MASTERARBEIT

Titel der Masterarbeit

"Do as I do" imitation in dogs: learning of transitive and intransitive actions from a conspecific model

verfasst von

Jennifer Bentlage

angestrebter akademischer Grad

Master of Science (MSc)

Wien, 2013

Studienkennzahl lt. Studienblatt:	A 066 878
Studienrichtung lt. Studienblatt:	Masterstudium Verhaltens-, Neuro- und Kognitionsbiologie
Betreuer:	ao. Univ.-Prof. Mag. Dr. Ludwig Huber

“First the animal must have observed that the door is opened by the hand grasping the handle and moving the latch. Next she must reason, by ‘the logic of feelings’—
if a hand can do it why not a paw?”
(Romanes 1892, p. 421)

“Learning to do an act by seeing it done”
(Thorndike 1898, p. 50)

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SUMMARY

The following thesis provides first evidence of conspecific's imitative abilities of the domestic dog (*Canis familiaris*) using the "Do as I do" paradigm. It is based on previous work done by Andrea Szucsich and her female dog Joy, who was trained to match on command her own body behavior to human or dog demonstrated actions (Szucsich 2008). During the "Do as I do" training the subject is trained to reproduce a set of actions demonstrated by a conspecific or a human demonstrator on command. For successful performance, the observer animal had to perform the same motor patterns as demonstrated (Huber *et al.* 2009).

In this study, eight dogs (four border collies, one berger blanc suisse, one flat-coated retriever, one poodle and one mongrel) were trained to copy transitive (object-oriented) and intransitive (body-oriented) actions demonstrated by another dog. The demonstrator dog had been taught, with the use of hand signals, to present a set of actions before the observer dog was given the command to copy. Three subject dogs reached the test criteria of 80% successful matches during training, but none showed an acceptable performance during the training session of copying intransitive actions (Bentlage & Huber 2013).

The first part of the testing phase was carried out with trained actions, known from the "Do as I do" training, but under different conditions: actions were shown by another demonstrator, the command for copying was either not given or given by someone else, and the observer dogs were confronted with novel actions or action sequences. During the second part, dogs were tested with untrained actions to determine their ability to transfer the command towards new situations. Results showed that dogs can be trained to imitate a conspecific on command, that they can transfer it to novel actions and to different models (conspecific and heterospecific). However, they failed to do so with new actions demonstrated on familiar objects, known from the pre-training and action sequences (Bentlage & Huber 2013). Altogether the results are in line with previous studies (Huber *et al.* 2009; Tópal *et al*. 2009) but with the crucial difference of having a conspecific rather than a human being as the model in the "Do as I do" paradigm.

ZUSAMMENFASSUNG (GERMAN SUMMARY)

Die vorliegende Arbeit liefert erste Beweise über die Fähigkeit von Haushunden (*Canis familiaris*), unter Verwendung des „Do as I do"-Paradigma, einen Artgenossen zu imitieren.
Während des „Do as I do" Trainings erlernen die beobachtenden Hunde, auf Kommando ein von einem Menschen oder einem Artgenossen gezeigtes Verhalten motorisch exakt zu reproduzieren (Huber *et al.* 2009).
Vorbild für die vorliegende Studie ist die Arbeit von Andrea Szuczich und ihrer Weimaraner Hündin Joy. Joy war in der Lage auf ein Kommando ihre eigenen Körperbewegungen auf die von einem Menschen oder einem Hund anzupassen, und diese zu imitieren (Szucsich 2008).

Für diese Studie wurden acht Hunde (vier Border Collie, ein Berger de Blanc, ein Flat-Coated Retriever, ein Pudel und ein Mischling) darauf trainiert, intransitive (körperorientierte) und transitive (objektorientierte) Verhaltensweisen, die von einem Artgenossen vorgeführt wurden, zu kopieren. Dieser stets gleiche Demonstrator reagierte auf ein nonverbales Kommando und führte daraufhin ein bestimmtes Verhalten aus. Anschließend wurde dem beobachtenden Hund von der Trainerin das Kommando „Do it!" als Nachahmungssignal geben.

Drei der fünf trainierten Hunde erreichten während des Trainings transitiver Verhaltensweisen das Testkriterium von 80% korrekter Nachahmung. Beim Training des Nachahmens intransitiver Verhaltensweisen erreichte keiner der Hunde das Testkriterium. In der an das Training anschließenden ersten Testphase wurden zwar die gleichen trainierten Verhaltensweisen gezeigt, allerdings wurden abwechselnd unterschiedliche Variablen verändert: ein anderer Hund diente als Demonstrator, das „Do it!"-Kommando wurde entweder gar nicht, oder von einer anderen Person gegeben, oder der beobachtende Hund wurde mit einer Abfolge verschiedener Verhaltensweisen konfrontiert.

Während der zweiten Testphase wurden den beobachtenden Hunden neue, zuvor nicht trainierte Verhaltensweisen demonstriert, um ihre Verallgemeinerungsfähigkeit zu überprüfen. Die Ergebnisse zeigen, dass die drei Hunde nicht nur in der Lage sind, das Verhalten eines Artgenossen auf Kommando korrekt nachzuahmen, sondern dass sie sogar vorher unbekannte Verhaltensweisen und neue menschliche oder hündische Demonstratoren nachahmen können. Sie scheiterten allerdings daran, neue Verhaltensweisen an bekannten Objekten und Sequenzen von Verhaltensweisen nachzuahmen. Insgesamt stimmen die Ergebnisse mit vorherigen Studien (Huber *et al.* 2009; Tópal *et al.* 2009) überein, jedoch mit dem wesentlichen Unterschied, dass hier bei dem „Do as I do" Paradigma ein Artgenosse und nicht ein Mensch als Model diente.

1 INTRODUCTION

1.1 Social learning

Learning from each other in a social group is an efficient method to extend and improve one's behavior repertoire in order to spend less time and energy (Huber *et al.* 2009) and is thought to be one of the main drivers for evolutionary processes and for the development of culture (Laland & Galef 2009; Tomasello 1999). Most researchers agree that social learning can have a beneficial effect on individual learning, though it is not a necessary benefit (e.g. Zentall 2001; Laland 2004; Huber 2011). Nevertheless, learning through observation and (possible) adaptive modifications of the behavioral repertoire may lead to a more flexible behavior compared to individual or species-typical learning (Huber 2011).

Social learning is not a single process and can have long and short term effects on the behavior. Former ones need to be distinguished from social influences based on the observers' motivation and perception. Motivational influences may affect the general motivation or arousal of the observer. The mere presence of the demonstrator (social facilitation) can lead to an increased arousal and therefore increases the likelihood of showing the target behavior (Zajonc 1965). An increase of general activity and incentive motivation can also be caused by reinforcement provided to the observer during the demonstration (see Caldwell & Whiten 2003), or by observing aversive motivated conditioning (e.g. John *et al.* 1986). Similar to that is contagion, showing a coordinated reflexive behavior that is automatically released with another individual. This behavior is species-typical and occurs only in the presence of the performing conspecific (e.g. Huber 2011; Zentall 2003; Zentall 2006; Zentall 2011). Social influences based on the individual's perception are the mechanisms of local (Thorpe 1956) or stimulus enhancement (Spence 1937), which describe learning because of attention to its environment rather than learning from others. The attractiveness of either the place where the objects is located or the movement of the object can be (although not necessarily) enhanced by a demonstrator being there.

A clear form of social learning is observational conditioning (Whiten 1992), in which the observer associates an unconditioned stimulus with an affective behavior by (only) observing the demonstrator's response. In another form the individual learns about affordances, functions and mechanisms of objects by observing others, then coming up with their own preferred technique to reproduce the results of the demonstrator. This mechanism is so called emulation (Tomasello 1990; also described as affordance learning (Zentall 2003) or object movement reenactment (Atkins *et al.* 2002)) and is linked to intelligent problem solving as the observer needs to understand the change of state produced by the manipulation (Huber 2011). For example, Keas can learn through observation how to use a tool (Huber 2001) but note that reproducing the outcome of an action is not necessarily linked to an understanding of the behavior (Tomasello 1996). In contrast, during the process of imitation, the animal learns an action by copying the specific behavioral pattern rather than the outcome of another individual which cannot be assigned to the described alternative mechanisms, which also result in behavioral matching (Zentall 2011). Researchers argued that the ability to imitate is affected by one's biological and phylogenetic basis and cognitive complexity (e.g. Tomasello *et al.* 1993; Whiten & Custance 1996; Visalberghi & Fragaszy, 1990). It has been considered to be an intriguing neuro-cognitive process in humans (Huber 2011) and that the process of imitation is a key feature for human culture (Tomasello 2009; Huber 2011). Furthermore, the process of copying should be differentiated based on (1) whether the action to be copied is already in the observers' repertoire or is novel (Byrne & Russon 1998; Subiaul 2007; Visalberghi & Fragaszy 1990), (2) whether the observer came to a real understanding of the demonstrator's goal and intention (e.g. Call & Carpenter 2002) and (3) whether the observers replicate the demonstrated action, or only the target object's movement caused by the demonstrator's interaction, or the effects resulting from the behavior of the demonstrator (e.g. Custance *et al.* 1999; Whiten *et al.* 2004).

In the last few decades, researchers became more interested in exploring such complex cognitive skills in other species (Whiten *et al.* 2004) and they have shown that various species are capable of matching a demonstrated action. Marmosets (*Callithrix jacchus)* showed imitative behavior towards the demonstrated technique of opening the lid of a baited film canister at the level of action matching (Bugnyar & Huber 1997) and body part matching (Voelkl & Huber 2000). A detailed analysis (Voelkl & Huber 2007) later revealed that the observer group copied "not only the body part or an overall action, but details of the movement" (Huber *et al.* 2009). However, it could also be that the 'copiers' use the same methods as demonstrated, and this is then mistakenly interpreted as imitation even though the subject emulated (Whiten *et al.* 2009).

1.2 Do as I do: A privilege of great apes and humans?

The preferred methods for examining the process of imitation have been the two-action task (Dawson & Foss 1965) and the "Do as I do" task (Hayes & Hayes 1952). During the two-action task, the subject observes a demonstrator solving a task by using one of at least two possible actions. Then, the subject is confronted with the same task. If the observer animal uses the same method as the demonstrator, it is considered to be imitating the demonstrator's behavior. During the "Do as I do" training, the subject learns to reproduce a set of actions demonstrated by a conspecific or human using a (verbal) command. To succeed at the "Do as I do", the observer animal has to show the same motor patterns as demonstrated. In contrast to the two-action task, this offers a different and a more detailed way to examine if the process of imitation is at work or not. The "Do as I do" task uses considerably more alternative behaviors, and subjects have to make a choice from a set of actions as opposed to two alternatives (which is the case for the two-action task). Additionally, it focuses on the reproduction of body movements rather than completing a task or solving a problem. To be successful, the observer has to understand the "concept of imitation" (e.g. Herman 2006; Whiten *et al.* 2004; but see Hoppitt & Laland 2008 for an alternative view). Using the "Do as I do" paradigm, imitative abilities have mainly been explored in the context of human cognitive evolution, and study subjects have primarily been humans (Hamlin *et al.* 2008), chimpanzees (*Pan troglodytes*) (Custance *et al.* 1995; Myowa-Yamakoshi & Matsuzawa 1999; Tomasello *et al.* 1993; Hayes & Hayes 1952), bonobos (*Pan paniscus*) (Tomasello *et al.* 1993) and orangutans (*Pongo pygmaues*) (Call 2001; Miles *et al.* 1996).

Hayes & Hayes (1952) were the first who used the Do as I do training technique with a non-human animal; their three-year-old home-raised chimpanzee (Viki). The subject was presented with a series of arbitrary actions, like blinking with eyes, spinning on one foot or clapping hands. If Viki did not copy the action within seconds, they either repeated the action or helped her to fulfill the response (e.g. by manipulating her hands) until she correctly copied. She imitated fifty-five out of seventy actions immediately and at least ten of them were previously completely unknown actions. This study is of interest because it controlled for stimulus enhancement, meaning that arbitrary actions were shown instead of technical problem solving tasks. Additionally, they controlled for contagion because the more actions that can be copied, the more unlikely it is that the underlying mechanism is contagion (Meltzhoff & Moore 1991). Nevertheless this study had weaknesses in such that it had limited scientific documentation of the training procedure, the demonstrated behaviors and the chimpanzee's responses. Therefore Custance *et al.* (1995) replicated the study with two juvenile nursery-reared chimpanzees (Scott and Katrina), and produced a well-documented procedure which filled in the gaps of the study conducted by Hayes & Hayes (1952). The animals were trained to obey the "Do it!" command using a set of

15 actions like stamping on the ground, wiping one hand on the floor or raising the arms. After three months of training and a correct response of 80% or better of the occasions, the chimpanzees were confronted with 48 novel test actions. Human observers, ignorant of the demonstrated action, identified a third of the shown actions as a match. However, the accuracy of the chimpanzees' imitation was poor, raising questions of whether the chimpanzees understood that they had to replicate as precisely as possible.

A later study (Myowa-Yamakoshi & Matsuzawa 1999) investigated which factors determine the ability to imitate in the "Do as I do" paradigm. Five chimpanzees were trained on 48 arbitrary (manipulative) actions that differed in their demonstration structure, meaning, that the demonstrations were directed at objects (e.g. shake a bowl) or the own body (e.g. put the bowl on its own head) and were familiar or novel. Actions directed at objects were distinguished on the basis of the demonstrator manipulating an object alone (e.g. push bowl against one's chest) or directing the object towards an external location (e.g. put ball into bowl). The study showed that chimpanzees were able to reproduce a demonstrated action in the first trial, although this was very rare (less than 6% of the overall trials). Furthermore, the authors found a better performance in test conditions involving familiar motor patterns than in conditions involving novel motor patterns. They concluded that the animals were not attentive toward the details of the body movements during the demonstrations; rather they were more focused on where the manipulated object was directed. In other words: the chimpanzees were emulating rather than imitating.

A further study included a human-reared and language-trained male orangutan (Chantek), who had shown that he was capable of imitating on command (Miles *et al.* 1996). Thus, Call (2001) tested and directly compared him with chimpanzees with the same set of actions that Custance *et al.* (1995) had used in their study. Chantek's performance was scored for body part usage, the type of action demonstrated and the response accuracy. In general, Chantek showed accuracy in the ability to copy the demonstrated action, and he therefore outperformed the chimpanzees from Custance's *et al.* study (1995). Nevertheless, some similar errors occurred in reproducing motor patterns—matching accuracy was high for the use of gross body parts but accuracy decreased remarkably when it came to the smaller movements within the gross motor patterns. Call (2001) argued that "an attention bias toward certain results or goals and a less differentiated ability to encode observed actions may be important factors contributing to observed error patterns" (Call 2001). In addition, this study confirmed the previously reported finding (Custance *et al.* 1995; Miles *et al.* 1996) that the subjects tend to repeat actions that they had performed in previous trials and chimpanzees' emulators (Myowa-Yamakoshi & Matsuzawa 1999).

Apart from studies with great apes, humans (especially infants) have also been the subject in imitation studies. Human newborn infants have demonstrated that they are able to imitate body oriented actions (Meltzoff & Moore 1977), and movements involving objects have been documented in 6-months old children (Collie & Hayne 1999; von Hofsten & Siddiqui 1993). However, these studies do not address the question whether children selectively imitate goal-relevant components. The first who tested this were Hamlin *et al.* (2007). They tested 7-months-old infants for their imitative behavior after seeing an adult interacting with one of two objects, grasping for them with different types of gestures. Their findings suggest that young infants have the ability to analyze actions on the basis of whether they are goal-directed or not.

1.3 Counterstrike: Imitation abilities in non-primate species using the "Do as I do" paradigm

The uniqueness of imitative abilities of humans and great apes (Miles *et al.* 1996) was refuted by studies using this paradigm with a parrot (*Psittacus* *erithacus*) (Moore 1992), dolphins (*Tursiops truncates*) (Bauer & Johnson 1994; Herman 2002; Jaakkola 2010; Xitco 1988), killer whales (*Orcinus orca*) (Abramson *et al.* 2013) and dogs (*Canis familiaris*) (Szucsich 2008; Huber *et al.* 2009; Topal *et al.* 2006).

The African grey parrot Okichoro showed the ability to imitate actions and words (Moore 1992), although this study differs in terms of response time compared to the chimpanzees. Over five years, the parrot received several daily sessions where the experimenter repeatedly presented a set of stereotyped movements that were verbally labeled (e.g. "look at my tongue" or "ciao"). Okichoro could copy arbitrary actions like shaking, waving or head nodding. Moore (1992) described the imitation abilities of the parrot as slow in its development and always in need of a specific time until they emerge ("incubation phase"). In birds, vocal mimicry is far more common than movement imitation, whereas quite the opposite is true for primates. Moore (1992, 2004) argues that there is a functional and evolutionary difference between avian and mammalian imitation and suggested that primates can learn essential skills by copying others actions (e.g. for tool use, or making), but for birds it is (only) related to social displays.

In addition to birds, cetaceans have also been the subjects in studies of imitation (Herman 2002; Marino 2002). Experimental evidence of action imitation has been demonstrated in bottlenose dolphins (Bauer & Johnson 1994; Herman 2002; Jaakkola 2010; Xitco 1988) and recently also killer whales (Abramson *et al.* 2013). Herman (2002) described a study of the dolphins Phoenix and Ake being able to imitate a human or another dolphin. In total, 12 actions were performed by each demonstrator (human and dolphin); eight actions from both, four by the human and additionally four by the conspecific. Two of the eight actions were shown by the human and the other dolphin, and two of the human demonstrated actions were shown for the first time and therefore novel in the "Do as I do" test. The other behaviors were already part of the observer dolphin's behavioral repertoire and were known from previous training or other tests. It seemed to make no difference to the observer dolphins whether they had a human or a dolphin as a model. In both situations, the observer copied two-thirds of the demonstrated actions successfully. One subject correctly copied two of the four novel actions, one demonstrated by the human model and the other by the conspecific. The author argued that the imitation was based on the functional behavior rather than on the “model-species” (human vs. dolphin), and on the detailed performance of the demonstrator. At the same time, Herman (2002) emphasized that it is unsure whether the two dolphins really understood the copy command, because the subjects were simultaneously acting together with the human action and were not waiting for the “Do it” command. In this case, the demonstrator’s performance, rather than the copy command, triggered the observer’s response. The study of Jaakkola (2010) showed the ability of a bottlenose dolphin (Tanner) to copy another dolphin in a “Do as I do” setup. First Tanner showed both the ability to copy vocal and motor behaviors in a blindfolded condition (wearing eyecups) and in a sighted condition. Later, a blindfolded human trainer was able to identify the dolphin’s behaviors using only the characteristic sounds associated with them. Jaakkola (2010) said that it is unclear whether the dolphin recognized the behavior via echolocation or via characteristic sounds. Recently a study conducted by Abramson *et al.* (2013) provided evidence for action imitation in killer whales. Three killer whales were trained to copy four to six body-oriented actions demonstrated by a conspecific using a verbal command for copying. The subjects were then tested with a set of novel actions including (a) 15 actions being already part of their behavioral repertoire and (b) two completely novel actions. Results showed that killer whales learn the “Do it!” command very quickly and that they are able to copy untrained and familiar actions successfully.

1.4 ONGOING PROCESS: SOCIAL LEARNING ABILITIES IN THE DOMESTIC DOG

Beside primates, birds, dolphins and whales, the dog is raising interest for ethologists studying social learning. The unique character and adaptive role of the domestic dog in the human society offers an ideal model to investigate their cognitive abilities (Kubinyi *et al.* 2003; Miklosi 2007) and in particular imitative abilities which are assumed to be the most rare and complex mechanisms in social learning (but see Huber *et al.* 2014).

Nel (1999) focused in his review on canine social behavior and its impact on social learning, which may have an adaptive role to local environmental conditions. For example, the avoidance of poisoned bait is socially transferred among group members in several canid species. The offspring and mates of experienced jackals learned to avoid poisoning cyanide guns, indicating a social transmission of the essential knowledge (Brand & Nel 1997). Wolves live in a family-based hierarchical social structure (e.g. Packard 2003) and such a social environment leads individuals to most likely acquire skills, such as hunting or communicating (Kubinyi *et al.* 2009), through social learning. A recent study provided evidence for local enhancement in dogs and wolves, in which both could benefit from a demonstration (human and dog demonstrator) (Range & Virányi 2013).

However, using a human as demonstrator could lead to limitations in action organization because of anatomical differences between dogs and humans (Huber *et al.* 2009), e.g. a human picks something from the ground predominantly using his/her hand, while a dog would use its mouth instead. Because of the species-specific behavioral aspects, the usage of a human as demonstrator causes problems in interpretation of the underlying mechanism. Dogs might draw different conclusions regarding the same task depending on demonstrator species (Kubinyi *et al.* 2009; Pongracz *et al.* 2008). When confronted with a detour task, the social learning performance of dogs with a conspecific model was not as good as with a human model

(Pongracz *et al.* 2001) even if they had some pre-experience in solving the task (Pongracz *et al.* 2003). Subsequently, they found that the social status of the dog only had an influence on their performance when an unfamiliar dog was the demonstrator; response was equal when a human demonstrated the actions. Subordinate dogs showed a better response compared to dogs with a higher status dogs (Pongracz *et al.* 2008). Similar to Pongraczs' *et al.* studies (2001, 2003) dogs learned to manipulate a handle attached to a box so that a ball could be released. Subjects that received a demonstration from a human learned the manipulation more rapidly and were more likely to push the handle using their nose, whereas dogs that received a demonstration without resulting in play (the ball was not falling out of the box, after manipulating the handle) showed a preference to touching. The authors explained this result as a predominant tendency to follow human gestures even if the outcome is not clear (Kubinyi *et al.* 2003).

A study by Range *et al.* (2007) showed some behavioral flexibility in response to a problem solving task demonstrated by a conspecific. A food container could be opened by pushing a rod down either by using the mouth or the paw, whereas most dogs showed a preference of using their mouth. Dogs were tested in three different conditions. In the two experimental groups they received a demonstration of a trained conspecific showing an "inefficient" method (mouth-free) and an "efficient" method (mouth-occupied by carrying a ball). Dogs in the control group did not receive any demonstration. Results showed that subjects in the control and "mouth-occupied" group preferred to use their mouth, whereas 15 of the 18 subjects in the "mouth-free" group used their paw. Priming the observer's tendency for grasping the rod with a ball placed next to the apparatus (Kaminski *et al*. 2011) could be excluded due to methodological and theoretical understandings (Huber *et al.* 2012). These results are in line with the findings of a similar study with young children (Gergely *et al.* 2002) and indicate that dogs also imitate in a selective and interpretative manner.

Observational experiences for solving a problem and showing the same or different actions seemed to have an influence as well (Range *et al*. 2011). Dogs were trained to open a sliding door of a box by using their head and paw. One group was rewarded when using the same body part (head or mouth) as demonstrated by the owner whereas the second group for using the alternative method. Results showed that dogs of the second group were significantly slower in learning the task. In an additional transfer test the performance of the dogs were consistent with the training in terms of being significantly slower in their counter-imitative responses.

1.5 Do as I do imitation in dogs

To date, several studies provide some evidence that dogs can use human actions as a cue to create functional matching behaviors with their own body. Tópal *et al.* (2006) trained Philip, a 4 year old Tervueren. Philip was first taught to obey the “Do it!” command and to reproduce nine actions consisting of body-orientation (intransitive) and object-orientation (transitive) actions. During testing, Philip was confronted with another demonstrator (to exclude Clever Hans effects) as well as novel actions that were already in the dogs’ behavioral repertoire. Importantly, Philip was a skillful and highly trained assistant dog. Furthermore, he was tested with actions demonstrated in a continuous row (action sequences) using the same procedure. Results of the second part of the study showed limitations of Philips’ imitative abilities in terms of copying fidelity. He confused the start and stop location, and he confused left/right. The authors concluded that the dog may have understood the action sequence in terms of relevance and the aim (Topal *et al.* 2006). Overall the study provides evidence that dogs can use human body actions as a cue for selecting functional matching behaviors with their own body. Philip was able to generalize the learned rule in test situations with trained and novel actions as well as a new demonstrator.

In contrast to Topal´s *et al.* study, the second study (Szucsich 2008) used much more complex actions and not only a human but also a conspecific as a model. The study focused on comparisons between (1) transitive and intransitive actions, (2) functional and non-functional actions, and (3) familiar and novel actions. First Joy, a two year old Weimaraner educated as a search dog, was trained by its owner (Andrea Szucsich) to reproduce eight actions on the "Do it!" command. During testing, Joy responded to novel actions with rare mismatches, and if so, she showed another trained action. She showed low-level copying performance with action sequences of which she matched only a third and in some cases just the second action, thus showing a "recency effect". Matching response to "exotic" actions was similarly poor. The author argued that Joy could neither use the action result nor the demonstrator´s goal to infer the action. Additionally a recent study focused on the "Do as I do" training technique showed that subjects using the "Do as I do" method outperformed, in regard to learn complex actions and sequences, the group using a shaping/clicker training method (Fugazza & Miklosi 2014a).

Being tested in the deferred imitation test, in which the copy command was given after a time span of 3-35 seconds rather than immediately after the model demonstrated the action, Joy performed correctly, thus showing first evidence for deferred imitation though her performance decreased as the post-command delay increased. In a more recent study dogs were able to reproduce the demonstrated action after a retention interval of 1.5minutes (novel actions) and 0.40 to 10 minutes (familiar actions) (Fugazza & Miklosi 2014b).

Joy was tested whether she would "blindly" copy actions or if she would try to make sense of them and would therefore try to find a plausible solution ("vacuum action"). For instance, the experimenter acted as if she was jumping over a hurdle, which was not present in the first test, but visible nearby in the second test. Joy´s responses were first to run in the same direction as the human, though did not jump, but stopped and looked back to the human. Half a year later, during the second testing session, a "real" hurdle was placed nearby. After the demonstration, Joy ran straight to the hurdle and jumped over it. It seems that she possibly made "sense" of the action rather than "blindly" copying it. Using another dog demonstrator revealed the dog´s ability to generalize. However, Joy spent less observational time with a dog model because (i) she had never experienced another dog during the Do as I do training and thus concentrated nearly the whole time on her owner and (ii) the demonstrator dog showed a higher level of dominance (Szucsich 2008; Huber *et al*. 2009).

1.6 Research questions and hypothesis

This study tested what a dog could learn from another dog in a "Do as I do" setting, and how it would copy or re-enact demonstrated actions made by a conspecific. To exclude the limitations mentioned above (e.g. being less attentive towards the dog demonstrator) this study modified the protocol designed by A. Szucsich (2008; but also see Huber *et al.* 2009) in terms of dogs observing a conspecific demonstrating the actions.

During the first part of the study, the aim was to see to what extent the dogs would generalize the command to novel setups or if their copying ability is restricted to the static and inflexible training setup. The hypothesis was that if they understood that they are supposed to imitate the demonstrated action, there would be no significant difference in their correct performance when using another demonstrator or another person giving the command. The second part of the study investigated the capabilities of the imitative behavior of dogs using action sequences consisting of two actions. Here the question arose whether the dogs prefer to copy the whole sequence, just the last action they saw, or do they show preferential treatment towards particular objects. Thirdly, the demonstrator dog showed novel actions on novel objects, and on objects that were already part of the training setup. The hypothesis was that it is easier to copy new actions on novel objects because the observer dog may be confused by stored associations between familiar objects and the actions they were trained with. Finally, dogs were tested with a so-called "pantomime action", which is an action shown without the "target object" being present (e.g. pretending to jump over a hurdle without the hurdle being present). This test condition was conducted to find out whether observer dogs are able to make sense of the shown behavior. The question was whether the observer dogs would blindly copy a demonstrated senseless action — such as jumping over an invisible hurdle — or whether they would perform the demonstrated action at an available object.

2 General methods

2.1 Subjects

Eight subjects were trained to be the observers: Four were Border Collies, Amy a 4-year-old female, Apryl a 3-year-old female, Miley a 3-year-old female and Ultimo a 3-year-old male; Mac Cloud was a 4-year-old male berger blanc suisse, Kira was a 5-year-old female flat-coated retriever, Mephisto was a 4-year-old male giant poodle, and Fenja was a 4-year-old female terrier mix. All observer dogs lived as companion dogs in their owner’s households, and they were well trained in different disciplines such as agility, herding, dog dancing or tricks. From the eight dogs that participated in the training, only three (see Fig. 1) met the test criteria of 80% successful matches during training and thus participated in the test.

Fig. 1: The three test observer dogs: Amy, Fenja and Miley (from left to right)

The demonstrations were shown by Monty, a castrated male Terrier mongrel with unknown age (approximately 11 years old), and Michel, a castrated 8-year-old male mongrel. Both dogs lived as pets in the household of the experimenter for eight (Michel) and five (Monty) years (see Fig. 2).

Fig. 2: The demonstrator dogs: Monty and Michel

2.2 Procedure

There were three aims of the training phase: a) to familiarize the dogs with the demonstrator dogs, b) to train a specific sample of actions (hereafter called "training actions") and c) to teach the "Do it!" command. The training and testing took place in an experimental room (length: 7.20m; width: 6m) at the CleverDogLab at the Veterinary University of Vienna. Training and testing procedure were both authorized by the Ethical-and Animal-Welfare commission of the Veterinary University of Vienna and in addition, owners signed a consent form to participate in this study.

2.2.1 Preliminary training

The dogs (observer and demonstrator) were taught by the experimenter and/or the owner to perform five actions using common training methods of positive reinforcement and particularly the use of "clicker training". Additionally the demonstrator dogs were taught to perform the actions only on nonverbal (hand signals) commands. This was done to prevent the observer dogs from learning the verbal instructions of the demonstrator dogs instead of the "Do it!" command.

The actions—shown in Table 1—differed in type and complexity. Two of the actions were "body-oriented" actions in which the dog demonstrates different tricks only using its body ("turn around" and "bow") and three actions were "object-oriented" actions where the dog interacted with an object. The "object-oriented" actions were "on top of table", "around cone" and "ball in box". The latter one was considered the most complex because two objects (ball and box) are involved in one action.

	Action name	Dog's (D) expected action
"body-oriented"	**turn around**	D goes to the mat and spins around its vertical body axis counterclockwise (right)
	bow	D goes to the mat and lies down with forelegs and chest while the hind legs and back part are still in the air
"object-oriented"	**on top of table**	D jumps on the table
	around cone	D goes counterclockwise around a cone
	ball in box	D goes to a box, takes a ball, which was lying in front of the box, takes it in its mouth and puts it into the box

Tab.1: List and description of the actions demonstrator and observer dogs were trained to do.

2.2.2 Training area and "Do as I do" training

Due to different levels of dog attention, pre-training sessions and experiences of the dogs with the "Do as I do-" training were individually adjusted. After a first meeting and a trial session in which the model dog demonstrated two actions on two objects, the training schedule was fixed for each dog (see Fig. 3). Some dogs skipped the first training step (see Fig. 3A) because they were already attentive to the dog demonstrator and did not show a preference for an object.

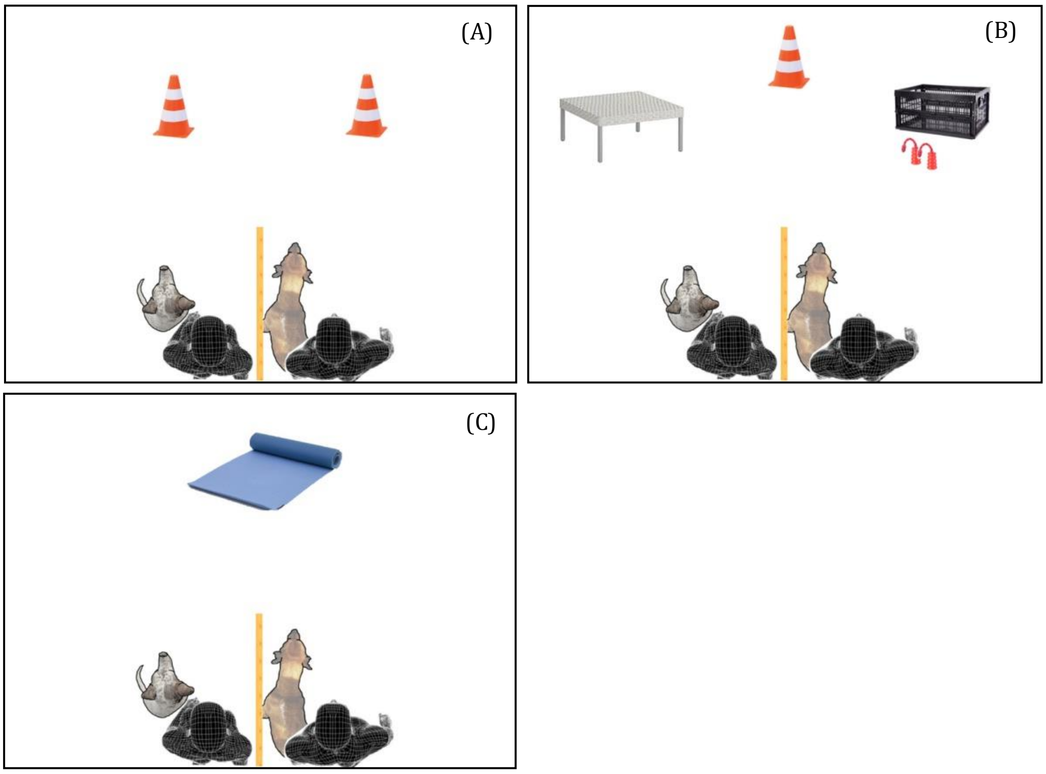

Fig. 3: A wooden wall separates the observer dog (left side) and the demonstrator dog (right side) visually from each other, although they can still hear and smell the other dog. *Amy* and *Fenja* are together with their owner on the left side whereas *Miley* was placed alone. The dog demonstrator and its trainer are hiding on the right side of the wall. (A) two similar cones; (B) table, cone, box with two balls in front (from left to right); (C) mat on which the demonstrator executes either a turn or a bow.

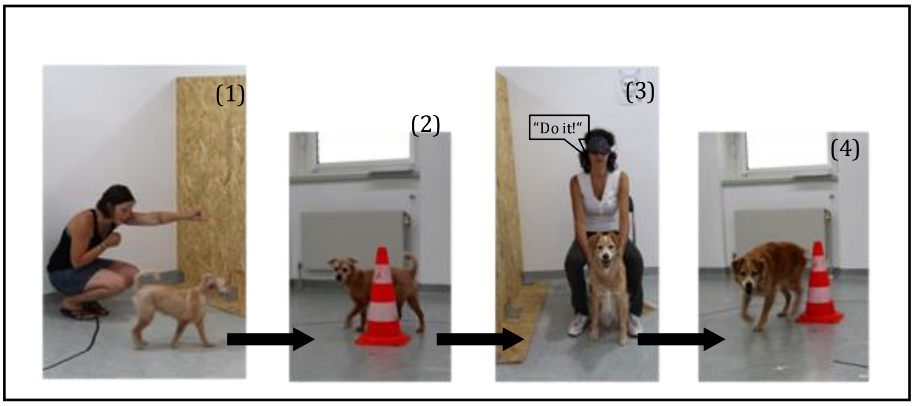

Fig. 4: “Do as I do” training: (1) Model is nonverbally sent; (2) Model shows an action; (3) Copy command of the blindfolded owner for the observer dog; (4) correct (matching) response of the observer dog.

The general procedure involved the demonstrator dog being sent by myself (this was always myself, the exceptions are reported) with a hand signal to one object where it performed the learned action before returning to me. Immediately after the return of the demonstrator dog, the observer dog was released by the owner or myself with a "Do it!" command (see Fig. 4). In Amy's and Fenja's case, the owner gave the command, and in Miley's case, the experimenter gave the command (because she was trained without her owner). As in the preliminary training, the dogs were not punished; they were only rewarded by the owner and in Miley's case by myself if they matched the action correctly.

The first part of the training (see Fig. 3A) was for the observer dogs to walk around either a right or left positioned cone. This dog had to walk around the same cone as performed by the demonstrator dog. The observer waited on the left side of the partition wall, while the demonstrator walked either around the right or the left cone and returned to me. In the beginning, the observer dog was released (by its owner or the experimenter) with the "Do it!" command while the demonstrator was on the way back behind the wall. Gradually, the observer dog was released later and later, so eventually the observer dog was released when the demonstrator dog had returned to its starting position (behind the wall, invisible for the demonstrator). This first training set up was conducted to exclude subject possible biases towards favorite objects, and to direct the observers' attention to the demonstrator dog. When the observer dogs reached high levels of performance (≥ 80% correct response), one of the cones was replaced by a new object.

The second part of the training (see Fig. 3B) extended the game to include the objects "table", "box" and "cone"—objects they already knew from the preliminary training. The spatial arrangement of the objects was presented in a random order. During the final training all objects were removed (see Fig. 3C) and the mat was placed in the middle of the room, equally visible for both the observer and the demonstrator dog. The demonstrator walked to the mat, sat down, and was then either instructed to turn around or to bow. After the observer dog reached high levels of copying precision (≥ 80% of correct response), the objects (table, box and cone) were added incrementally. Due to low performance in all observer dogs, the experimenter decided to move forward without the body actions and this were removed from the testing part, whereas the mat was still an object previously used in training (only for Amy and Miley).

2.3 Testing phase

The testing phase consisted of two parts. During the first part, dogs were tested for their ability to transfer the learned copy command to new actions, while the second part involved actions performed toward unknown objects. The aim of the tests was to understand whether the dogs could transfer the copy command, and if so, how far the dogs could be pushed in their imitation abilities.

2.3.1 General procedure:

The set up was the same as that used during training. The criterion needed for a test to be conducted was 80 % correct performance during training. Amy needed 19 training sessions, Miley needed 28 and Fenja needed 11 for reaching this criterion. For Fenja and Amy, the owner was blindfolded during the test situation, and Miley stood alone where the observer dogs were. The trainer sent the demonstrator dog using a nonverbal signal to perform the trained action towards an object. After the demonstrator returned, the experimenter gave the owner a verbal command ("ok"), and the owner then released the dog with the "Do it!" command. After the observer dog performed a matching action, the dog was verbally praised. If the dog did not show the demonstrated action, neither a response nor punishment was provided. Fenja was additionally rewarded with food due to motivational problems because of the fact that the demonstrator got treats for his performance. Test trials and control trials in which the demonstrator made one step in front of the partition wall (being visible to the observer dog for 5 seconds), were interspersed. Control trials were interspersed in the training trials. One test session consisted of eight (Fenja and Miley only during "sequence" testing) or eleven (Amy) trials.

2.3.2 Testing sessions with known objects

In this test session, the trained actions were demonstrated as usual but under different circumstances, meaning that demonstrations were shown by another (known) conspecific or a heterospecific (human) demonstrator. Observer dogs were tested whether they understood the "Do it!" command using conditions in which no command was given or someone else gave the command (The "Do it!" command). Furthermore, the ability to transfer the learned procedure was tested with another dog or a human demonstrator (a different demonstrator). Additionally, dogs were tested in sessions with action sequences, which means two trained actions were presented in a row (action sequences).

The "Do it!" command

This condition was conducted to investigate whether the dogs needed the "Do it!" command to show an action after the demonstration and if they perform in the same way if somebody else gives the command. During the first part, the observer dog was released without saying anything (in Miley's case the demonstrator showed an action and after returning the experimenter waited for 5 seconds). The procedure in the second part was the same, but instead of the owner giving the "Do it!" command, the experimenter gave it. In Miley's case, the owner stood next to the experimenter and gave the command. Due to logistic reasons the test trials were not interspersed, but were presented in a row.

Different demonstrator

Dogs were tested with another dog demonstrator (Michel) and a human demonstrator (the experimenter). The procedure was the same as described above. Both the dog and the human were familiar to the observer dog.

Action sequences

Action sequences had never been demonstrated during training and were twice interspersed in trained actions. Sequences are a combination of actions used in the training and therefore were already known to the dogs. In the case of Amy and a set up with four objects there are 12 different sequence possibilities, for Miley and Fenja there are 6 possibilities.

action name	Dog´s (D) expected action
table—cone	D jumps on the table before he walks counterclockwise around the cone
table—mat	D jumps on the table before he walks to the mat and bows on it
table—box	D jumps on the table before he throws the ball into the box
cone—table	D walks counterclockwise around the cone before he jumps on the table
cone—mat	D walks counterclockwise around the table before he walks to the mat and bows on it
cone—box	D walks counterclockwise around the cone before he throws the ball into the box
mat—table	D walks to the mat and bows on it before he jumps on the table
mat—cone	D walks to the mat and bows on it before he walks counterclockwise around the table
mat—box	D walks to the mat and bows on it before he throws the ball into the box
box—table	D throws the ball into the box before he jumps on the table
box—cone	D throws the ball into the box before he walks counterclockwise around the table
box—mat	D throws the ball into the box before he walks to the mat and bows on it

Tab.2: List and description of the action sequences and the dog´s expected action

2.3.3 Testing sessions with untrained objects and actions

This testing phase was twofold and it focused on the dog's ability to transfer the copy command to new actions on known objects as well as on new objects. The test condition of a “pantomime action” is a novel action for which the target object is just partly visible. Test trials were interspersed and were shown twice during one test session. Each session was shown only once to see the spontaneous response of the observer dogs. All demonstrations were shown by Monty, whereas in some cases the demonstration was shown by the human model as well as by the dog demonstrator. Thus in some cases the observer dogs saw twice in the same session.

New actions

The set up was the same as described earlier and test trials were interspersed between trained actions. Objects were already known from the training, but during this test condition, the demonstrated actions differed from the learned ones. For example, the dogs were confronted with a demonstration in which Monty walks around the box, whereas observers had learned for weeks to put a ball into the box. Each demonstration was shown twice: two times in one session, to see observer dogs’ spontaneous response.

Action name	Dog´s (D) expected action
cone left	D walks clockwise around a cone
around box	D walks to a box and then counterclockwise around the box
ball out box	D walks to the box, takes one ball with its mouth and put it in front of the box

Tab.3: List and description of the new actions shown at the known objects and the expected response of the observer dog for successful correspondence.

New objects

In this testing phase, test trials consist of actions with new objects. Due to space limitations, one already known object was replaced with a new one. The demonstration order was the same as during the other test sessions, whereas the action on the new object had been shown at the order position of the replaced action. Half of the actions were completely novel in that they were not part of the observer dogs' repertoire. The other half was novel in the sense that they were never used in the context of the "Do as I do" training before. For example, all of the tested dogs are trained in agility sport, therefore they know very well how to jump over a hurdle. Furthermore the dogs learned to put a ball in a box during training, but putting something else in the box, for example a rope, is a special case. This action involves two objects—one (the box) was already present and used, and the rope took the place of the ball. Each demonstration was presented twice, two times in one session, to see the dogs' spontaneous response.

Action name	Dog´s (D) expected action
hurdle jump	D walks to the hurdle, jumps on the way there and back twice over it
bell	D goes to the bell (hanging on a string) touches it with its nose so that it makes a noise
nose target	D walks to two smaller cones, touches one with it nose so that it falls to the side
other ball	D goes to a box, picks up a rope (which was lying in front of the box), takes it with its mouth and puts it into the box

Tab. 4: List and description of the actions shown towards trained objects by Monty or the experimenter and the expected response of the observer dog for successful correspondence.

"Pantomime" action

The purpose was to figure out whether the dogs would copy "blindly" the demonstrated action even if this action did not make sense, or if they would instead try to complete the action by "making sense of it" and performing an appropriate and context-specific similar action. The model demonstrated an action for which the object was not fully in place, in this case the hurdle stick was placed on the ground rather than put up. The demonstrator showed a behavior which makes sense only if a "real" hurdle would be present, but the dogs do not necessarily have to jump that high over a stick which is lying on the ground. Two hurdles were present, one in place (functional) and one put down to the floor (non-functional). Monty performed first a demonstration of a "real" jump (over the functional hurdle) and in the second trial performed a 'pantomime action' over the non-functional hurdle (see Tab.5).

Action name	Dog´s (D) expected action
real hurdle	D walks halfway around the hurdle, sits down and jumps over the stick
pantomime hurdle	D walks halfway around the fake hurdle, sits down and jumps in the air over the stick

Tab. 5: List and description of the "pantomime" actions demonstrated by Monty or the experimenter and the expected response of the observer dog for successful correspondence.

2.4 Statistics

For coding the videotaped training and test sessions the program Solomon Coder (version: beta 12.09.04© András Péter) and Microsoft Excel 2007 were used. Attention span (observer dog looks at the demonstrator) from the start of demonstration—the demonstrator is visible and came out from behind the partition wall—to the end ("Do it!" command) was measured for each trial as well. Images were modified, such as cutting the frame or changing the brightness, using the GIMP 2.6 image manipulation program. Observer dogs' attention span towards the familiar demonstrator dog, a novel dog demonstrator and a human demonstrator were measured. The percentage of correct responses with another demonstrator was compared using the Friedman Test and the Wilcoxon Signed Rank Test. These tests were also applied for comparison of correct performances to the demonstrator when nobody gave a copy command or somebody else said "Do it!".

Inter-observer reliability of the analysis was provided by two untrained colleagues. Both coded video clips for attention towards the demonstrator and correct matches of the demonstrated action, and the action of the observer at test. The clips were labeled with the observer dogs' name and the date of testing to exclude some biases. Scorers were asked to code the matches in form of match or no-match and to give comments on the behavior if the match was not the same as that of the demonstrator.

A randomly chosen set of 11 video clips of the three dogs were double coded by two coders, and inter-observer reliability for all variables was high ($r > 0.9$, $P < 0.001$ for each variable).

3 Results

3.1 The "Do as I do" training

One third of the dogs who underwent training reached the test criterion, which was set at 80% correct performance. Three of the participants either gave up or had serious health issues and therefore were excluded. Another two did not give up, but were excluded due to time restrictions. Both participants attended in the training for 14 and 15 sessions, but had either attention or motivation problems. Amy had 19 training sessions, Fenja 11 and Miley 28 sessions before they were tested. Miley attended extensive training in body-oriented actions, but never reached an acceptable level of success. Fenja and Amy stopped working and confused the learned copying of interactions with objects. For this reason, they were excluded from this part of the training.

3.2 Tests with trained objects

3.2.1 The "Do it!" command

In the test condition when another person gave the copy command, two of the three observer dogs performed well. Miley's response was above chance (Wilcoxon two signed test: z=-2.121, p=0.034, N=15) and Amy´s performance was nearly above chance (Wilcoxon two signed test: z=-1.890, p=0.059, N=10). The third observer dog failed in copying the observed actions when somebody else gave the command, but she performed better when no command was given.

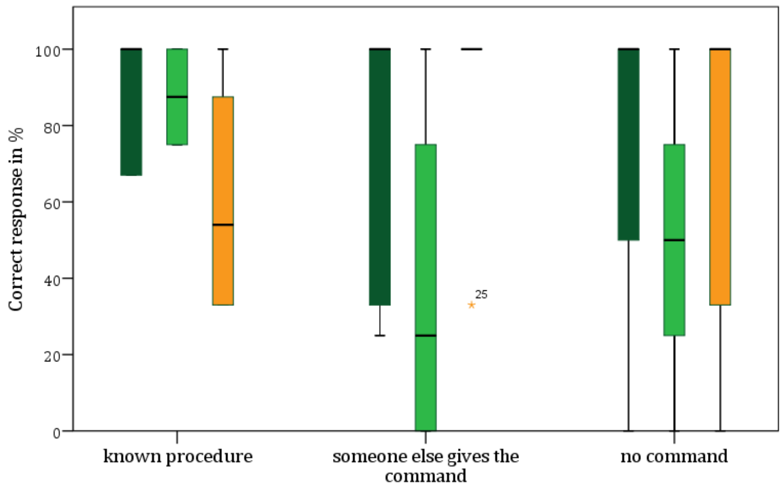

Fig.5: Percentage of correct responses in three different test conditions, with a known demonstrator (Monty), when no “Do it!” command was given and someone else giving the “Do it!” command. The three bars represent the performance of the tested dogs: Dark green Amy, brighter green Fenja, and orange Miley.

3.2.2 Control trials

Control trials were presented in all test sessions with the known demonstrator dog (Monty). Fenja was the only observer dog who in nearly all the cases did not do any action if the demonstrator did not show an action. Amy responded the same way in 47% of the time when confronted with the control trials, and in about one quarter of the cases she put the ball in the box. To some degree Miley’s response was similar. Miley did not show an action by standing still in 58% of the trials, and in 30% of the test trials she ran around the cone. Total numbers of control trials differed because (i) Amy worked with four objects, as opposed to three—resulting in more test sessions—and (ii) Miley was restricted in testing time and missed some tests.

	On top of table	Around cone	matt	box	Did nothing	In total
AMY	11 (13.3%)	6 (7.2%)	5 (6.0%)	22 (26.5%)	39 (47.0%)	83
FENJA	0 (0.0%)	0 (0.0%)	0 (0.0%)	2 (0.4%)	45 (99.6%)	46
MILEY	3 (8.3%)	11 (30.6%)	1 (2.8%)	0 (0.0%)	21 (58.3%)	36

Tab.6: Total numbers and percentages of the observer dogs' responses to control trials interspersed in test sessions.

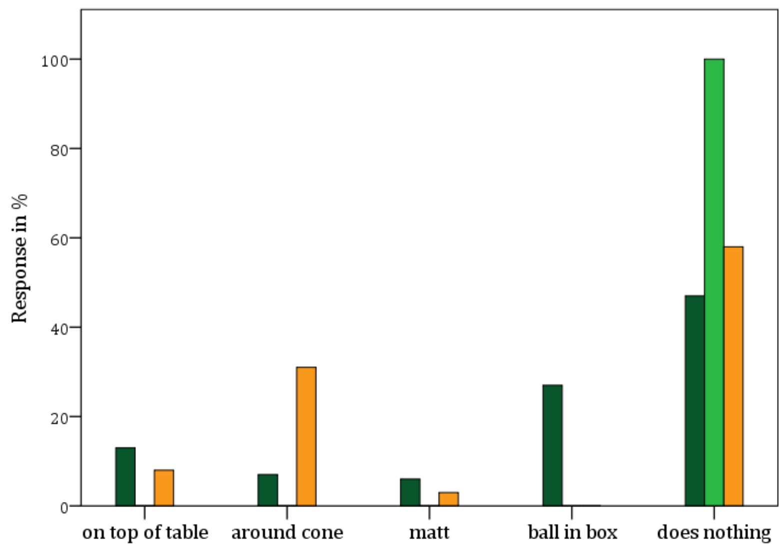

Fig.6: Percentages of observers' response during test situations when control trials are demonstrated. The three bars represent the performances of the test dogs: Dark green Amy, brighter green Fenja, and orange Miley.

3.2.3 Response to another demonstrator

During testing, the observer dogs showed different responses to the new demonstrator. Only one observer dog (Amy) performed above chance in the test condition, in which the known demonstrator was Monty (Wilcoxon matched paired test: z=-2.070, p=0.038, N=15). Fenja's response was close to chance (Wilcoxon matched paired test: z=-1.857, p=0.063, N= 10) whereas

Miley's performance was worse than chance (Wilcoxon matched paired test: z=-0.736, p=0.461, N= 7). Comparisons between groups revealed that there was no significant difference between the test conditions (Friedman test: χ^2= 1.529, p=0.465, N=). Figure 7 shows the percentages of correct performances of the three tested dogs in test conditions. Overall, the performances by Amy and Fenja with a "new" demonstrator (Michel or experimenter) were lower than with the known demonstrator. Performance ranged from 0 to 100% of correct response. On average, the correct response with the known demonstrator was 84.23%, with another dog 63.33% and with a human demonstrator 54.63%. Miley was outstanding and was not performing over chance when the known demonstrator showed the actions, and surprisingly the correct response was even higher and above chance when another dog was showing the actions (Wilcoxon matched paired test: z=-2.032, p=0.042, N= 15). Miley was not tested in the third condition due to time limitations caused by being pregnant.

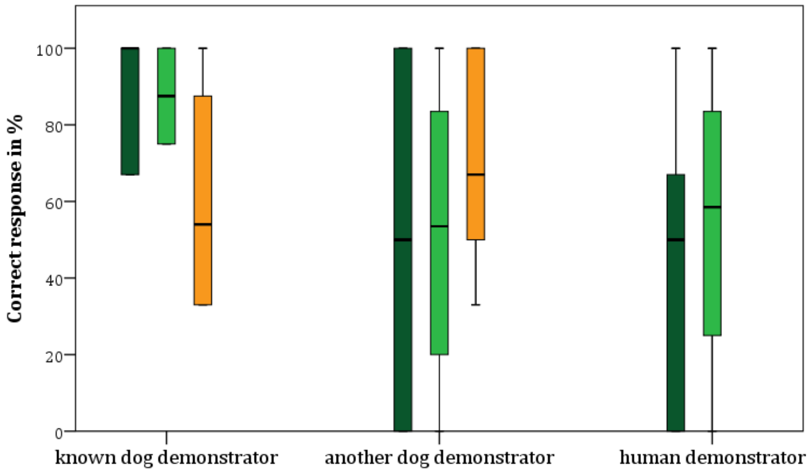

Fig.7: Percentage of observer dogs' correct performance during test trials with different demonstrators. The three bars represent the performance of the test dogs: Dark green Amy, brighter green Fenja, and orange Miley.

The attention span toward the demonstrator fluctuated depending on the action presented and the demonstrator used. In figure 8 the individual attention level towards the three different demonstrators (Monty, Michel, and experimenter) is shown. During control trials the attention of nearly all observers decreased dramatically, approaching zero (not shown here). On average, in 92% of the entire demonstrations, observer dogs were attentive towards the familiar demonstrator (Monty), 82% with another dog (Michel) and 79% with a human acting as the demonstrator. Attention toward the known demonstrator was constantly high and with a "new" conspecific demonstrator (Michel) the attention level showed an increasing trend. When the human acted as demonstrator, Fenja responded attentively in a similar pattern as with another dog, whereas right from the beginning Amy showed an overall high response (during the first three trials, she was 100% attentive towards the human).

The performances of the demonstrators differed in respect to duration. The demonstrator dog (Monty) showed the actions on average of 5.9±1.8 seconds, Michel performed on average with 10.2±3.7 seconds and the human model acted in 7.9±1.4 seconds. Thus the fastest demonstrations were shown by the dog model Monty and the slowest ones by the other dog, Michel.

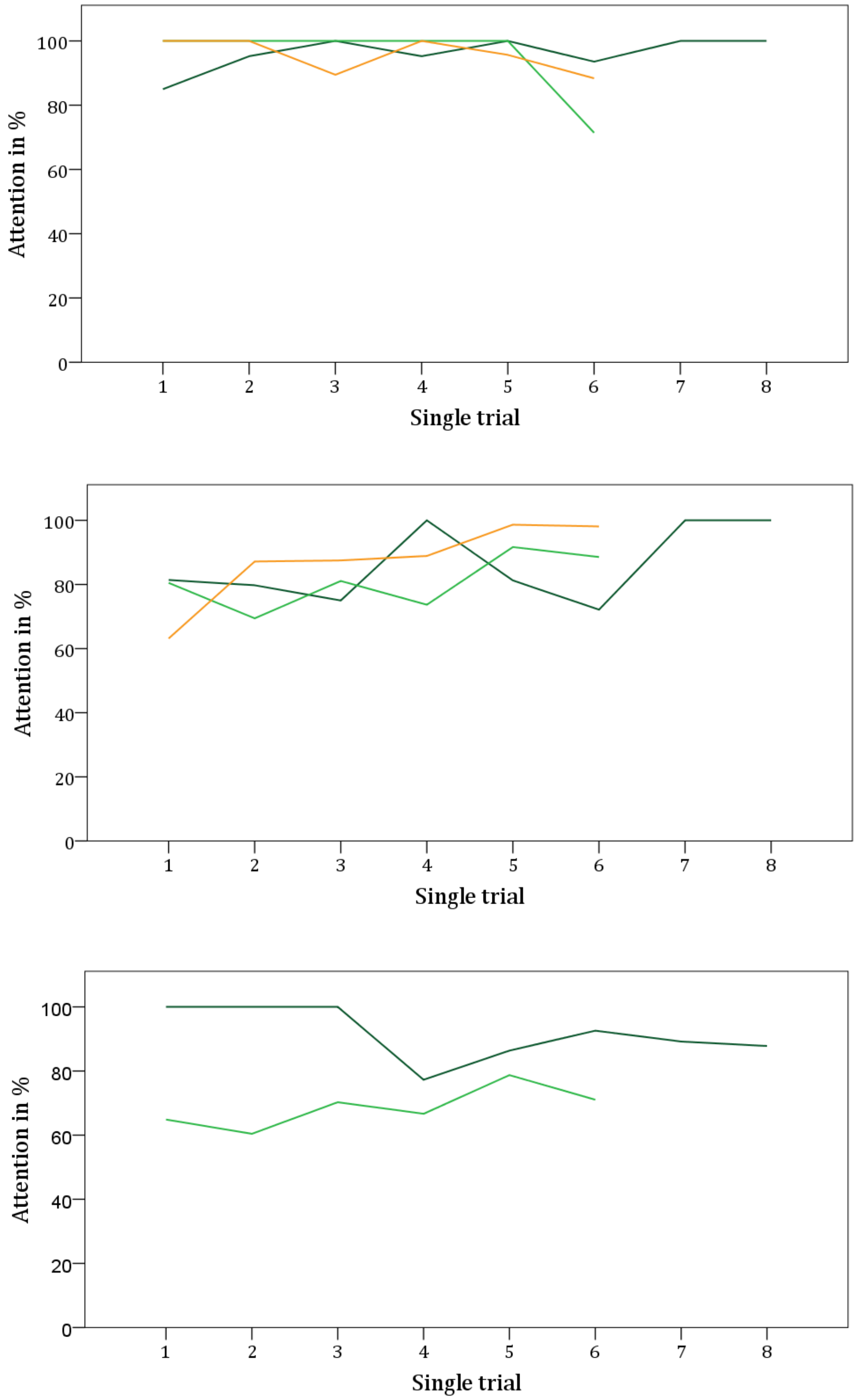

Fig.8: Percentages of observer dog's attention span towards demonstrator during test trials with trained actions shown by (a) a human demonstrator, (b) another dog demonstrator (*Michel*) and (c) a human demonstrator (*experimenter*). Colored lines indicate the observer dogs: Dark green *Amy*, brighter green *Fenja*, and orange *Miley.*

3.2.4 Spontaneous response on action sequences

In the majority of the cases, the response to the action sequences required the dog to copy the action of the last object the demonstrator interacted with. In sum, 26 sequences were presented, from which the observer dogs copied the second part of demonstration 2.5 times more than the first part (first object: action six times copied; second object: action 15 times copied). Only once did a dog show a correct full response to both demonstrated actions, meaning both demonstrated actions were repeated by the observer dog, but only in their outcome, not in the details of the motor pattern. After Monty demonstrated the sequence "table—cone", Amy jumped on top of the table and after one extra copy command she ran around the cone. In another presented sequence ("cone—table") Fenja ran straight to the cone before she made a curve and jumped on the table.

Observer (O)	AMY	FENJA		MILEY
Demonstrator	**Dog**	**Dog**	**Human**	**Dog**
Action name				
table—cone	O jumps on the table and after two extra "Do it!" commands she runs around the cone	O runs around the cone		O jumps on the table, after the first extra "Do it!" she turns around and after the second she bows
table—mat	O jumps on the table and after two extra "Do it!" commands she runs around the cone			
table—box	O runs to the mat and stands on it	O does nothing and after two extra "Do it!" she puts one ball into the box	O puts one ball into the box	O puts both balls into the box
cone—table	O jumps on the table	O runs in the direction of the cone, turns to the left and jumps on the table	O jumps on the table	
cone—mat	O runs around the cone and after one extra "Do it!" she runs again around the cone before she turns around her own body axis			
cone—box	O takes the ball, turns around her own body axis while looking at her owner and puts the ball in the box	O does nothing and after one extra "Do it!" she puts one ball into the box		O puts the ball into the box

Tab.7a: List and description of the dog's spontaneous responses to action sequences performed by a conspecific or a human demonstrator

Observer (O)	AMY	FENJA		MILEY
Demonstrator	Dog	Dog	Human	Dog
Action name				
mat—table	O jumps on the table			
mat—cone	O goes to the mat and after two extra “Do it!” she bows			
mat—box	O puts the ball in the box			
box—table	O jumps on the table	O jumps on the table		O jumps on the table
box—cone	O runs around the cone	O does nothing and after one extra “Do it!” she puts one ball into the box	O puts one ball into the box	O runs around the cone
box—mat	O takes one ball to her owner and after one extra “Do it!” she jumps with the ball in her mouth on the table			

Tab.7b: List and description of the dog’s spontaneous responses to action sequences performed by a conspecific or a human demonstrator

3.2.5 Spontaneous response to new actions on familiar objects

Overall, the observer dogs showed the learned action for each specific object instead of copying the new and unknown action. In all cases, they interacted with the same object as the model during demonstration. They never performed an action with a different object. During the second demonstration (data not shown) there was a case in which the demonstrator took the ball out of the box and put it on a spot not visible to the observer, at one side of the box. Fenja ran to the box, took the other ball out and brought it to her owner. In another demonstration, the model put the ball two meters further away from the box than usual. In this case Miley made a detour to collect the ball rather than going straight to the box.

Observer (O)	AMY	FENJA	MILEY
Demonstrator	Dog	Dog	Dog
Action name			
cone right	O runs counterclockwise around the cone	O runs counterclockwise around the cone	O runs counterclockwise around the cone
around box	O puts the ball into the box		
ball out box	O runs around the box	O puts the ball into the box	O puts the ball into box

Tab.8: List and description of the spontaneous responses to new actions shown at known objects

3.3 Tests with novel objects

3.3.1 Spontaneous response to novel objects

One observer dog, Miley, copied all actions with the exception that the experimenter gave an extra copy command in the "nose target" condition. Amy copied the outcome in two out of four correct. The action "hurdle jump" was copied from a dog demonstrator and touching the bell was demonstrated by a human model. Test trials with the "nose target" or "another ball" were not copied, instead in both cases she went to the new object location. A similar response was given to the novel ball, which was put into the box instead of the known one. She went to the box and took the new ball out of the box. Contrary to Amy's responses, Fenja showed a clear preference for copying actions demonstrated by the known demonstrator dog. With the human demonstrator, in all test trials she showed previously learned actions, e.g. running around the cone in the "bell" condition or running around one of the small cones in the "nose target" condition. Overall, she did not match the presented actions on new objects and showed a preference of showing pre-trained actions (e.g. jumping on the table). All observer dogs jumped on first reaction over the hurdle, even after the owner of Fenja offered help by pointing to the hurdle, with Amy jumping just one way. Both Amy and Fenja failed when the human demonstrated the action.

observer (O)	AMY		FENJA		MILEY
Demonstrator	**Dog**	**Human**	**Dog**	**Human**	**Dog**
Action name					
hurdle jump	O jumps one way over the hurdle	O does nothing and goes behind the partition wall to the human demonstrator	O jumps after two extra “Do it!” commands and with help of the owner over the hurdle	O runs around the cone	O jumps over the hurdle
bell	O runs around the cone	O touches the bell with the nose	O does nothing and after two extra “Do it!” commands and with help of the owner she touches the bell	O jumps on table	O touches the bell with the nose
nose target	O goes behind the nose target, looks at her owner and after one extra “Do it!” she goes behind the box	O does nothing and goes behind the partition wall to the human demonstrator	O goes to the nose target, sniffs at them and returns to the owner	O runs around the two cones (as learned for the big cone)	O touches the nose target and after one extra “Do it!” she knocks it over
other ball	O takes the rope, is playing with it and brings it to her owner		O goes to the box, takes the rope out of the box and brings it to her owner		O puts the rope into the box and brings the other one to the experimenter

Tab.9: List and descriptions of the first responses to new actions and objects demonstrated by a dog and human model.

3.3.2 Pantomime action

Most of the responses to the "pantomime jump" were running over the stick that was placed on the ground (the "pantomime hurdle"). Fenja was the only observer dog who jumped only once over the "real hurdle" after she received a demonstration by myself that showed the "pantomime jump".

Observer (O)	**AMY**		**FENJA**		**MILEY**
Demonstrator	**Dog**	**Human**	**Dog**	**Human**	**Dog**
Action name					
pantomime hurdle	O runs over the stick	O stands still, not moving	O runs over the stick	O jumps over the other "real" hurdle	O runs over the stick

Tab.10: Descriptions of the first responses to the "pantomime hurdle".

4 Discussion

This study was built on previous training protocols (Abramson *et al.* 2013; Szucsich 2008; Topal *et al.* 2006) and adjusted for dogs which were confronted with a conspecific instead of a human demonstrator. With this important modification I could show that dogs can be trained to copy another dog on command and that they were able to transfer the learned concept to new actions as well as to different models (conspecific and heterospecific). However, this study also showed that the tested dogs had several problems to copy intransitive actions, action sequences, new actions demonstrated at familiar objects and a "pantomime action". These results were fully in line with previous "Do as I do" studies with dogs and other species, and suggested that using a conspecific as a model for dog observers bears no advantage over using a human demonstrator. The reasons for this somewhat unexpected result are discussed in the following.

4.1 Training

Dogs needed between 11 and 28 training sessions to learn how to copy transitive actions, but they did not reach the test criteria when confronted with intransitive actions. This asymmetric copying fidelity had been described in earlier studies using chimpanzees (Call 2001; Myowa-Yamakoshi & Matsuzawa 1999), bottlenose dolphins (Herman 2002) and dogs (Szucsich 2008; Topal *et al.* 2006; see also Tennie *et al.* 2009). A second reason why they never reached test criteria could be that the training was not precise enough. The transitive training (one step before) focused on interactions and manipulations of objects and it could be that simply the outcome of the action was rewarded (e.g. put ball in box) instead of the detailed behavior pattern. Thus, it is likely that the dogs did not develop a "sense" for observing the demonstrator carefully enough and instead copied the details of the action.

4.2 The "Do it!" command

Test trials focusing on the "Do it!" command underlined how strict the dogs relied on the learned procedure of copying and how pre-training could have had an influence on later performance. Test trials focusing on the "Do it" command were designed to see if the dogs learned the copy command or if the surrounding, the arrangement of the test and the set up triggered their performance. If they had understood the "Do it!" command correctly, they should have copied the observed behavior as well when a different person gave the command and not if no command was given. The session in which no command was given was conducted to see whether the observer dogs needed the command or if the testing area and the procedure (dog model demonstrated an action, observer dog was released with the "Do it!" command) led them to copy. The results suggested the inflexibility of the set up and pointed to how important a precise and detailed training is for an understanding of the copy command. The dogs did not necessarily need the copy command; it was more likely that they associated the room, the arrangements and the demonstrator performance with the copying response. This assumption would be supported by the previous study in dolphins by Herman (2002) in which the dolphin acted at the same time as the demonstrator and was not waiting for the "Do it!" command. It would be interesting to see how the subjects would react in another experimental environment with a more precise training, especially with a more detailed training of copying body movements.

In detail, Miley's performance was best with another person giving the copy command. She was an open-minded dog and was known to be trained by her owner as well as other people. This seems to be the reason why she could adapt so quickly when the command was given by somebody else. Interestingly, she had performed worse with the trainer known from the "Do as I do" training. There are two possible reasons for this response. First, the last training session was 1.5 months before, which was delayed because of her heat and that she was not allowed to work in the first two weeks of her pregnancy. The second reason could be that she was halfway through her pregnancy when she was.

In Fenja's case, the results of the control trials showed that she understood the copy command because she only acted when something was shown beforehand. On the other hand, she was the only one who stuck to a strict execution of the trained actions, meaning she was not copying the new actions on known objects as well as new objects. She was a reliable working dog with learned tricks but was not copying new ones. Her owner was often giving her unconscious hints, e.g. the owner used head nods to indicate the target object and it seemed that Fenja relied on this. Strikingly, in a third of the cases, both Miley and Amy showed a preference to act on one object. In 30.6 % of the control trials, Miley preferred to go around the cone whereas in 26.5% of the cases, Amy put the ball into the box. Both offered an action when nothing was shown and in only half of the control trials they did not show a response. The two Border Collies are trained to offer tricks when they are asked to do something (free shaping), therefore it is questionable whether they really understood the copy command or just adapted another command to their concept of offering actions.

4.3 Type of demonstrator

Correct performance and attention span towards the different demonstrators were compared using one single test session and therefore the findings cannot be generalized. First, it could be that the observer dogs did not learn during training to observe details of the demonstrated actions; it is probable that they have just learned to link a specific action to one object. For example, all observer dogs ran counterclockwise around the cone (as they have learned during training) though the demonstrator showed it the other way around. It could be that they saw to which object or direction the demonstrator (Monty) ran and then repeated the action they had done over and over again during training (see detailed discussion about different actions and objects in 4.4.). A second potential reason for the high fluctuation could be the time span of the demonstrations, i.e. Michel took twice as long as Monty when showing an action.

The attention toward another dog model depends on the way the model demonstrated (Szucsich 2008), and on the rank of the observer. In a detour task it was found that after a demonstration, subordinate dogs showed a better response compared to dogs with a higher status (Pongracz *et al.* 2008). Another study by Pongracz *et al.* (2012) showed that the rank of the subject among its conspecific at home has an influence on its performance. Dominant dogs were more successful in solving a simple two-action task compared to subordinate ones. Dogs live in a complex social life and have to deal with both humans and conspecifics. Due to the domestication process the social structure and activities have changed, which might be paralleled by a decreased attention towards their conspecific (Viranyi *et al.* 2008).

Having a human demonstrator should be discussed on the individual basis. Fenja showed a similar pattern to the other dog demonstrator (constant increase of the attention), while for the first few trials Amy showed 100% attention towards the human demonstrator. The study conducted by Herman (2002) with dolphins showed that the observer did not show a different response towards a conspecific or heterospecific demonstrator, and that the outcome was similarly good. However, studies using dolphins can only in part be compared to dogs' performances, because of the dogs' overall unique role in the human society.

Previous studies showed that in social learning tasks, dogs are significantly more attentive towards a human rather than a dog model (Range *et al.* 2009), which would support Amy's high attention towards the human. Her overall stable attention could also be explained by the domestication process, in which dogs were selected for being highly attentive towards humans (Hare & Tomasello 2005) and were trained from an early age on to pay attention towards humans and react on the behavioral cues of their owners (Serpell 1996).

Taken together we would assume that the higher the attention level, the better the performance, which was not the case with a human demonstrator—the attention level was high but performance was low. The results could be explained by another underlying mechanism (observational conditioning), in which the demonstrator drew the observer´s attention to the object by manipulating it and getting reinforced. Observational conditioning may lead to associative processes while imitative learning is absent (Zentall 2006). The selected attentive behavior towards human or – as discussed in the previous study (Szucsich 2008) – the demonstrator species used in training sessions. In the current study, dogs had never been trained with a human as demonstrator, whereas they received extensive (and rewarded) training with a dog demonstrator. Szucsich (2008) reported the same but inverse—Joy learned during training to observe the human and later in the test situation was confronted with a demonstrator dog for the first time.

4.4 Action sequences

The overall response to the action sequences was poor; only one demonstrated action was copied and this action was usually the second one (58% of the cases). These results are supported by earlier findings and can be explained by a "recency effect" (Huber *et al.* 2009; Szucsich 2008).

In one trial, an observer dog (Amy) copied a whole sequence ("table—cone") even though she did so with help of one extra "Do it!" command. In cases in which the observer dog copied the first action and then waited (not seeming to carry on with the sequence) it received an additional "Do it!" command. Amy's performance could be explained by either the dogs' ability to transfer and extend the learned concept or simply that she heard a second time the copy command and "offered" a random action. Due to the object arrangement, in which the table was placed leftmost and the cone was the only object nearby, the second action after the extra "Do it!" is most likely the one closest to the first object, thus the correct response here is probably just accidental. Evidence for this possible explanation could be found in Amy's response towards the demonstration of "table—mat" in which she acted the same way: "Observer jumps on the table and after two extra "Do it!" commands she runs around the cone".

In cases without an extra copy command it happened that the observer dog simply carried on performing actions. For example, in the test condition of "table—box" Miley put both balls into the box. Results of the previous study (Szucsich 2008) showed a similar pattern which was explained as "Joy was waiting for a response from me after she finished one action and when nothing came she performed another task".

Nevertheless it seems that dogs understood that something was different and new with the demonstrations. Fenja, who was reliable in copying familiar actions, stood still (in one third of the cases) at her place after the first "Do it!" command. This unusual response indicates that maybe the dog was not prepared (trained) to observe and remember two actions in a row which naturally resulted in an extended demonstration time. Thus, it cannot be excluded that dogs are unable to copy action sequences rather that it was the training that should be adjusted.

4.5 New actions and new objects

Interactions with new objects were easier to copy. All observer dogs jumped over the hurdle after a conspecific demonstrated this behavior. In some cases, the dog did not copy the action but remained in her sitting position, which suggests that they understood that something was different. Sometimes the dogs went to the new object and just stood behind it looking at the owner or experimenter. In this case, we can assume that they learned that the target object is the one the demonstrator was interacting with. It is important to note that the new actions should be differentiated on the basis of their novelty. "Novelty is a relative concept and thus it has to be decided how "novel" the action for the subject is" (Miklosi 1999; Whiten & Custance 1996). Novelty is a requirement of imitation whereas this is not an explanation of all cases of true imitation because it is difficult to exclude experimental learning (Russon 1996; but see Huber 1998). Additionally we cannot be sure about the behavioral history of a non-captive animal (Huber 1998); our knowledge is based on reports of the owners. Based on these half of the demonstrated actions were completely novel (e.g. bow) and the other half were already in the behavioral repertoire (e.g. hurdle jump), but never were used in the "Do as I do" training.

Demonstrations of new actions on familiar objects, like "cone right" or "around box", failed because observer dogs were showing the actions they learned during training with the objects. An explanation would be that the training was not detailed enough and often just the outcome (e.g. putting the ball into the box) was important. In this case, one can understand why the observer dogs were simply repeating well-trained actions. Pongracz *et al.* (2003) found that prior experience of a V-shaped fence can have an inhibitory effect on the performance and finding of alternate solution. It seems that regardless of whether the demonstrator ran around the box or put a ball in or out of it, it is important that the model is interacting with the box and how they interact with the box was not important. This association between object and action should also be taken into account concerning the fluctuations in dog's attentive behavior towards the demonstrator. These results suggest that the possible underlying mechanism is not imitation but rather goal emulation or local/stimulus enhancement.

4.6 Special case: pantomime hurdle

The "pantomime hurdle" was designed to investigate whether the dogs would turn a senseless action into a meaningful one, which is to copy an action where the 'target object' is not visible (Huber *et al.* 2009). The set up used here was adapted to the demonstrator dogs' problem to show a pure jump (without hurdle) while having two similar hurdles in the room, one with the rod on the ground and one with a lifted rod. The demonstrator dog needed the "fake" hurdle as a hint to where to jump in the air.

In most cases (three out of five), the observer dog ran over the stick (the non-functional hurdle) which was placed next to the functional hurdle on the ground. Again, this suggests that they learned during training to go to the object that the demonstrator was interacting with. One dog, Amy, didn´t move at all after the "pantomime" demonstration of a human, she remained standing at her position. A possible solution for her response could be that the demonstration was shown by a human and the dogs were taught to copy a conspecific during training. However, in one case Fenja jumped over the functional hurdle and it seemed that she made "sense" of the demonstrated "pantomime" jump. Another possible reason for this response could be a location effect. The functional hurdle was placed in front of the observer dog and was faster and more easily reachable. Finally, Fenja is a highly trained agility dog and is eager to work with objects usually part of this kind of dog sport, which includes with hurdles.

In comparison to the previous study (Szucsich 2008), where Joy jumped over a hurdle placed somewhere in the testing area, the set up used in the current study was slightly different. A human demonstrator is easily "trained" and in Joy's case the human could pretend that she would jump over a hurdle, whereas it is much harder to teach a dog to do so. This testing should be repeated, similar to the test set-up of Szucsich (2008), with one real hurdle and a dog that is not in need of a helping cue to perform a pure "hurdle jump".

4.7 Conclusion

Overall, these findings are in line with previous "Do as I do" studies (Huber *et al.* 2009; Szucsich 2008; Topal *et al.* 2006), but add one crucial element to the understanding of imitation in non-human animals. This study provides first evidence of the dog's ability to copy a conspecific rather than a human model in the "Do as I do" context.

A limit in the copying capacity was found with regard to (a) action sequences, (b) actions directed towards objects that had already been used in the training of different actions, and (c) intransitive actions. The results suggest that — in addition to some imitative tendencies with a few transitive actions —overall the dogs' performances were strongly driven by local/stimulus enhancement, observational conditioning and affordance learning/goal emulation. Clearly, it would need further, more focused training regimes to bring the imitative capacities of dogs to the front.

Further investigations should focus on some critical details of the training. The observer dogs need to learn that copying the movement details is important, not just reenacting the outcomes of actions or grossly repeating actions on the same objects. If dogs are not trained in such a focused way, they would not copy novel movements that are demonstrated toward objects which were already part of their initial training. This study highlights the difficulties of dog imitation, both in terms of the dog's potential and the appropriate training/testing method.

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ACKNOWLEDGEMENT

Ludwig Huber for being my supervisor and personal motivator in times when I did not know how to proceed

Alina Gaugg for letting me piloting and conducting tests with her beloved dog Miley

Lisa Wallis for help in statistics and always having an open ear for critical questions about study designs

Corsin Müller and **Elizabeth Baxter** for their support in English improvement and for useful comments on the work

All the **dog owners** for coming to the lab every week over months

And last but not least the **demonstrator** dogs for being reliable workers who ran around cones, put balls into a box and jumped on a table for about 500 times. Without them the study could have never been conducted!

APPENDIX

I. TRAINED ACTIONS

"Turn"

"Bow"

"On top of table"

"Around cone"

"Ball in box

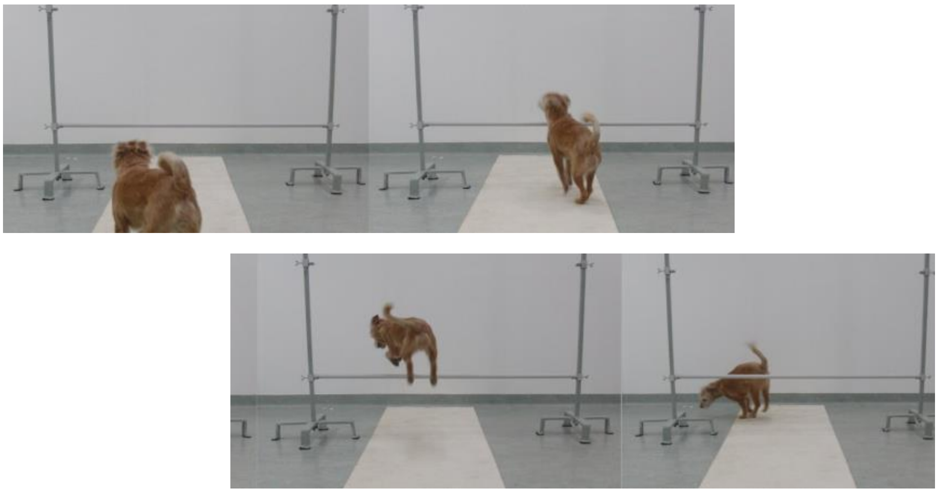
II. NEW ACTION

"Cone left"

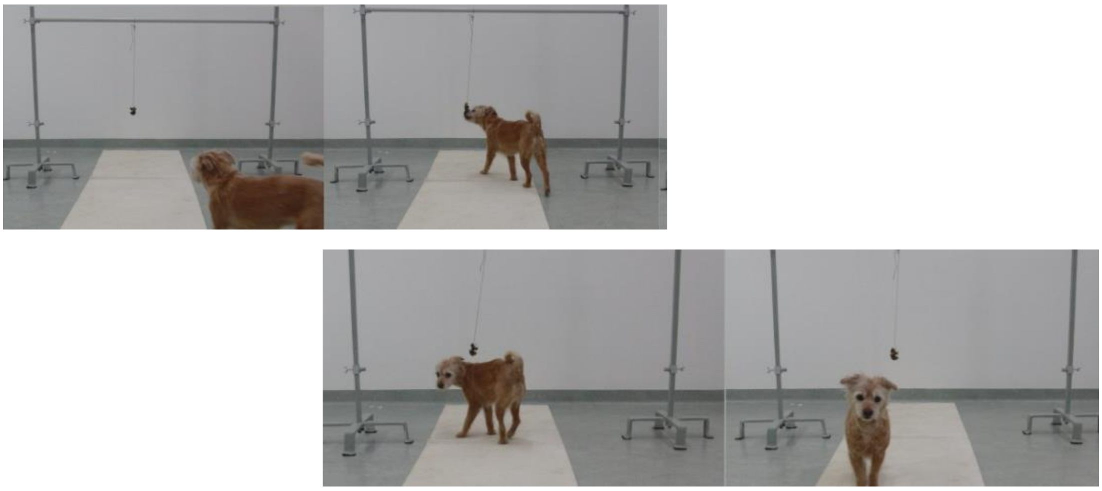
"Ball out of box"

"Around box"

“Hurdle”

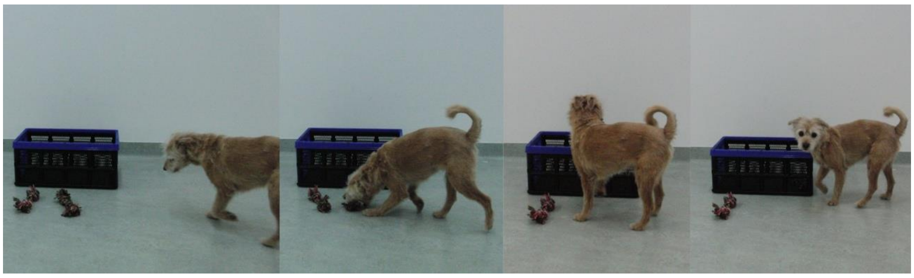


“Bell”



“Nose target”

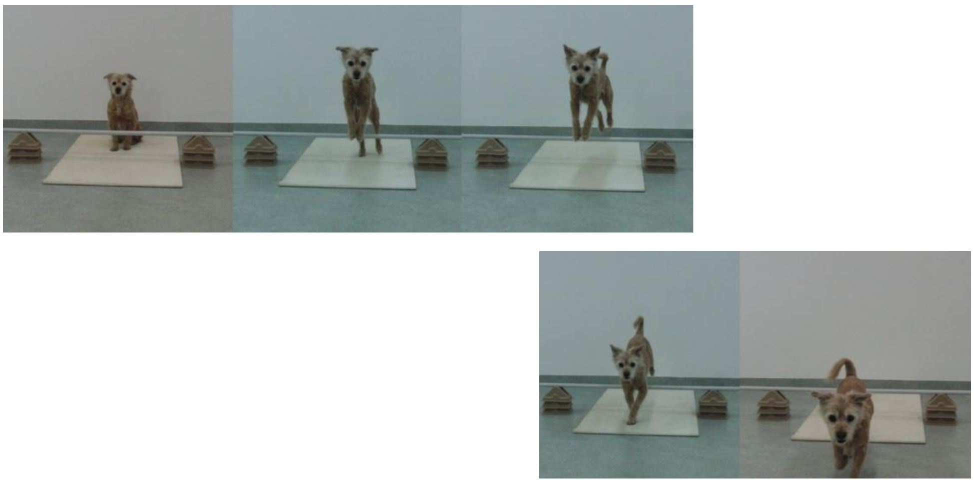
"Other ball



III. PANTOMIME HURDLE

"Pantomime hurdle"

"Real hurdle"



CURRICULUM VITAE
JENNIFER BENTLAGE

PERSONAL DETAILS:

Name:	Bentlage, Jennifer
Place and date of birth:	12.03.1986, Steinheim/ Westfalen, Germany
Nationality:	German

CONTACT:

Permanent address:	Ybbstrasse 38/19, 1020 Vienna
Email:	jennifer.bentlage@gmail.com
Mobil phone:	+43 (0) 680 3336319

EDUCATION:

10/2012 - now	Master thesis "Do as I do—imitation in dogs: learning of transitive and intransitive actions from a conspecific" Supervisor: Prof. Dr. Ludwig Huber Clever Dog Lab, Unit of Comparative Cognition, Messerli-Research Institute University of Veterinary Medicine Vienna, Medical University of Vienna, University of Vienna
10/2010 - now	Master of Science in Behavior, Neurobiology and Cognition at the University of Vienna, Austria
10/2009 - 02/2010	Bachelor thesis "Cost trap for the domestic dog?! Trade off between body size and total reproductive fitness" (2.1) Supervisors: Prof. Dr. Peter Kappeler, Dr. Cornelia Kraus Department of Behavioral Ecology and Sociobiology/ Anthropology
10/2006 - 0 2/2010	Bachelor of Science in Biology at the University of Göttingen, Germany
09/1996 – 06/2005	Abitur at the Herman-Vöchting-Gymnasium in Blomberg, Germany

WORK EXPERIENCE:

07/2013-now	University of Veterinary Medicine Vienna, Messerli-Research Institute Lab assistant of the Clever Dog Lab Providing support with administration of projects and students
06/2012 – now	University of Veterinary Medicine Vienna Provided expertise in dog handling for children during different workshops
04/2012 – 05/2013	University of Veterinary Medicine Vienna, Messerli-Research Institute Video coder of different behavioural and cognitive experiments conducted at the Clever Dog Lab
03/2010 – 08/2010	Eötvös Lórand University Budapest, Department of Ethology Internship supported by the Leonardo da Vinci programme. Research assistant at the Family Dog Project, carrying out research projects with dogs and owners regarding interspecific communication, social relationships and cognition
03/2006 – 08/2006	Alfred Wegener Institute for Polar and Marine Research, Biological Institute Helgoland Internship with the focus on planktology and nutrition physiology of cancer
08/2005 – 01/2006	Animal Pard Net society—an organization for stray dogs in Greece Provided medical care and socialization for stray dogs

LANGUAGE SKILLS:

German (native)
English (fluent) – Certification UNIcert III Scientific English
French (basics)

OTHERS:

Microsoft Office (advanced)
Photoshop (advanced)
SPSS Statistics (basic)

REFERENCES:

JULIE HECHT, MSc

Applied Ethologist

Lab Manager of the Horowitz Dog Cognition Lab at Barnard College, New York

Email: julblue@gmail.com

Dr. ÁDÁM MIKLÓSI

Head of the Department of Ethology at Eötvös Loránd University, Budapest

Email: amiklosi@gmail.com

Dr. CORNELIA KRAUS

Research Scientist at the Department of Sociobiology/ Anthropology at the University of Göttingen

Email: ckraus1@gmail.com