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Is the dog's tendency to overimitate dependent on the relationship to the human demonstrator?

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Submitted by
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Abstract

The field of social learning is extremely versatile and extensively studied by cognitive research. Within this field, overimitation (the faithful copying of a perceivably unnecessary action demonstrated by a model) is a fascinating phenomenon that has so far only been investigated in children, primates and canines. While it is highly prevalent and persistent in children, primates show no evidence of overimitation. For canines the literature shows mixed evidence. While Johnston et al. (2017) and Huber et al. (2018) found half of their subjects copying an irrelevant action, Huber et al. (2020) found much lesser subjects to do so with a stranger as model. It was concluded that dogs copy irrelevant actions if demonstrated by their caregiver but not if demonstrated by a stranger. The present study followed Huber et al. (2018, 2020) and attempted to investigate dog's underlying motivations to overimitate their caregiver. I tested the hypothesis according to which the quality of the dog-human dyad's relationship influences the dog's tendency to overimitate. For this purpose, a study consisting of two tests was conducted. First the overimitation test developed by Huber et al. (2018). Second, a battery of tests developed by Cimarelli et al. (2019), aiming at measuring various components of the relationship between the dog and its caregiver. The overimitation test revealed comparable results to Huber et al. (2018) but the copying accuracy was in general a little lower, probably because the high temperatures in summer negatively affected dogs' motivation/ ability to concentrate or due to minor methodological differences. The relationship test showed results comparable to Cimarelli et al. (2019). As I did not find an association between the components of the relationship and the tendency to overimitate, the hypothesis could not be supported. Still, some interesting associations and grounds for further investigations were detected. Attention towards the caregiver, joint activities including training background as well as play influenced dogs' copying accuracies for the irrelevant and relevant action. Additionally, I have argued that the perceived context and the individual goal might play a considerable role with respect to overimitation.

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1. Introduction

1.1. Background on social learning and imitation

Numerous social species rely on their conspecifics to learn important tasks by observing or interacting with them. This ability, in general referred to as social learning, is an adaptive mechanism and enables animals to learn how to behave appropriately in situations, where the costs of individual learning might be too high (Boyd and Richerson 1988). Prominent examples for such behavioural modifications are predator avoidance, food selection, motor skills, routes to target areas (e.g., for resources) or transmission of complex behavioural sequences (Boyd and Richerson 1988, Pongrácz 2014). An especially interesting species to study social learning and related phenomena is the domestic dog (*Canis Familiaris*) as they do not only learn from conspecifics but also from humans (Pongrácz 2014). They are enculturated in human societies and are mostly considered as family members and companions. Dogs are suggested to live and work together with humans since 18. 000 - 30.000 years (Thalmann et al. 2013). As the oldest domesticated species, they have a stunning ability to understand and read us and outperform other species in interpreting social cues emitted by humans. Therefore, various studies on the (interspecific) social learning abilities of dogs have been conducted within the past two decades reaching from basic perceptual, associative abilities such as visual discrimination (Range et al. 2008) to competences requiring highly complex cognitive capacities such as inferential reasoning (Aust et al. 2008), selective (rational) imitation (Range et al. 2007) and perspective taking (Catala et al. 2018).

In cognitive research, various categories of social learning including for example contagion, social facilitation, local- and stimulus enhancement, observational conditioning and imitation are described (Zentall 2006). Imitation occurring in animals is one of the most controversial topics in this respect. Through imitative learning, it is possible to acquire complex behavioural sequences and it has often been claimed to be uniquely human or, to a lesser extent, present in great apes too. These claims fail to consider that we are missing data from a large part of the animal kingdom. Whether we grant animals the ability to imitate depends on various factors such as the exact definition we choose, the qualitative level of specificity (product- versus process-oriented copying) and the type of imitation (automatic, rational or deferred imitation) we refer to. Different species might show different levels and performance might depend on the

causation underlying imitation specificity (Huber et al. 2009). Without further research we can therefore not conclude that only humans show this ability. However, testing for "true" imitation (Voelkl and Huber 2000) is a complex issue. It is necessary to thoroughly control for lower-level effects such as species typical (contagion), motivational (social facilitation) and perceptual (local or stimulus enhancement) factors that might elicit behaviour matching (Zentall 2006). The results of some studies (e.g., Pongrácz et al. 2012) initially aiming at testing for imitation in dogs could be explained by such effects.

Nevertheless, there is evidence for automatic and even rational as well as deferred imitation in dogs (Huber et al. 2014). Whereas automatic imitation is described as the result of an internal motor representation in the observer of an action, rational imitation comprises flexibility and voluntariness of the imitation mechanism (Huber et al. 2009). Range et al. (2011), for instance, trained two groups of dogs to open a sliding door with their mouth and paw. One group was rewarded for imitating the demonstrator, using the same body part, the other was rewarded for counter-imitating, using the respective other body part. The second group was significantly slower to learn the task which suggests that dogs are subject to automatic imitation. In another study by Range et al. (2007) one dog was trained to demonstrate pushing an apparatus down with the paw. Two groups of dogs were observing this action. One while the demonstrator carried a ball in its mouth and the other while the mouth was not occupied. The authors found that dogs observing the demonstrator opening the apparatus while its mouth was occupied by a ball were less likely to use the paw as well, indicating that the dogs were imitating selectively.

A key requirement of true imitation is enduring representation of the demonstrator's behaviour or "deferred imitation". To test for this requirement the Do-As-I-Do method in which the animals are taught the basic rule to copy whatever the partner demonstrates, is a useful tool. A Weimaraner named Joy that was previously trained with the Do-As-I-Do method showed positive evidence for deferred imitation when she matched a familiar action after 35s delay (Huber et al. 2009). Later, this evidence for deferred imitation was supported by studies with larger samples of dogs (Fugazza and Miklósi 2013, Fugazza et al. 2016). The studies on selective imitation as well as Do-As-I-Do studies suggest that dogs have at least some capacities such as sequence learning and inhibition of automatic copying tendencies, that are required for more complex forms of imitation (Huber et al. 2014).

1.2. The phenomenon of overimitation and its occurrence in dogs

A fascinating phenomenon within imitation is the faithful copying of an action that is irrelevant to reach the goal after observing a demonstrator performing such an action. This phenomenon has been named overimitation by Lyons et al. (2007) and was defined as "imitation of perceivably causally unnecessary actions in relation to the goal of an action sequence performed by a model" in a review by Hoehl et al. (2019). Overimitation was initially discovered in children when comparing imitation in children and chimpanzees (Whiten and Horner 2005). The seemingly irrational behaviour has further been extensively investigated in children and partly in primates and has been found to occur frequently and persistently in children (for review see Hoehl et al. 2019). For example, if a demonstrator was tapping the side of a jar with a feather before opening it and retrieving a toy, children did so as well (Lyons et al. 2007). Underlying reasons, mechanisms and functions of overimitation are to date not fully explored and various possibilities are discussed (Whiten 2019).

According to Keupp et al. (2015) there are three broad types of accounts. Some argue that overimitation occurs due to an automatic tendency to interpret all elements of a demonstrated action as causally relevant. However, this account does not predict the existing context sensitivity and flexibility of overimitation. The occurrence of the phenomenon is for example sensitive to the characteristics of the demonstrator, the goal of the action and the circumstances under which it is presented. In contrast, both other accounts allow to interpret this flexibility and context sensitivity that has already been demonstrated (Keupp et al. 2015, Burdett et al. 2018). Rational normative action interpretation accounts suggest that children are in fact aware that an action is irrelevant but interpret it rather as conventionally than causally essential. For example, in Gergley et al. (2002) children copied a strange solution to an action more often, if the demonstrator would have had another choice than if they had no choice. Others suggest that overimitation is socially motivated (Meltzoff 2007, Nielsen 2006, Over and Carpenter 2013). The irrelevant action is thus performed to affiliate with the demonstrator. In Nielsen and Blank (2011), for instance, the presence and absence of the demonstrator influenced the rate of overimitation shown by children.

So far, no account can fully explain all instances of overimitation by itself. Due to its absence in bonobos (Clay and Tennie 2018), chimpanzees (Whiten and Horner 2005) and orang utans

(Nielsen and Susianto 2010), overimitation was suggested to be uniquely human and evidence for the distinctive nature of human cultural capacity, i.e., an adaptation to life in artefact-rich and causally opaque human cultures. However, humans are not the only species living within these cultures. It has been suggested and supported that the domestic dog, due to domestication, enculturation and co-evolution, might be exceptional regarding overimitation (Johnston et al. 2017, Huber et al. 2018, 2020). Especially in view of affiliation accounts supported for example by Nielsen and Blank (2011), Over and Carpender (2009, 2012) and Huber et al. (2018, 2020) they are a particularly interesting species to study the phenomenon. Dogs benefit from their ability to learn from humans and show many parallels to human children in their social learning abilities. For example, the studies by Gergley et al. (2002) and Range et al. (2007) mentioned above were quite similar in methods as well as in results showing the ability to selectively imitate in both, children and dogs. They have a unique ability to form interspecific relationships with us and, compared to other species, they are much more sensitive to social cues emitted by humans such as pointing and gaze (e.g., Reid et al. 2009, Gácsi et al. 2004, Soproni et al. 2001, 2002). The tendency to overimitate a human demonstrator might therefore be higher in dogs than in primates.

The current experimental evidence shows mixed results on dogs' ability to overimitate. In the studies of Johnston et al. (2017) and Huber et al. (2018) between 50 and 75 % of the participating dogs replicated a causally irrelevant action. Johnston and colleagues themselves argue against the presence of overimitation in dogs, because the number of dogs performing the irrelevant action decreased over trials i.e. the dogs learned that it had no effect. Still, 50 % of dogs, as opposed to 75 % in the first trial, kept copying the irrelevant action until the last trial. Those dogs either failed to learn about the inefficiency of the action or still had reason to perform it. Of course, this is a much lower frequency than we find in children but nevertheless a much higher number than we find in primates. In the study by Johnston et al. (2017) the causally irrelevant and the causally relevant action were both performed on the same object (a transparent puzzle box). They were spatially and temporally close and it could have been problematic for the dogs to identify which part of the demonstration might have been relevant.

Huber et al. (2018) used a different experimental design separating the two actions both spatially and temporally. Additionally, instead of an experimenter, the dogs' caregivers were

asked to demonstrate the actions. Despite the physical separation from the relevant action (and from the reward), half of the dogs copied the irrelevant action at least partly. Interestingly, dogs seem to overimitate selectively. In fact, in a follow up of Huber et al. (2018) dogs' tendency to overimitate has been compared with either the caregiver or an unfamiliar experimenter as demonstrator. With the experimenter as demonstrator nearly none of the dogs copied the irrelevant action (Huber et al. 2020). The importance of familiarity in this context might be a result of lacking attention towards unfamiliar people. Many species, including humans (Corriveau et al. 2009) and dogs (Horn et al. 2013a) have been shown to attend more to familiar individuals and individuals to whom they are attached. However, these three studies have been the only ones so far, to investigate this topic. To explain under what circumstances dogs would overimitate and to what extent they are able to understand this framework, further research is needed.

1.3. Relationship as an important predictor of behaviour

An interesting but rarely studied factor within the topic of imitation and related phenomena such as overimitation is the influence of the quality of the relationship between demonstrator and observer on copying behaviours. Depending on the goal underlying the copying of an action, the relationship between the demonstrator and the observer might play an important role in determining the quality and specificity of imitation. Corriveau et al. (2009) for example showed that children with an insecure-avoidant attachment type relied less on their mothers' claims than children with an insecure-resistant attachment type. According to Ainsworth (1989) attachment is defined as an affectional bond with security and comfort obtained from the relationship. The dog-human attachment is, in this respect, often compared to the mother-infant attachment.

Different patterns of attachment relationship similar to those found between mother and child are found in dogs as well (Miklósi et al. 2004). It has been shown that the caregiver can provide a safe haven and a secure base as seen in human children (Gácsi et al. 2013, Horn et al. 2013a, Palmer and Custance 2008). For instance, dogs' heart rate increase during a stressful situation is significantly lower if the caregiver is present indicating his/her function as safe haven (Gácsi et al. 2013). While the duration of manipulating an apparatus did not increase when the dog was with a stranger instead of alone, it was significantly higher in presence of the caregiver.

This provides evidence for their function as a secure base leading the dog to explore the environment in a more relaxed manner (Horn et al. 2013a). Through referential looking, dogs gain information about the environment and how to behave appropriately. Merola et al. (2012) found a high rate of referential looking and mirroring the caregiver's reaction when confronted with a novel and potentially scary object. Further, dogs show behavioural synchronization with closely bonded conspecifics and humans which means that they are sensitive to other's behaviours and able to adjust their own behaviour accordingly (Duranton and Gaunet 2018).

Importantly, not only social familiarity but the respective quality of the relationship between caregiver and dog has been shown to influence behaviour in various situations. Mongillo et al. (2010) showed that dogs look significantly longer at their caregivers than at strangers and Horn et al. (2013b) found that dogs' attention towards a human depends on the nature of the dog-human relationship rather than on familiarity only. In fact, dogs attended to the same extent to strangers and familiar people but showed higher attention towards their caregiver i.e. the person with whom they share many activities and who mostly feeds them. Other variables suggested to differ among attachment types are distress during separation and greeting afterwards. Rehn et al. (2013) concluded that these variables can be used to understand how dogs experience their relationship with a certain human.

Cimarelli et al. (2016, 2019) found that dogs' reactions to a social threat depend on the caregiver's interaction style and the relationship type. Dogs whose caregivers showed a "warmer" interaction style and dogs with a close relationship (characterized by high affiliation and low stress levels) to their caregiver would more likely retreat from a threatening stimulus, seeking protection by the caregiver. Cimarelli et al. (2019) developed a battery of behavioural tests, mimicking everyday situations to characterize different relationship patterns between dog and human. The paradigm showed promising results in identifying components that are important in this respect and confirms that there is qualitative variability in dog-human relationships. Dogs might in fact overimitate more likely if the caregiver is the demonstrator but still not all of them do so. The varying quality of dyads' relationships could be a possible explanation for this.

1.4. Aim, hypothesis and prediction

To further investigate dogs' underlying motivations to copy or not to copy a causally irrelevant action I conducted an additional follow up of the two studies by Huber et al. (2018, 2020). My aim was to test whether the relationship quality has an influence on the dog's tendency to copy an irrelevant action demonstrated by its caregiver. The previous finding that dogs overimitate their caregiver but not an unfamiliar person already suggests that there is an important social component to this issue. Based on this finding, I hypothesized that the relationship between the dog-human dyad would influence the dog's tendency to overimitate its caregiver. I addressed this question using the relationship test developed by Cimarelli et al. (2019) combined with the overimitation test developed by Huber et al. (2018). Altogether, 64 dogs participated in both tests. After the caregiver demonstrated first the irrelevant action (touching two coloured dots) and second the relevant action (opening a sliding door with a treat inside) the dogs freely moved in the room potentially copying the actions. On the same day after a short break the relationship test including exploration of an unfamiliar area, separation from the partner, reunion with the partner and a novel object test was conducted. I expected that this second test would reveal important components of the relationship similar to those found in Cimarelli et al. (2019) (Reference, Stress and Affiliation). I further expected that those components, that are typically related to a good relationship, (e.g., affiliative behaviours, reference to the partner) would positively correlate with the tendency to copy the irrelevant action.

2. Method

2.1. Ethics statement

The methods used in this study were approved by the institutional ethics committee of the University of Veterinary Medicine Vienna, in accordance with good scientific practice guidelines and national legislation (ETK-03/08/2017 & ETK-19/04/97/2014). All procedures were non-invasive and handling of the dogs always consisted of positive interactions. The caregivers participated voluntarily with their dogs and gave a written consent.

2.2. Subjects

A total of 64 dogs took part in the experiment. Participants were required to be at least one year old, food motivated and naïve to the test-situation. All dogs were family dogs and were brought to the Clever Dog Lab by their caregivers. The caregivers were asked to fill out a questionnaire (Appendix 1) on training history, home environment and daily activities of their dogs. I am not willing to describe the relationship between humans and their pets as a mere ownership. This is why the commonly used term “dog owner” is replaced by the terms “partner” or “caregiver” throughout this document.

2.3. Overimitation test

The overimitation test was conducted in the same way as by Huber et al. (2018). All dogs were tested at the Clever Dog Lab, Vienna. For the test a white wooden plate (150 x 100 cm) was installed to cover a corner in the wall. This plate was modified with a cut-out (6 x 7 cm) covered by a white sliding door (10 x 9 cm) at a central position and 50 cm above the floor (Fig. 1B). The door could be moved within two table tracks (30 cm, one above, one below) via a brown wooden handle (4 cm long, 2 cm diameter) to the left or to the right (9 cm) and revealed a food receptacle. The receptacle could be filled with a sausage or another same sized treat provided by the partner if the participating dog was allergic to the ingredients. A white laminated poster (172 x 106 cm) was mounted at a distance of 130 cm from the sliding door but at the same wall. Two white, A4-sized sheets of paper (standard reprographic paper) with printed colour dots (9 cm in diagonal; one blue and one yellow) were glued to the poster 50 cm above the floor (Fig. 1A).

The testing room (6.0 x 3.3 m) was furnished with three cameras which were mounted at approximately 2 m of height and positioned to record the detailed performance of the dogs during the test. In addition, there was a chair to sit for the experimenter during the demonstration.

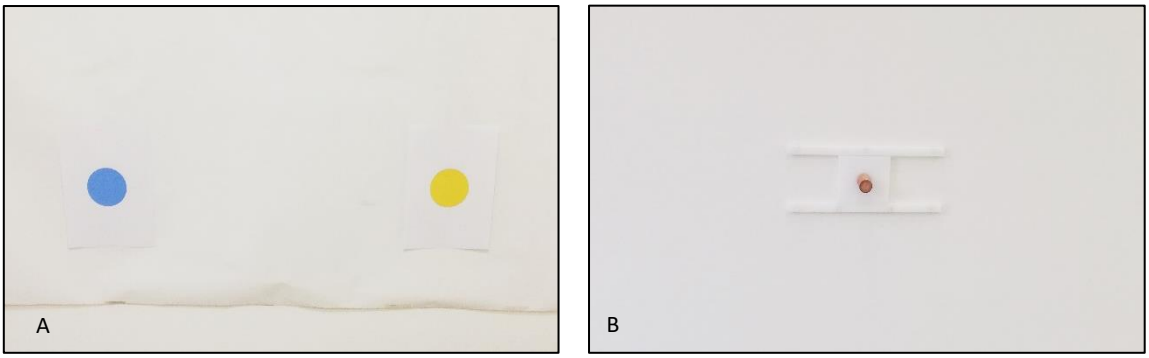

Figure 1: Coloured dots for the irrelevant action (A) and sliding door for the relevant action (B).

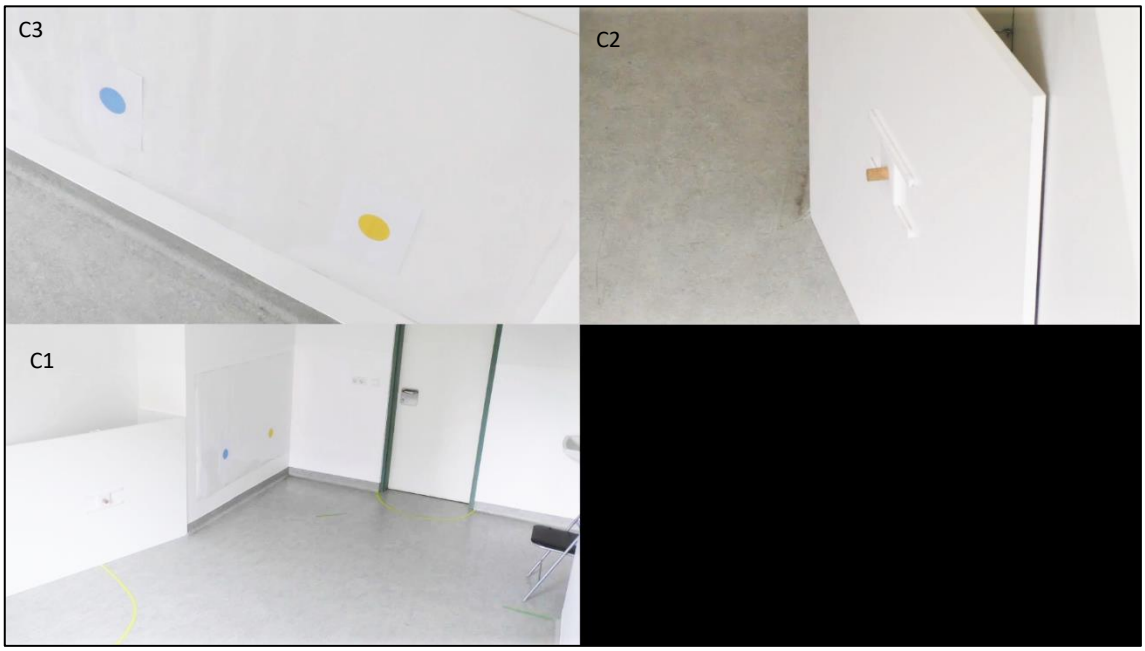

Figure 2: The scenario of the overimitation test as recorded by camera one (C1), two (C2) and three (C3) arranged as seen in figure 3.

The partners of all dogs were instructed via video example and verbally what to do during the test but were not informed about the aim of the study and our predictions. They were asked to behave as naturally as possible. In addition, I asked each partner to touch a plane white paper out of view from the dog prior to the test session which was then glued to the door of the testing

room (170 cm from the observer position). The paper served as a scent control to check whether the dogs would simply follow scent cues left by the partner.

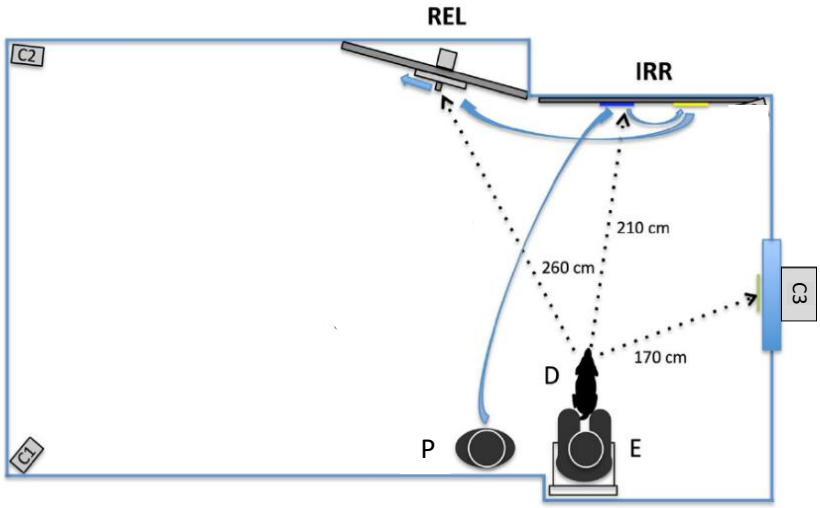

Figure 3: Assembly of the overimitation test. The experimenter (E) sitting on a chair with the dog (D) while the partner (P) is standing beside at the opposite site of the target objects for the irrelevant (IRR) and the relevant (REL) action. Included are distances to all objects and camera positions (C1-3).

To start the test the experimenter brought the dog to the observer position. The dog was on a short leash and the experimenter was sitting behind it on a chair with the partner standing to the left (Fig. 3). When the dog was sitting quietly, the partner fed the dog a treat to gain attention and started the demonstration. It was attempted to show the actions in a dog-like manner by using the same body parts the dog would use. Therefore, the partner got down on hands and knees to touch the dots and open the sliding door with his/her nose. In contrast to Huber et al. (2018) I did not divide the subjects into different groups but only demonstrated the classical overimitation sequence in which the irrelevant action is followed by the relevant action. The demonstration lasted 39.6 s on average (range = 23.5 - 69.5 s). The causally irrelevant action was touching the two, coloured dots, first the blue, then the yellow, with the nose. The relevant action followed after walking to the white wooden wall. Partners got down on hands and knees again and pushed the handle of the sliding door with their noses, opening it to the left. The treat was taken out, shown to the dog and then placed into the food box again (out of the dog's view as covered by the partner's body). After the demonstrator returned to the starting position the dog was released by the experimenter immediately. The dog was allowed to explore the room freely for two minutes and possibly copy the demonstrated actions. Meanwhile the partner was

asked to remain passive. Manipulation of the sliding door as well as touching of the dots was recorded in detail by the cameras in the room mentioned above. One camera captured the whole scenario, one focused on the poster with the coloured dots and one on the sliding door (Fig. 2).

To prevent an influence of scent cues from previously tested dogs I cleaned the poster and the white wooden wall including the sliding door after every session. The A4 sheets with the colour dots were replaced by freshly printed ones for every dog.

2.4. Relationship test

The tests for the relationship between dog and partner were conducted in the same way as by Cimarelli et al. (2019) except for the social threat test which I did not include as it was not used to determine the relationship by Cimarelli et al. (2019). Testing took place in an outdoor area (25 x 13 m) with trees and a ground covered in grass. The area was surrounded by a not opaque, chain-like fence. Subjects were undisturbed by passers-by as they were away far enough and the surroundings were quiet. All tests were recorded with a camera on a tripod.

Figure 4: Arrangement of the four phases of the relationship test. Exploration (EX), Separation (SE), Reunion (RU) and Novel object test (NO).

The test consisted of four sub-tests (Fig. 4):

Exploration of an unfamiliar outdoor area (3 minutes): When the dog and the partner entered the area, the dog was released from the leash while the experimenter closed the gate. The situation aimed at simulating a visit at the dog park. The partner was instructed beforehand to behave as naturally as possible and to walk around in the area without calling the dog or giving commands. Responding to attention seeking by the dog was allowed (looking at or talking to the dog).

Separation (3 minutes): After the exploration phase, the dog was taken to a fenced corner inside of the area by the partner. To allow visual separation, the partner was then hiding behind a blanket at the opposite side of the enclosure. The separation phase started when the partner was behind the blanket and was out of view from the dog.

Reunion (3 minutes): The separation phase ended with the experimenter opening the fenced corner and allowing reunion with the partner who was standing up and moving away from the blanket. The partner was allowed to respond normally to the greeting of the dog but instructed not to call the dog. Additionally, he/she should not re-initiate greeting if the dog stopped the interaction but rather behave as during the exploration. After 3 minutes the dog was leashed and taken out of the area and behind a visual barrier where they stayed for approximately 5 minutes.

Novel object (3 minutes): In the meantime, the experimenter placed a novel object inside the enclosure. The object (either a plastic cube, a children toy tent shaped like a castle, a stuffed hippo or a big bag, all purchased from IKEA) was dangling from a rope (Fig. 5). The rope was thrown over the branch of a tree and held by the experimenter on the other side so it could be moved from the outside and out of sight of the dog. As soon as the experimenter was ready, the dog and its partner entered the enclosure again. The dog was released from the leash to start the novel object phase and the partner was instructed to behave in the same way as during exploration. After 3 minutes the partner leashed the dog again and they left the area.

Figure 5: Objects used during the novel object phase of the relationship test.

2.5. Data analysis

2.5.1. Overimitation test

After the three video streams of the Clever Dog Lab's video recording system were merged, they were used for coding with the behaviour coding software Loopy (© loopbio GmbH). Approaching the wall with the dots (yes or no), approaching the wooden wall with the sliding door (yes or no) sniffing the dots (yes or no), sniffing the sliding door (yes or no), touching the blue dot (yes or no), touching the yellow dot (yes or no), the order of touching the dots (blue > yellow or yellow > blue), pushing the sliding door to the demonstrated direction (yes or no) and pushing the sliding door to the wrong direction (yes or no), were coded. Approaching was defined as getting as close as one meter to the target objects. Sniffing the dots was defined as sniffing somewhere at the white laminated poster the dots were attached to and sniffing the sliding door as sniffing somewhere at the white wooden plate. Only if the dog's nose precisely touched the coloured dot, it was counted as "touching the dot". After the dog was released from the leash in the video, coding was continued for two minutes. The coded variables resulted in two copying fidelity levels for each dog, one for the irrelevant and one for the relevant action. I defined six (0-5) copying fidelity levels for the irrelevant and five (0-4) for the relevant action (Tab. 2). Additionally, the duration of the demonstration (s) and the percentage of time the dogs were looking at their caregivers during the demonstration (attention) were measured.

2.5.2. Relationship test

The recorded videos were coded with the Loopy software (© loopbio GmbH) according to a previously set ethogram (Tab. 1) based on the one used by Cimarelli et al. (2019). As the number of variables coded during the four phases (Exploration, Separation, Reunion and Novel Object) was quite hight, I reduced them by running a Principal Component Analysis (PCA) with Varimax Rotation. Initially, the behaviours were coded separately for each subtest. For the

analysis they were summed up, resulting in nine variables. The variables stress and greeting had to be removed to increase overall explained variance and interpretability. I applied a Bartlett`s test in order to check sphericity and calculated the KMO. To calculate the internal consistency of each extracted component I calculated Cronbach's alpha.

Table 1: Ethogram used for coding the relationship test videos. The frequency of point behaviours and the duration of state behaviours was analysed. The ethogram is based on the one used by Cimarelli et al. (2019).

Behaviour	Type	Definition
Gaze at the partner	State	The dog orients its head towards the partner
Alternation of gaze between the partner and the novel object	Point	The dog's head orientation towards the partner is followed/preceded within 1 s by a look towards the object
Affiliative behaviours	Point	The dog grooms, sniffs, body rubs or licks the partner
Play	State	The dog engages in a behavioural pattern including gently biting, chasing, jumping and wrestling with the partner showing a relaxed body posture and facial expression
Greeting	State	The dog interacts in a friendly and relaxed manner with the partner, holding the ears back, visibly wagging the tail
Fear-related behaviours	Point	The dog shows a crouched body position, tail tucked between the legs or jumps away from the object
Synchronized behaviours	State	The dog moves in the same direction as the partner within 2 s and at a distance closer than 2 meters (i.e. active locomotion, sniffing on the ground, barking)
Stress-related behaviours	Point	The dog shows yawning, body shaking, self-grooming, lips or nose licking, scratching
Marking	Point	The dog urinates, defecates, scent rolls or scratches the ground

2.5.3. Association between the relationship components and copying fidelity

To estimate the extent to which the copying fidelity of the irrelevant action was influenced by the main components resulting from the PCA of relationship test data (Reference, Fear and Affiliation) a cumulative logit link model was used (Agresti 2007). In addition, the age of the dog as well as its copying fidelity of relevant action were included as additional predictors to control for their effects. To avoid 'cryptic multiple testing' and keep the type I error rate at the nominal level of 0.05 this full model was kept with a null model lacking Reference, Affiliation and Fear but being otherwise identical. This comparison was based on a likelihood ratio test (Dobson 2002). The model was fitted in R (version 3.6.3, R Core Team 2020) using the function clm of the package ordinal (Christensen 2019). Model stability as estimated by dropping dogs from the data, one at a time, fitting the full model to the subsets obtained and comparing the

model estimates obtained for these subsets with those obtained for the full data set. This revealed the model of good stability (see results). Collinearity assessed by means of Variance Inflation Factors (VIF; Field 2005) was no issue (maximum VIF: 1.294).

2.5.4. Questionnaire and exploratory analysis

From the questionnaires (Appendix 1) the caregivers filled out in the beginning, I extracted how often they usually play with their dogs and engage in joint activities (e.g., sports and training) with them. For each variable I assigned levels from 0 (no playing/activities) to 3 (daily playing/activities). Questions on training regarded experience with target training, touchscreens, eye-tracker studies and the Do-As-I-Do method. The more tasks the dogs had experience with, the higher the "training status" (0-5). Additionally, the number of dogs living in the household was noted. This data was then used for exploratory analysis. I checked for a possible influence of training status of the dogs, self-reported frequency of play and joint activities, recorded frequency of play from the relationship test as well as the percentage of time dogs were looking at their partners during the demonstration and the number of dogs living in the household on the shown behaviours during the overimitation test using spearman correlation or logistic models. A list of all tests and included variables can be found in Appendix 2.

2.5.5. Interrater-Reliability

While all videos were coded by one main coder, a second person, blind to the aim and the hypothesis of the study was asked to rate 10 % of the videos in order to calculate inter-observer reliability. The same number of overimitation test and relationship test videos was randomly chosen from the sample.

3. Results

A total of 64 dogs have completed both, overimitation and relationship test. Five dogs had to be excluded from the analysis due to demonstrator errors during the overimitation test. A list of the remaining 58 dogs and the copying fidelity levels of both actions can be found in Appendix 3.

3.1. Overimitation

On average, the demonstration took 39.6 seconds and dogs were gazing at their partner for 95.40 % of the time (range = 53.55 - 100 %) showing that attention was relatively high. Four dogs scored a copying fidelity level of zero for the relevant action as well as for the irrelevant action. For both actions the highest percentage of dogs (irrelevant = 29.31%, relevant = 53.45 %) showed a copying fidelity level of two meaning that the dogs approached and sniffed at the target object. In general, looking at the two highest copying fidelity levels for both actions reveals that the copying precision for the relevant action was higher (Tab. 2).

Table 2: Number and percentage of dogs showing different copying fidelity levels for the irrelevant and the relevant action. For the copying fidelities that were shown by most dogs N and % are boldfaced.

Copying fidelity level	Irrelevant action	N (58)	%
0	No action	12	20.69
1	Approaching the wall with the dots	14	24.14
2	Sniffing the wall with the dots	**17**	**29.31**
3	Touching one dot	12	20.69
4	Touching both dots in wrong order	1	1.72
5	Touching both dots in correct order	2	3.45
	Relevant action		
0	No action	4	6.90
1	Approaching the wooden wall with sliding door	2	3.45
2	Sniffing the wooden wall with sliding door	**31**	**53.45**
3	Opening the sliding door to the wrong direction	12	20.69
4	Opening the sliding door to the right direction	9	15.52

In the exploratory analysis I discovered that training status affected opening the sliding door to the correct direction (logistic model, $p = 0.019$) but none of the other behaviours shown. Attention during the demonstration had an influence on the copying fidelity level of both irrelevant (Spearman rank correlation, $p = 0.055$) and relevant (Spearman rank correlation,

p = 0.015) action as well as on approaching the sliding door (logistic model, *p = 0.0347*). Further, the self-reported level of joint activity had an effect on approaching (logistic model, *p = 0.006*) and sniffing (logistic model, *p = 0.016*) the sliding door, sniffing the dots (logistic model, *p = 0.051*) and sniffing door and dots combined (logistic model, *p = 0.051*). The self-reported level of play from the questionnaire affected approaching dots (logistic model, *p = 0.006*) and door (logistic model, *p = 0.009)*, sniffing the door (logistic model, *p = 0.012)* as well as the overall copying fidelity of the irrelevant action (Spearman rank correlation, *p = 0.058*). The observed level of play recorded during the relationship test had no effect on either of those variables.

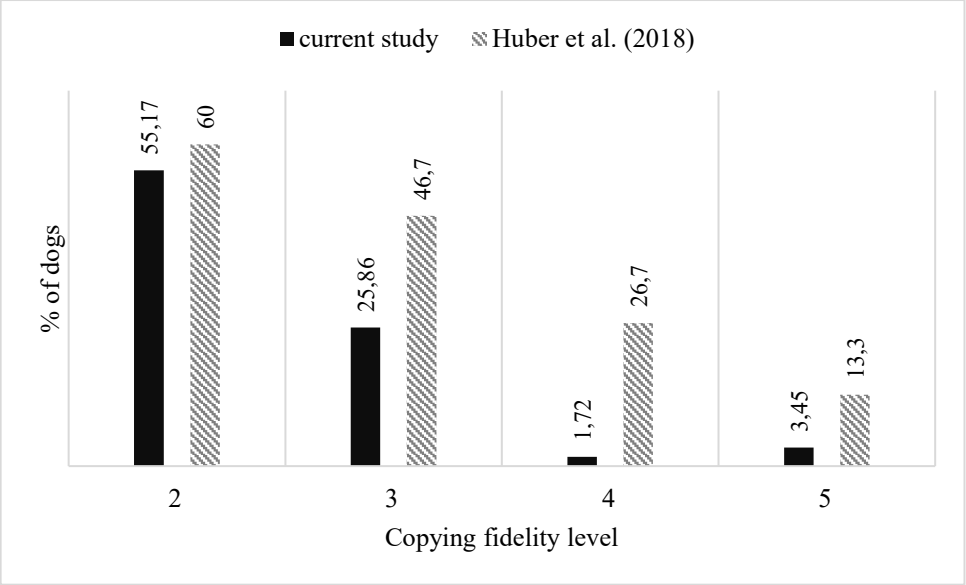

Figure 6: Comparison between the copying accuracy for the irrelevant action in Huber et al. (2018) and the current master thesis project (N (Huber et al. 2018) = 15, N (current study) = 58). For this comparison all dogs with a certain level or higher were included for the level (e.g., level 2 includes all dogs sniffing the wall and those that sniffed the wall and touched one or both dots).

In comparison to Huber et al. (2018) the irrelevant action was copied less precisely in this master project. In Huber et al. (2018) 60 % approached and sniffed at the coloured dots and 55 % did so in my study. However, only 26 % touched one or both dots in the present study in contrast to 47 % in Huber et al. (2018) (Fig. 6).

3.2. Relationship

Based on their eigenvalue (>1), the PCA revealed three main behavioural components that together accounted for 66.94 % of the total variance (Tab. 3). The first component was labelled "Reference" and included the variables gaze at the partner, synchronized behaviour and marking, explaining 34.08 % of total variance (*Cronbach's alpha = 0.65*). The second component contained alternation of gaze between the partner and the novel object and fear-related behaviours. It accounted for 18.12 % of total variance and was labelled "Fear" as these behaviours suggest fear and/or insecurity due to the presence of the novel object (*Cronbach's alpha = 0.46*). The third component was labelled "Affiliation" as it contained affiliative behaviours and play. Affiliation explained 14.75 % of total variance (*Cronbach's alpha = 0.26*).

Table 3: Loadings of all variables for each component. Eigenvalues, Cronbach's alpha and the percentage of explained variance for each component.

Variables	**Components**		
	Reference	Fear	Affiliation
Gaze at the partner	**-0.519**	0.106	-0.132
Synchronized behaviours	**-0.501**	-0.207	-0.307
Marking	**0.474**	0.265	0.212
Alternation of gaze between partner and novel object	-0.334	**0.595**	-0.057
Fear-related behaviours	-0.113	**0.663**	0.226
Affiliative behaviours	-0.235	-0.107	**0.700**
Play	-0.275	-0.267	**0.548**
Eigenvalue	2.385	1.268	1.032
Variance explained (%)	34.08	18.12	14.75
Cronbach's alpha	0.65	0.46	0.26
Loadings for each variable in boldface			

3.3. Association between the relationship components and copying fidelity

Overall, there was no significant influence of the three test predictors (Reference, Fear and Affiliation) on the copying fidelity of the irrelevant action (full-null model comparison: $\chi^2 = 0.323$, $df=3$, $p = 0.956$). Correspondingly, none of the individual test predictors was

significant (Tab. 4). For the control predictors, age did not have a significant effect on copying fidelity, but dogs with a higher copying fidelity of relevant actions also had a higher copying fidelity of irrelevant actions.

Table 4: Results of the cumulative logit link model of copying fidelity of the irrelevant actions (estimates, together with standard errors, significance tests and range of estimates when excluding dogs one at a time).

term	Estimate	SE	z	P	min	max
0|1	0.202	0.893	0.226	0.821	-0.266	0.527
1|2	1.597	0.914	1.748	0.081	1.125	1.922
2|3	3.029	0.956	3.169	0.002	2.593	3.407
3|4	4.936	1.098	4.495	0.000	4.659	5.461
4|5	5.372	1.177	4.562	0.000	5.091	6.184
Reference	-0.029	0.157	-0.184	0.854	-0.085	0.082
Fear	-0.102	0.221	-0.463	0.643	-0.179	-0.026
Affiliation	0.080	0.267	0.297	0.766	-0.146	0.283
Age	-0.062	0.096	-0.645	0.519	-0.114	-0.031
Fidelity_REL	0.891	0.263	3.388	0.001	0.795	0.978

3.4. Interrater-Reliability

For the overimitation test, inter-observer reliability was excellent (Interclass Correlation Coefficient (ICC) = 0.998, $F(173,174) = 1044$, $p < 0.001$).

Depending on the coded variable, the inter-observer reliability for the relationship test ranged from excellent to good (Intraclass Correlation Coefficient, ICC, ranging between 0.62 and 0.991). The ICC, p- and F-values for each coded variable can be found in Appendix 4.

4. Discussion

4.1. Summary of the main results

The results of the overimitation test showed, that while 80 % approached and 55 % of dogs sniffed at the coloured dots, only 26 % touched one or both dots. I discovered that attention during the demonstration had an influence on the copying fidelity of both actions and training status affected opening the sliding door to the correct direction. Further, the self-reported level of joint activity from the questionnaire the caregivers filled out in the beginning affected approaching and sniffing the door, sniffing the dots and sniffing door and dots combined. The self-reported level of play affected approaching dots and door, sniffing the door as well as the overall copying fidelity of the irrelevant action. The PCA of the relationship test data revealed three main components I labelled "Reference", "Fear" and "Affiliation". They showed good overall explained variance and interpretability. Concerning the association, the model did not reveal a significant influence of Reference, Fear and Affiliation on the copying fidelity levels of the irrelevant action. Also, none of the individual test predictors were significant. Age did not affect the response either but dogs scoring higher for copying the relevant action also did so for the irrelevant action. Overall, the hypothesis that the relationship between the dog-human dyad influences the dogs' tendency to overimitate the partner cannot be supported by this study.

4.2. Overimitation results compared to previous studies

Compared to Huber et al. (2018) dogs copied the irrelevant action less precisely. Figure 6 shows that whereas roughly the same percentage of dogs approached and sniffed at the coloured dots, only 26 % touched one or both dots in the present study in contrast to 47 % in Huber et al. (2018). Interestingly, I could find the same kind of difference but to a lesser extent for the relevant action. In both studies around 35 % of dogs opened the sliding door anyhow but in Huber et al. (2018) dogs more frequently opened the door to the correct direction (33 % as opposed to 16 %). Although I tried to replicate the overimitation test precisely, there were minor methodological differences. It is possible that the dogs participating in this study were per chance overall not as skilled in precisely copying an action as those participating in Huber et al. (2018). Also, in their study, the dogs did a short attention test before continuing with the actual overimitation procedure maybe influencing dogs' mindsets somehow. Another explanation for the differing results could be the strong temperature differences during data

collection. The data for Huber et al. (2018) was collected during autumn whereas for this study I tested during late spring and summer. As there is no air condition in the Clever Dog Lab temperatures were mostly very high which could have negatively affected dogs' overall motivation or their ability to concentrate. The fact that the same kind of difference was found for the relevant action supports this suggestion.

For both actions I found the highest percentage of dogs to show a copying fidelity level of two. This means that they approached and sniffed at the target object implying a certain amount of interest. Still, even for the relevant action where the aim was to get food, only 36 % completed the action. This might indicate that the dogs were interested in the objects their partner performed an action on and tried to copy it but could not do it with high precision. In the current study 80 % of dogs at least approached the coloured dots. I did not include a control group that only saw the relevant but not the irrelevant action to check whether there would be a difference in interest in the wall with the dots. However, Huber and colleagues (2018, 2020) already showed that dogs who did not see the irrelevant action being performed hardly showed any interest in the wall with the dots. Therefore, it is unlikely that the dogs would have shown such interest in the wall with the dots if they had not seen their partner doing something there.

Further, compared to Huber et al. (2020) I could still observe a higher tendency to copy the irrelevant action. With an unfamiliar experimenter instead of the caregiver as demonstrator only 27 % of dogs approached and sniffed the wall with the dots and while no dog touched both dots, 18 % touched one of them. For the relevant action the three studies differ to lesser extent. Huber et al. (2020) found 24 % of dogs opening the sliding door as opposed to around 35 % in the current study and in Huber et al. (2018). A possible reason for the strong variance might be the influence of various internal and external factors on the imitative abilities in general. Subtle aspects could interfere with subjects' performances. Konrad et al. (2016), for example, found 6 months-old but not 12-months old infants performing better in imitative tasks after they have slept well the night before. It is not clear what mechanisms underlie the capacity for imitation. With high between and within species variation of imitative competences and levels of specificity, it is discussed whether there is only one or rather a variety of different mechanisms involved (Huber et al. 2009). With the missing insight on the underlying cognitive processes of overimitation in dogs it is difficult to confidently determine the specific reason for the

difference within the two groups that saw their caregiver demonstrating the actions in the same test.

High flexibility and context sensitivity for the occurrence of overimitation have been found in the great number of studies conducted with children. Hoehl and colleagues (2019) argue that the main factors influencing overimitation in children are the motivation to comply with assumed behavioural norms and a wish to affiliate with the model. These factors, in turn, highly depend on how the situation is perceived by the observer and on the characteristics of the model. Unfortunately, we have no way of knowing how the dogs perceive the situation and what their individual expectations and goals might have been. Because most participating dogs were already familiar with the Clever Dog Lab environment, some of them could have been expecting to be trained in a new task instead of being free and allowed to behave independently.

As imitation is a form of social learning, the dogs training history and experience with social learning tasks could be important. The fact that dogs performing better at copying the relevant action also did so for the irrelevant action supports this suggestion. Further, I could find an effect of training status on opening the sliding door to the correct direction indicating an influence of training history on copying precision. In contrast to Huber et al. (2018, 2020) I did not find it to affect any other behavioural variable. Training was found to increase dogs' problem-solving abilities in general (Marshall-Pescini et al. 2008, 2016). We can, therefore, suggest that training can improve their ability to precisely imitate. However, it is not only important if the dogs are trained but also in what way and for what purpose they are trained (Topál et al. 1997, Rooney and Cowan 2011). For instance, training via positive methods instead of punishment increases the learning ability of dogs (Rooney and Cowan 2011). Further research is needed to specify what kind of experience and training would increase dogs' tendency to overimitate their caregiver.

4.3. PCA Components: Reference, Fear and Affiliation

I found that the relationship between dogs and their human partners can be described based on three main components. Although the coded variables were the same, the composition of the components resulting from the PCA is slightly different to Cimarelli et al. (2019). The reason for this is most likely that in their study also dog-dog dyads were tested and included in the analysis. With dogs as partners, the participants were behaving somewhat differently than with

their caregiver. Nevertheless, the components I identified are well interpretable. The first component Reference consists of the variables gaze at the partner, synchronized behaviours and marking. Gaze is an important cue in everyday interactions used to communicate and for social referencing. Nagasawa and colleagues (2015) argue that an oxytocin-mediated positive loop developed during the co-evolution of dogs and humans. The gaze of the dogs at their caregivers elevates caregivers' oxytocin levels which drives them to elicit affiliative behaviours that strengthen the relationship and, in turn, reinforce the gazing behaviour. Also, dogs have been found to be more attentive and to show higher reference towards closely bonded individuals (Horn et al. 2013b, Mongillo et al. 2010, Dunbar and Shultz 2010, Cimarelli et al. 2019). It follows, that gaze can be used as a predictor for relationship quality. Besides, keeping close attention to the partner is important for being able to stay close. As dogs are highly dependent on their caregivers it makes of course sense to do so.

Another function of gaze or attention is the ability to synchronize with the partner. Behavioural synchrony between conspecifics is widespread among social species and has various adaptive values for groups and pairs such as foraging efficiency, social cohesion and maintaining pair bonds. The domestic dog shows all three types of synchrony (temporal, behavioural and local) on an interspecific level with their human partners, probably as means to bond or affiliate with the caregiver (Duranton et al. 2015, 2017, 2018). As my test took place in an unfamiliar outdoor area, dogs might have used social referencing in order to gain information about the novel environment.

The third variable, marking, was negatively correlated with gaze and synchronized behaviours. As marking is often shown by high ranking individuals (Lisberg and Snowdon 2009, 2011) this could be an indicator of dogs exploring the area more independently and confidently, therefore, looking less at their partners and marking more. In Cimarelli et al. (2019) the variable marking was correlated with stress-related behaviours. Another possible explanation is, therefore, that dogs with a more tense relationship who show lower reference and higher stress levels, mark more frequently. However, in the present study I had to exclude the variable stress from the analysis to increase overall explained variance which is why this result could not be replicated in this case.

The second component Fear included the variables alternation of gaze between the partner and the novel object as well as fear-related behaviours. The pairing of these two variables makes sense because dogs often use referential looking in situations of uncertainty, probably as a result of the secure base effect. The secure base effect is not only an essential component of attachment relationships between mother and child but also between dog and caregiver (Mariti et al. 2013, Horn et al. 2013a, Palmer and Custance 2008). For example, dogs often seek humans' help to solve a problem, for instance in the impossible task paradigm (Bentosela et al. 2016, Passalacqua et al. 2011, Lazzaroni et al. 2020) or to acquire information and adjust their behaviour accordingly in the presence of a novel, potentially scary object (Merola et al. 2012) or a stranger (Duranton et al. 2016). It is not fully clear what the variable fear itself tells us with respect to the relationship quality as literature on fear mainly focuses on welfare implications and behavioural problems resulting from it. That is of course not to say that a negative relationship would not elicit fearfulness in dogs. However, fearful responses to the novel object were in general low while referential looking was frequently performed by the dogs during the present study and represents an important factor.

The third component Affiliation included the variables affiliative behaviours and play. These variables are likely linked to a positive and strong emotional bond (Payne et al. 2015, Sommerville et al. 2017). It is argued that the types of play behaviour, dogs engage in with their partners, represent relationship patterns in dogs (Rooney and Bradshaw 2003). Further, physiological reactions to affiliative interactions are exceedingly alike in dogs and humans speaking for a similar positive experience in both species (Odendaal and Meintjes 2003). Dunbar and Shultz (2010) have further discussed how gaze, behavioural synchronization and affiliative behaviours are linked and how they are indicators for relationship quality. It is concluded in Dunbar and Shultz (2010) as well as in Cimarelli et al. (2019) that high reference as well as high affiliation to the partner represent a high degree of bondedness or closeness.

4.4. Association between the relationship components and copying fidelity

In the current study I did not find an association between the relationship components resulting from the PCA and the dogs' tendency to imitate irrelevant actions shown by their caregiver. After all, relationships between two individuals are multidimensional and extraordinarily complex constructs. They depend not only on the personal characteristics, but also on ontogeny

and previous social experiences of both parties (e.g., Cimarelli et al. 2016, Brussoni et al. 2000). Pairing this construct with overimitation, which is an exceedingly complex behaviour itself, takes methodological expertise and high thoroughness. On top of that, there is scarce literature on overimitation in dogs as this is only the fourth project related to this issue. Therefore, it is not yet known what factors really are important in this context and how to test for them best. Methodologically, there are different attempts to assess the relationship quality between dog and human such as the Monash Dog Owner Relationship Scale (MDORS) (Dwyer et al.2006) or adapted versions of Ainsworth's strange situation test (Ainsworth 1969). Using a questionnaire-based assessment might have given more structured and straight forward results. However, we cannot rely on those only as they don't reveal much about how the dog really perceives the relationship. Rehn et al. (2013) concluded for example, that the dog's bond is not associated with the level of the caregiver's perceived emotional closeness to the dog assessed via MDORS. Because the relationship test by Cimarelli et al. (2019) has previously shown good results for determining the relationship quality and is based on behavioural observation instead of the caregiver's perception alone, I decided to use this method. Still, during the relationship test, dogs were observed for a short period of time and in specific situations. Only a fraction of their natural behaviour could be captured which is why the subtle aspects that could predict the tendency to overimitate might have been underrepresented.

4.5. Possibly important factors

Although the expected result did not occur, the exploratory analysis revealed some interesting associations that deserve further investigation and the suggestion that overimitation in dogs is socially motivated should not be rejected. An important factor for overimitation but also for social learning in general is of course attention; an individual paying no attention would not be able to learn from the demonstration. The overall attention of the dogs during the demonstration in this study was high but I could still see an effect on the copying fidelity levels of both actions. As the demonstrator always was the dog's caregiver the variation in attention is not merely a matter of whether the person is familiar or not. Rather, it might be a matter of the relationship's nature as shown for example in Horn et al. (2013). Also training seemed to affect copying precision as dogs with a higher training status were more likely to open the sliding door to the correct direction and dogs with higher copying accuracy for the relevant actions also performed

better at copying the irrelevant action. The possible influence of training on overimitation has already been discussed in point 4.2. Training via positive methods does not only increase dogs' learning abilities but also represents a form of joint activity improving the relationship. Deldalle and Gaunet (2014) for instance, found that positive reinforcement is less stressful and related to a higher attentiveness towards the caregiver indicating a more stable relationship. However, I could not detect an influence of the relationship components resulting from our test on attention during the demonstration. Therefore, the variation in attention could simply be a result of individually varying interest in the task itself instead of the relationship.

It has already been mentioned before that context and perception are important for overimitation. The perceived context and the individual goal might dampen the influence of the respective relationship on copying behaviour as means to affiliate i.e., if the dog's goal is not to affiliate but to get the food reward only, the relationship might not influence their behaviour or their attention. However, we cannot ask the dogs about their perception of the situation and their goals. During testing, a considerable number of dogs were not immediately moving towards the objects but waiting for a command or instructions by the caregiver, maybe indicating rather a training context with the goal of learning a new task and pleasing the partner by behaving obedient than a social or playful context with the goal of affiliating with the caregiver. This could be another explanation for the lacking association as the behaviour of dogs perceiving an obedience-based task would possibly be influenced to a lesser extent by the relationship. The presence of such context sensitivity is for example supported by Kerepesi et al. (2015) who found that dogs did not differ in their behaviour towards a merely familiar person versus the caregiver in tasks based on obedient behaviour but did so in situations involving separation from the caregiver or play.

The self-reported frequency of joint activities from the questionnaire the caregivers filled out in the beginning affected approaching and sniffing the door, sniffing the dots and sniffing door and dots combined. The self-reported frequency of play affected approaching dots and door, sniffing the door as well as the overall copying fidelity of the irrelevant action. Due to their influence on different parts of the actions, it seems that those variables might increase dogs' overall willingness to copy the demonstrated actions. Joint activities as well as play are also indicators of relationship quality and there is evidence that play represents the relationship

between dog and human. Sommerville et al. (2017), for instance, conclude that there is strong evidence to support the theory of social cohesion as a function of play in dogs and Rooney and Bradshaw (2003) found that the type of play behaviour reflects relationship patterns in dogs. Also, play with high levels of contact and movement was correlated with caregivers' positive affect (Horowitz and Hecht 2014). Interestingly, the self-reported frequency of play affected four variables whereas the observed frequency of play recorded during the relationship test had no effect on those variables. The reason for this is probably that I rarely observed play during the relationship test. This is because there were no objects to play with in the area but maybe also because the area was unfamiliar to the dogs and exploring was more important than playing in this situation. It is also possible that the dogs were not comfortable enough in the strange environment to start playing as play is usually a sign of a relaxed state (Burghardt 2005) or that it simply was too hot for such an activity as I tested in summer. What we categorize as play is a rather heterogenous behaviour. Bradshaw et al. (2015) for example describe various types of play that are distinctly motivated and are shown under different circumstances. Therefore, it might be interesting to specifically have a look on play behaviours and variants of play in the context of overimitation. It could for example be that more playful dogs in general or dogs engaging in a certain kind of play would show a higher tendency to overimitate.

Other important aspects in identifying different attachment styles in dogs according to Rehn et al. (2013) are stress during separation and greeting behaviour afterwards. Greeting at reunion is an important part of well-functioning relationships and strengthens the social bond between the individuals. Behaviours such as proximity seeking and physical contact but also duration and intensity of greeting can be used as indicators for relationship quality (Rehn et al. 2013). The variables stress and greeting were coded but had to be removed from our analysis in order to increase overall explained variance and are therefore missing in our data. Their possible role as predictors for the occurrence of overimitation cannot be ruled out.

4.6. Conclusion

To conclude, the overimitation test revealed comparable results to Huber et al. (2018) but the copying accuracy was in general a little lower, probably because the high temperatures in summer negatively affected the dogs' motivation or due to minor methodological differences. Future studies should therefore be conducted in environments with mild temperatures to

exclude the possibility of such an influence. Also, I have argued that the perceived context could be important for overimitation. The test could be modified in a way that dogs would perceive a more playful context instead of an obedience-based context.

According to the present results, some aspects of a relationship such as attention, play and joint activities including training background might be more important than others in predicting the dog's tendency to overimitate. Although the results from the relationship test seemed to be reasonable in describing the relationship between the dogs and their human partners, it is well possible that the probably subtle aspects that predict the tendency to overimitate cannot be measured with this method. Therefore, focussing on specific behavioural variables (e.g., play or attention) in more detail would eventually be more suitable to determine dogs' motivations to overimitate their human partners. It would also be possible to combine the relationship test with questionnaires to receive a more detailed picture. Regarding training, a detailed history including not only training status but also methods used for training should be ascertained as they can have a considerable influence on the dog-human bond.

Even though the hypothesis of a link between the quality of a dog-human dyad's relationship and the likelihood of the dog imitating irrelevant actions of the human partner could not clearly be supported by this study, some insights on possible predictors for the occurrence of overimitation in dogs could be gained. However, it remains an exciting task for the field of cognitive biology to further disentangle the underlying motivations that elicit overimitation in our canine companions.

5. Summary

Overimitation (the faithful copying of a perceivably unnecessary action demonstrated by a model) is a fascinating phenomenon that has so far only been investigated in children, primates and canines. While it is highly prevalent and persistent in children, primates show no evidence of overimitation. For canines the literature shows mixed evidence. While Johnston et al. (2017) and Huber et al. (2018) found half of their subjects copying an irrelevant action, Huber et al. (2020) found much lesser subjects to do so. It was concluded that dogs copy irrelevant actions if demonstrated by their caregiver or at least a familiar person, because the task is interpreted as social interaction, but not if demonstrated by a stranger. The present study followed the ones by Huber et al. (2018, 2020), but attempted to investigate dog's underlying motivations to overimitate a human demonstrator. From the previous studies the hypothesis was derived that not only the familiarity, but the relationship quality between the dog-human dyad would facilitate the dog's tendency to overimitate its caregiver. To test for this, two paradigms have been combined in this master thesis. First, the overimitation test developed by Huber et al. (2018) with the caregiver demonstrating an irrelevant and a relevant action. Second, a battery of tests developed by Cimarelli et al. (2019), which included exploration of an unfamiliar area, separation and reunion with the partner as well as a novel object test. The overimitation test revealed comparable results to Huber et al. (2018) but the copying accuracy was in general a little lower, probably because the high temperatures in summer negatively affected dogs' motivation / ability to concentrate, or due to minor methodological differences. The relationship test showed results comparable to Cimarelli et al. (2019). However, due to a lack of association between the components of the relationship and the tendency to overimitate, the hypothesis could not be supported. Still, some interesting associations and grounds for further investigations were detected. Attention towards the caregiver, play, as well as joint activities including training background influenced dogs' copying accuracies for irrelevant and relevant action. Additionally, I have argued that the perceived context and the individual goal might play a considerable role with respect to overimitation.

6. Zusammenfassung

Überimitation (das gewissenhafte Nachahmen einer wahrnehmbar unnötigen Handlung, die von einem Model demonstriert wird) ist ein faszinierendes Phänomen, dass bis jetzt nur bei Kindern, Primaten und Caniden untersucht wurde. Das Verhalten ist bei Kindern stark ausgeprägt, konnte bei Primaten aber noch nicht beobachtet werden. Was die Caniden betrifft, finden wir gemischte Ergebnisse in der aktuellen Literatur. Bei Johnston et al. (2017) und Huber et al. (2018) kopierte circa die Hälfte der Tiere eine unnötige Handlung, während viel weniger Individuen das gleiche Verhalten bei Huber et al. (2020) zeigten. Dies bestätigte die Hypothese von Huber et al. (2020), dass Hunde eine irrelevante Handlung vornehmlich dann kopieren, wenn sie vom Hundehalter demonstriert wird, weil sie die Aufgabe als eine soziale Interaktion verstehen, viel weniger wahrscheinlich aber, wenn sie von einem Fremden demonstriert wird. Als Folgestudie zu Huber et al. (2018, 2020) hatte diese Masterarbeit zum Ziel, die zugrundeliegende Motivation der Hunde für Überimitation weiter zu erforschen. Die Hypothese, dass die Beziehung zwischen Hund und Mensch, mehr als nur Bekanntschaft, Einfluss auf die Tendenz des Hundes zur Überimitation hat, wurde getestet. Dazu wurde eine Studie, bestehend aus zwei Tests durchgeführt. Erstens testete ich Hunde entsprechend der Überimitations-Prozedur, welche von Huber et al. (2018, 2020) entwickelt wurde. Dabei wurde der Hundehalter als Model gebeten, eine Handlungssequenz bestehend aus einer irrelevanten und einer relevanten Handlung zu demonstrieren. Zweitens führte ich den Beziehungs-Test von Cimarelli et al. (2019) durch. Dieser Test inkludiert das Erkunden eines unbekannten Areals, Trennung und Wiedervereinigung mit dem Halter sowie einen „Novel-Object-Test“. Der erste Test zeigte vergleichbare Resultate zu jenen von Huber et al. (2018). Die Genauigkeit der kopierten Aktionen war jedoch geringer, was wahrscheinlich daran lag, dass die hohen Temperaturen im Sommer die Motivation bzw. Konzentrationsfähigkeit der Hunde negativ beeinflusst haben. Der zweite Test zeigte ebenfalls gute Ergebnisse, nämlich vergleichbar mit jenen von Cimarelli et al. (2019). Allerdings konnte keine Korrelation zwischen den Komponenten der Beziehung und der Tendenz zur Überimitation gefunden werden. Daher konnte die aufgestellte Hypothese nicht unterstützt werden. Trotzdem wurden einige interessante Assoziationen und mögliche Grundlagen für die weitere Forschung entdeckt. Aufmerksamkeit dem Halter gegenüber, gemeinsames Spielen sowie gemeinsame Aktivitäten inklusive Training beeinflussten die Genauigkeit beim Kopieren der irrelevanten und der

relevanten Handlung. Zusätzlich wurde argumentiert, dass der wahrgenommene Kontext und das individuelle Ziel des Hundes im Zusammenhang mit Überimitation eine wichtige Rolle spielen könnten.

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8. List of tables and figures

9. Appendix

Appendix 1: Questionnaire the caregivers filled out before participating in the study. The document language is german as all participants were german speakers.

1. **Training:**
    a. Hat der Hund Erfahrung mit “Target Training“ also Dinge mit der Nase berühren? Ja Nein
    b. Hat der Hund Erfahrung mit Touch Screen Studien am Clever Dog Lab?
        Ja Nein
    c. Hat der Hund Erfahrung mit Eye Tracker Studien am Clever Dog Lab?
        Ja Nein
    d. Hat der Hund Erfahrung mit der „Do as I do“- Methode (vorgezeigte Bewegungen/Handlungen nachahmen)
        Ja Nein
    e. Ist/war der Hund Teil der fMRI-Studie am Clever Dog Lab?
        Ja Nein
2. **Wie alt ist Ihr Hund?**

3. **Umfeld des Hundes**
    a. Leben noch andere Hunde im Haushalt
        Ja Nein
        Wenn Ja wie viele:
    b. Wie viele Personen Leben im Haushalt

    c. Von welcher/n Person/en wird der Hund betreut/ Wer ist verantwortlich
        Nur Ich Ich und mein Partner alle Familienmitglieder
    d. Wie oft spielen Sie mit Ihrem Hund?
        Nie manchmal regelmäßig täglich
    e. Wie oft und warum gehen Sie mit Ihrem Hund spazieren?
        Nie nur wenn notwendig (Gassi/Tierarzt etc.) regelmäßig täglich
    f. Wie oft finden gemeinsame Aktivitäten statt? (Training, Sport, etc.)
        Nie manchmal regelmäßig täglich

Appendix 2: All tests of the exploratory analysis and which variables were included. The tests that revealed significant result are boldfaced. I checked for an influence of training, self-reported frequency of play (SR play), self-reported frequency of joint activity (SR activity), frequency of play recorded during the relationship test (REL play), the percentage of time dogs were looking at their partner during the demonstration (attention) and the number of dogs living in the household on the copying accuracy of the irrelevant (IRR) and the relevant (REL) action as well as on specific behavioural variables shown during the overimitation test. Door all refers to the combination of approaching, sniffing and opening the door and dots all to the combination of approaching, sniffing and touching the dots.

training	**SR play**	**SR activity**	**REL play**	**attention**	**Nr. of dogs**
		Spearman Rank Correlation			
IRR	**IRR**	IRR	IRR	**IRR**	
REL	REL	REL	REL	**REL**	
dot touching	dot touching	dot touching			
door right					
		Logistic Models			
open door	open door	open door	open door	open door	open door
touch one dot	touch one dot	touch one dot	touch one dot	touch one dot	touch one dot
door right	door right	door right	door right	door right	door right
one dot + door	one dot + door	one dot + door	one dot + door	one dot + door	one dot + door
approach door	**approach door**	**approach door**	approach door	**approach door**	approach door
approach dots	**approach dots**	approach dots	approach dots	approach dots	approach dots
sniff door	sniff door	**sniff door**	sniff door	sniff door	sniff door
sniff dots	sniff dots	**sniff dots**	sniff dots	sniff dots	sniff dots
sniff both	sniff both	**sniff both**	sniff both	sniff both	sniff both
door all	door all	door all	door all	door all	door all
dots all	dots all	dots all	dots all	dots all	dots all

Appendix 3: List of the dogs participating in both tests and copying fidelity levels of irrelevant (IRR) and relevant (REL) action.

Nr.	Name	Sex	Breed	birth_date	IRR	REL
1	Majka	F	Mix	01/01/2016	0	3
2	Loki	M	Australian Shepherd	09/04/2017	2	2
3	Benny	M	Border Collie	28/06/2013	0	3
4	Luna	F	Mix	20/05/2013	1	2
5	Bella	F	American Staffordshire	13/11/2015	3	2
6	Gina	F	Shepherd Mix	06/08/2013	1	2
7	Linus	M	Flat Coated Retreiver	07/01/2020	2	3
8	Fero	M	Belgian Shepherd	11/09/2013	1	4
9	Daisy	F	Hungarian Viszla	05/03/2016	1	2
10	Sheila	F	Boer Collie Mix	24/12/2012	3	4
11	Aiko	M	Australian Shepherd	16/08/2011	3	2
12	Toffee	M	Continental Bulldog	01/02/2014	1	2
13	Lara	F	Mix	08/05/2011	2	4
14	Nala	F	Labrador Retreiver	25/11/2016	2	4
15	Senna	F	German Shepherd	25/12/2013	2	3
16	Akin	M	Rodasian Ridgeback	01/04/2009	2	2
17	Ophelia	F	Hungarian Viszla	06/08/2009	5	4
18	Kex	M	Labrador Retreiver	01/08/2013	1	2
19	Shadow	M	Border Collie	14/12/2014	1	3
20	Loki	M	Mix	01/09/2014	1	3
21	Samson	M	Mix (herd protecting dog)	01/06/2010	0	0
22	Vega	F	Border Collie	09/07/2019	0	2
23	Keres	F	Vizsla	03/10/2017	5	3
24	Prim	F	Sheltie	09/12/2015	0	1
25	Casca	F	Mix	25/01/2019	1	1
26	Akyla	F	Old German Shepherd	27/05/2013	2	2
27	Aila	F	White Swiss Shepherd	22/05/2017	2	4
28	Milo	M	Golden Retreiver	22/08/2015	2	2
29	Eva	F	Golden Retreiver	29/05/2017	3	2
30	Leilani	F	Golden Retreiver	22/04/2006	0	0
31	Denis	M	Australian Shepherd	06/02/2010	1	2
32	Patou	F	Pyrenees Mountain Dog	08/02/2016	0	0
33	Ame	M	Akita	16/03/2016	2	2
34	Balthasar	M	Belgian Shepherd	25/11/2014	1	2
35	Aramis	M	Giant Schnauzer	27/09/2012	2	4
36	Danny	F	Mix	20/11/2014	1	2
37	Ben	M	Englisch Springer Spaniel	07/04/2012	2	3
38	Bruno	M	Beagle	12/02/2015	2	3
39	Monty	M	Australian Shepherd	08/05/2019	1	2
40	Asta	F	Border Collie	05/10/2018	0	2

41	Timo	M	Husky Mix	01/02/2019	3	4
42	Cookie	M	Bearded Collie	13/03/2012	3	2
43	Janosch	M	Mix Cocker-Lagotto	16/11/2018	3	3
44	Candy	F	Airedale Terrier	22/05/2019	2	4
45	Blue5	F	Australian Shepherd	15/09/2013	4	2
46	Eyko2	M	Australian Shepherd	14/05/2008	3	2
47	Bolt	M	Mix	14/08/2015	3	2
48	Charly5	M	Spanish Water Dog	25/08/2016	2	2
49	Emma12	F	Labrador Retreiver	08/10/2018	3	2
50	Chomsky	M	Rottweiler	17/12/2015	3	3
51	Bena	F	Mix	13/12/2011	0	2
52	Chivas	M	Sibirian Husky	16/07/2015	2	2
53	Dino2	M	Mix	09/12/2011	0	2
54	George3	M	Bearded Collie	06/12/2015	3	2
55	Balou	M	Labrador Retreiver	12/08/2011	1	2
56	Bela2	F	Mix	01/02/2009	0	2
57	Finley	M	Shetland Sheepdog	11/07/2017	2	3
58	Balu2	M	Mix	01/09/2014	0	0

Appendix 4: What behaviours were coded for which subtests of the relationship-test and inter-observer reliability Intraclass correlation coefficient (ICC) for each coded variable.

Behaviour	**Type**	**Subtest**	**Interrater-rel.**
Gaze at the partner	State	Exploration, Reunion, Novel Object	F (5,6) = 6.3, p = 0.0219, ICC = 0.727
Alternation of gaze between the partner and the novel object	Point	Novel Object	F (5,6) = 41.1 p < 0.001 ICC = 0.952
Affiliative behaviours	Point	Exploration, Reunion, Novel Object	F (5,6) = 5.9 p = 0.026 ICC = 0.709
Play	Point	Exploration, Reunion, Novel Object	F (5,6) = 4.2 p = 0.054 ICC = 0.615
Greeting	State	Reunion	F (5,6) = 9.7, p = 0.008 ICC = 0.813
Fear-related behaviours	Point	Novel Object	F (5,6) = Inf p < 0.001 ICC = 1.0
Synchronized behaviours	State	Exploration Reunion Novel Object	F (5,6) = 141.0 p < 0.001 ICC = 0.986
Stress-related behaviours	Point	Exploration Separation Reunion, Novel Object	F (5,6) = 19.5 p = 0.001 ICC = 0.903
Marking	Point	Exploration Reunion Novel Object	F (5,6) = 221.0 p < 0.001 ICC = 0.991