bucket choice	A
Dog ID	167
Dog Name	Nura
First baited bucket	grey
Fam phase 2 first trial type	displ.
Fam phase 3 first trial type	displ.
Test condition	SC
Dog breed	german spitz
Sex	f
Castration	no
FCI group	5
Age in months	97
Dog sport exp.	yes
Hider	CH
Communicator	LL
Phase 1 trials	4
Phase 2 trials	2
Phase 3 trials	2
No choice trials	no
Total trials	8
Bucket choice	B
Dog ID	168
Dog Name	Levi3
First baited bucket	blue
Fam phase 2 first trial type	no displ.
Fam phase 3 first trial type	displ.
Test condition	FB
Dog breed	golden retriever
Sex	m
Castration	no
FCI group	8
Age in months	26
Dog sport exp.	yes
Hider	LL
Communicator	CH
Phase 1 trials	2
Phase 2 trials	2
Phase 3 trials	2
No choice trials	no
Total trials	6
Bucket choice	A
Dog ID	169
Dog Name	Breezy
First baited bucket	grey
Fam phase 2 first trial type	displ.
Fam phase 3 first trial type	no displ.
Test condition	SC
Dog breed	italian spinone
Sex	f
Castration	no
FCI group	7
Age in months	41
Dog sport exp.	yes
Hider	LL
Communicator	GR
Phase 1 trials	4
Phase 2 trials	2
Phase 3 trials	2
No choice trials	no
Total trials	8
Bucket choice	B
Dog ID	170
Dog Name	Amica
First baited bucket	blue
Fam phase 2 first trial type	no displ.
Fam phase 3 first trial type	no displ.
Test condition	SC
Dog breed	german spitz
Sex	f
Castration	yes
FCI group	5
Age in months	117
Dog sport exp.	yes
Hider	LL
Communicator	CH
Phase 1 trials	2
Phase 2 trials	2
Phase 3 trials	2
No choice trials	no
Total trials	6
Bucket choice	B
Dog ID	171
Dog Name	Roku
First baited bucket	grey
Fam phase 2 first trial type	displ.
Fam phase 3 first trial type	displ.
Test condition	SC
Dog breed	mudi
Sex	m
Castration	no
FCI group	1
Age in months	57
Dog sport exp.	yes
Hider	CH
Communicator	VB
Phase 1 trials	3
Phase 2 trials	3
Phase 3 trials	2
No choice trials	no
Total trials	8
Bucket choice	A
Dog ID	172
Dog Name	Kaya3
First baited bucket	blue
Fam phase 2 first trial type	displ.
Fam phase 3 first trial type	displ.
Test condition	SC
Dog breed	samojede
Sex	f
Castration	no
FCI group	5
Age in months	58
Dog sport exp.	yes
Hider	CH
Communicator	GR
Phase 1 trials	3
Phase 2 trials	3
Phase 3 trials	2
No choice trials	in2
Total trials	7
Bucket choice	B
Dog ID	173
Dog Name	Quintus
First baited bucket	blue
Fam phase 2 first trial type	displ.
Fam phase 3 first trial type	no displ.
Test condition	TB
Dog breed	hovawart
Sex	m
Castration	yes
FCI group	2
Age in months	68
Dog sport exp.	yes
Hider	GR
Communicator	LL
Phase 1 trials	4
Phase 2 trials	2
Phase 3 trials	2
No choice trials	no
Total trials	8
Bucket choice	B
Dog ID	174
Dog Name	Lea4
First baited bucket	blue
Fam phase 2 first trial type	no displ.
Fam phase 3 first trial type	displ.
Test condition	TB
Dog breed	cocker spaniel
Sex	f
Castration	no
FCI group	8
Age in months	13
Dog sport exp.	yes
Hider	LL
Communicator	CH
Phase 1 trials	2
Phase 2 trials	2
Phase 3 trials	2
No choice trials	no
Total trials	6
Bucket choice	B
Dog ID	175
Dog Name	Niki4
First baited bucket	grey
Fam phase 2 first trial type	no displ.
Fam phase 3 first trial type	displ.
Test condition	TB
Dog breed	german spitz
Sex	f
Castration	no
FCI group	5
Age in months	86
Dog sport exp.	no
Hider	GR
Communicator	VB
Phase 1 trials	2
Phase 2 trials	2
Phase 3 trials	2
No choice trials	no
Total trials	8
Bucket choice	B
Dog ID	176
Dog Name	Knödl
First baited bucket	grey
Fam phase 2 first trial type	no displ.
Fam phase 3 first trial type	displ.
Test condition	FB
Dog breed	welsh corgi pembroke
Sex	m
Castration	yes
FCI group	1
Age in months	58
Dog sport exp.	yes
Hider	CH
Communicator	VB
Phase 1 trials	3
Phase 2 trials	2
Phase 3 trials	2
No choice trials	in2
Total trials	7
Bucket choice	A
Dog ID	177
Dog Name	Nash4
First baited bucket	grey
Fam phase 2 first trial type	displ.
Fam phase 3 first trial type	no displ.
Test condition	SC
Dog breed	border collie
Sex	m
Castration	yes
FCI group	1
Age in months	42
Dog sport exp.	yes
Hider	CH
Communicator	VB
Phase 1 trials	2
Phase 2 trials	2
Phase 3 trials	2
No choice trials	no
Total trials	6
Bucket choice	B
Dog ID	178
Dog Name	Harry3
First baited bucket	grey
Fam phase 2 first trial type	displ.
Fam phase 3 first trial type	no displ.
Test condition	SC
Dog breed	beagle
Sex	m
Castration	yes
FCI group	6
Age in months	57
Dog sport exp.	yes
Hider	VB
Communicator	GR
Phase 1 trials	2
Phase 2 trials	2
Phase 3 trials	2
No choice trials	no
Total trials	6
Bucket choice	B
Dog ID	179
Dog Name	Nico7
First baited bucket	grey
Fam phase 2 first trial type	no displ.
Fam phase 3 first trial type	no displ.
Test condition	TB
Dog breed	german spitz
Sex	m
Castration	yes
FCI group	5
Age in months	111
Dog sport exp.	yes
Hider	CH
Communicator	LL
Phase 1 trials	2
Phase 2 trials	2
Phase 3 trials	2
No choice trials	no
Total trials	7
Bucket choice	B

Dog ID		180	181	182	183	184	185	186	187	188	189	190	191	192	193	194
Dog Name		Dunni	Maja7	Nara	Darcy	Maya8	Vanja	Nanouk3	Aramis8	Kiani	Bruno5	Alesha	Jake	Yivi4	Luise2	Kalea2
First baited bucket		grey	grey	blue	blue	grey	grey	grey	blue	grey	grey	blue	blue	grey	blue	grey
Fam phase 2 first trial type		displ.	displ.	displ.	displ.	displ.	displ.	displ.	displ.	displ.	no displ.	displ.	no displ.	no displ.	no displ.	no displ.
Fam phase 3 first trial type		no displ.	no displ.	no displ.	displ.	displ.	displ.	no displ.	no displ.	no displ.	displ.	no displ.	no displ.	no displ.	displ.	no displ.
Test condition		TB	FB	TB	SC	TB	SC	FB	FB	FB	TB	TB	SC	FB	SC	FB
Dog breed		miniature pinscher	miniature american shepherd	bohemian shepherd	portuguese water dog	labrador retriever	portuguese water dog	german spitz	german spitz	whippet	romagna water dog	greyhound	border collie	german spitz	white swiss shepherd	flat coated retriever
Sex		f	f	f	f	f	f	m	m	f	m	f	m	f	f	f
Castration		yes	no	no	no	no	no	no	no	yes	no	yes	yes	no	yes	yes
FCI group		2	1	1	8	8	8	5	5	10	8	10	1	5	1	8
Age in months		59	44	13	33	54	76	143	42	83	21	29	88	42	101	59
Dog sport exp.		yes	yes	yes	yes	no	yes	no	yes	yes	yes	yes	yes	yes	yes	yes
Hider		GR	VB	CH	VB	VB	GR	VB	CH	VB	VB	GR	VB	CH	VB	CH
Communicator		VB	CH	VB	GR	LL	VB	GR	CH	VB	VB	VB	VB	CH	VB	CH
Phase 1 trials		2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
Phase 2 trials		2	2	4	2	2	2	2	2	2	2	4	2	2	3	2
Phase 3 trials		2	2	3	2	2	2	2	2	2	2	2	2	2	2	2
No choice trials		no	no	no	no	no	no	no	no	no	no	in phase	no	no	no	no
Total trials		6	6	9	6	6	6	6	6	7	6	8	6	8	7	6
Bucket choice		B	A	B	B	A	A	A	B	B	B	A	B	B	B	B

Acknowledgement

I hereby would like to extend my gratitude towards my supervisors, Univ.-Prof. Dr.rer.nat. Ludwig Huber and Lucrezia Lonardo, PhD, for their input and constructive feedback. I am also grateful for the staff at the Clever Dog Lab Vienna, especially lab manager Mag.rer.nat. Karin Bayer, for their support.