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Human animal connection in common marmosets (Callithrix jacchus)
Effect of interaction type on performance and preference

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Ethical considerations

This study was approved by the Animal Ethics and Experimentation Board of the Facility of Life Sciences (Nr. 2024-016).

The marmoset monkey lab follows all national regulations and sticks to the guidelines regarding Callitrichidae laid out by EAZA (European Association of Zoos and Aquaria).

Abstract

Humans form connections with non-human animals in various contexts. The type of interaction experienced might influence the impact of such a connection. This study focused on different types of interaction between lab animals and their trainers, in this case common marmosets (*Callithrix jacchus*) at the University of Vienna. Two interaction types were defined, actively training a marmoset (AT) or passively observing (PO). The goal was to see if the interaction type influences a marmoset's performance in a husbandry task (entering a transport box) as well as their preference between experimenters. The study was conducted in two phases, with a reversal of roles within a training pair in phase 2. I hypothesized that the monkey would show a better performance and higher preference with the AT in phase 1. The second phase was conducted to see if the order of exposure of importance to the marmosets, in this case the marmosets should show a better performance and higher preference with the last AT. The marmosets did enter significantly further into the box with the AT in phase 1. Comparing phase 1 and 2 for each role separately, results showed that the latency to enter the box was significantly higher with the PO in phase 2 than compared to phase 1. Regarding the preference test, I could not find any significant preference for one of the experimenters. The results suggest that interaction type influences a marmoset's performance, highlighting its relevance for animal welfare and research outcomes.

1 Introduction

Humans establish relationships amongst themselves on a daily basis. On top of that, relationships with non-human animals have been long part of the human history (Tancredi & Cardinali, 2023, e.g. dogs). The formation of such a connection can occur in various contexts, for example between a human and his pet, a farmer and his livestock or an animal keeper and zoo animals. Another context where such a connection can be found is in animal research. Depending on handling processes and procedures a great variation of interactions and levels of connections can be found (Hinde, 1976; Neely et al., 2018).

Before diving further into the topic, some clarifications regarding key terms. First, all non-human animals will be referred to as animals throughout the paper. In addition, three key terms require clear definitions in this field of interest: human-animal interaction (HAI), human-animal relationship (HAR) and human-animal bond (HAB). Stating clear definitions of those terms is necessary to avoid confusions. Even though these three key terms are in frequent use in this area, their use and definitions vary greatly and there is no real theoretical foundation of the research area (Hosey & Melfi, 2014). The definitions given here are a combination of previous definitions as well as own personal insights (Hinde, 1976; Hosey, 2013; Rault et al., 2020; Russow, 2002). A hierarchical order can be established for these terms, starting with HAI as the most basic and HAB as the most complex-layered term. HAI describes any kind of single interaction between two parties, this can be any kind of physical contact or even just a brief visual contact. The impact level is kept minimal for both parties. HAR is the outcome of repeated HAIs, meaning it describes reoccurring interactions between the same two parties. One or both parties can be affected by this relationship but only to a certain extent. For a HAB a significant impact on both parties must occur, either through a single interaction or a collection of repeated interactions. Since the focus of this project lies with the type of HAI and it is hard to draw a clear line between the terms HAR and HAB, human-animal connection (HAC) is going to be used as a collective term for HAR and HAB throughout the paper.

Studying the formation of HAC and its impact could help with the assessment of animal welfare, as well as give further insight into the performance of study subjects and the reliability of those results (Boivin et al., 2003; Hosey & Melfi, 2014; Rault et al., 2020; Waiblinger et al., 2006; Zulkifli, 2013). It has been observed that HAC can have effects on both parties, while they may vary greatly in their impact and origins (Bayne, 2002; Hosey, 2008, 2013; Russow, 2002).

Carrasco et al. (2009) for example observed several beneficial behavioural changes in captive gorillas when they experienced additional play, encouraged by trainers, next to the training. The changes included a drop in abnormal behaviours and an increase in species-typical behaviour. Furthermore, the gorillas seemed less interested in the visitors and focused more on their conspecifics, displaying more social play and less intragroup tension. Similarly, Baker (2004) detected an improvement in group dynamics (less tense, more grooming) in captive chimpanzees after they were exposed to additional positive unstructured human interactions. These results show that positive HAI can have an impact on animal behaviour even post-exposure.

Since training as well as the experimenters can have a major impact on HAC, gaining further insight on this topic could prove to be a key factor to improve lab procedures and thus animal welfare. Furthermore, as training is a big part of a lab animals' day, especially in behavioural research, it lends itself to make training the focus of such studies. For instance, training methods focusing on aggression reduction and positive reinforcement training in rhesus macaques resulted in less aggressive behaviour towards trainers (Minier et al., 2011). Overall, positive reinforcement training can be seen as a powerful tool to improve animal welfare in captive animals in three areas. Firstly, it can lead to voluntary cooperation by the animals which leads to improved husbandry and medical care. Secondly it can enhance social management by an increase of affiliated behaviours and decrease of aggression. Finally, positive reinforcement training can lead to an improved psychological wellbeing by directly addressing fear and discomfort through desensitization techniques (Laule & Whittaker, 2007).

Revising previous studies regarding training and its impact on HAC and animal welfare, one can see a broad variety of results. Possible reasons for the variance in results are the used taxa as well as other factors such as previous experiences with humans (Rault et al., 2020; Zulkifli, 2013). Captive western gorillas were shown to distinguish between positive familiar, negative familiar and unfamiliar voices and coordinate their behaviour accordingly. They showed more negative reactions towards the negative familiar and unfamiliar voices than towards the positive familiar voices, showing how past experiences with a human can leave a deep impact on a gorillas preference for humans (Salmi et al., 2022).

However, as Bayne (2002) pointed out, one must consider the fact that lab animals are influenced by all activities around them, meaning that not only the way of active training but also their handling and all other activities surrounding them can leave traces. While a study in 2018 detected less depressive-like behaviour in mice after being handled gently compared to aggressive handling (Neely et al., 2018), Lambeth et al. (1997) showed higher wounding incidents in captive chimpanzees during weekdays compared to weekend days. A number of routine procedures such as veterinary procedures or sanitization of the enclosure were conducted during the weekdays, resulting in higher human activity during the weekdays. This shows that even standard procedures and the resulting HAI can have a negative impact on the chimpanzee's welfare. It is important to note here that the HAI mentioned are of different types, some with direct contact between animal and human and some where the humans were merely in the presence of the animals. I propose to describe the former type of interaction as active and the latter one as passive, distinguishing between different type of HAI might be an important factor in this field. In addition, it shows that not all increased human contact necessary leads to an improvement in animal welfare.

The objective of this study was to investigate if the type (active or passive) of HAI has an impact on the animal's performance in a husbandry training task as well as preference towards the experimenters. The study species chosen for this project is the common marmoset (*Callithrix jacchus*). Acquiring further knowledge about the impact of HAC on common marmosets could help improve their handling and experimental procedures, thus influencing their overall welfare. Common marmosets are a commonly used species in animal research and lab facilities (Manciocco et al., 2009; Schiel & Souto, 2017), thus the results of this study could have benefits for a great number of individuals. To my knowledge, training and HAC in common marmosets in the setting of research labs have only been the focus in a limited number of studies. For instance, according to Bassett et al. (2003), common marmosets showed a positive change in their reaction to handling and being removed from the home cage after experiencing increased human contact through training. Another study, investigating the effects of positive HAI on the behaviour of common marmosets, showed significant changes in their behaviour after being exposed to additional positive interactions with familiar caretakers for several weeks (Manciocco et al., 2009). The changes included an increase of play, grooming and affiliative behaviour and a decrease of self-scratching and ‘phee calls’. McKinley et al. (2003) observed an improvement in performance (i.e. decrease in number of training sessions needed) after common marmosets went through extensive training.

Positive reinforcement training can impact an animal’s performance positively during other husbandry procedures and training. However, whether it is the additional time spent with a experimenter or the positive interaction is still unclear (Ward & Melfi, 2013). Hence for this study, I distinguished between two different types of HAI, active and passive. Each type of HAI was allocated to one person within a training pair, i.e. active trainer (AT) and passive observer (PO). While the AT had direct interactions with the study subjects (e.g. target training) the PO, was merely present without engaging in any way with the study subjects.

The study was divided into two phases, whereby the roles of AT and PO were switched in the second phase. For phase 1, I hypothesized that an individual would create a stronger HAC with an AT than with a PO. Therefore, I predicted, that subjects should perform better in the transport box test with the AT then the PO and additionally prefer the AT over the PO in the preference test.

In the second phase, I investigated if it mattered to the marmosets which type of HAI happened first. As this was more exploratory, I had two alternative predictions. If the order of familiarisation does not matter to the marmosets, I would predict no difference in test performance or preference between AT and PO in the second testing round. The alternative prediction would be that the order of familiarisation is of importance to the marmosets. In this case I hypothesised that the stronger HAC is established with the experimenter that interacted last as an AT with the animal. This would result in a better performance in the transport box test and a higher preference for the last AT.

Additionally, the preference test was used to see if the marmosets showed an overall personal preference towards one of the experimenters, disregarding their role, as one cannot exclude the possibility of the experimenter’s identity (Waitt et al., 2002) playing a role in their performance or preference. If the marmosets did show a personal preference for one of the experimenters within a pair, any differences in their performance might be originating from the preference they have for the person rather than the type of HAI. Making this an important part for the interpretation of the results.

2 Material and Methods

2.1.1 Safety precautions

All experimenters read and agreed to follow the AFC agreement and the marmoset monkey lab instructions. Additionally, the experimenters received an introduction visit to the marmoset monkey lab and for every step of the study an experienced trainer was present.

2.1.2 Subjects and Housing

15 adult common marmosets (*Callithrix jacchus*) (6f/9m), kept in the AFC (Animal Care Facility) at the University of Vienna, were part of this project. Two additional individuals, Pasta and Vincent, were excluded from the project. Pasta was excluded due to still being an infant at the time and Vincent due to his long nails that hinder him while walking through the tunnels, The marmosets are housed in three keeping rooms in 6 family groups, each consisting of 2 to 4 individuals. There was no visual contact between the different families, however due to the setup, some families experience partial auditory contact. The marmosets were split into two sets for this project, set 1 and set 2 (Table 1).

Table 1

Husbandry of the common marmosets at the University of Vienna

Set	Room	Family	Individuals
2	1	Aurora	Aurora, Lokri
		Jack, Vaiana	Jack, Vaiana
		Clelis	Bambi, Blinky Bill, Maui
1	2	Feline	*Pasta*, Feline, Kobold
		V-Group	Matilda, Melvin, *Vincent*
	3	Sprichtel	Herr Nilsson, Kiara, Nala, Smart

Common marmosets kept at the University of Vienna ordered by their set, their keeping room, their family and list of individuals (individuals not participating in project marked in cursive).

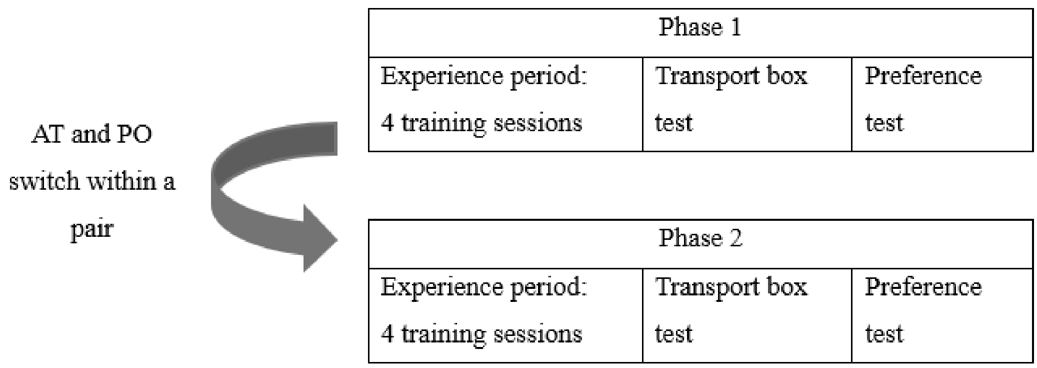
The temperature and humidity in all keeping rooms are controlled and kept constant (24-26°C; 40-70%). The enclosures contain several possibilities for the marmosets to climb and jump around such as branches, hammocks as well as little houses for them to use as a retreat. The floors of the cages are laid out with mulch and spot heating lamps as well as UV lamps are placed in the cages. If the outside temperature allows it, the doors to the outside space of each cage can be opened so the marmosets can additionally use the outdoor enclosure. The marmosets are fed three times a day (morning, noon, evening) and have access to water ad libitum. Their diet consists of vegetables, fruits, animal-based proteins (insects, meat, dairy products and eggs), porridge with vitamin and minerals supplements and gum/ gummi arabicum. During training, additional treats are offered to the marmosets, mostly corn waffles and as an extra incentive fruit.

2.1.3 Experimental design

To investigate the effect an interaction type has on the establishment of a human animal connections, a study over 6 months (February to July 2024) at the University of Vienna Biology Building was conducted. The study was divided into two phases, with each being subdivided into experience period and tests (transport box test and preference test) at the end of each phase (Figure 1). All 15 common marmosets participated in every trial, however due to some external interferences some data points had to be excluded from parts of the analysis.

Figure 1

Study design



The human subjects involved in this study were six master students (experimenters) from the University of Vienna. Shortly before the study started, each one of the experimenters spent an equal amount of time (room 1: 80 min, room 2: 80 min, room 3: 70 min) in the marmosets' keeping rooms to get to know the individual marmosets and to be able to differentiate between each of them. An experienced trainer (e.g. PhD student, animal keeper or a master student) accompanied the experimenters throughout all stages of the study. The experimenters were paired up in the beginning of the study and remained in these training pairs for the duration of the study. Each experimenter within a pair was allocated a role, active trainer (AT) or passive observer (PO), for half of the monkeys (set 1 or set 2) and the opposite role for the other half of the monkeys at the beginning of the study ((Table 1).

Table 1). This allowed to control for training experience of the experimenters. After the first phase was concluded the roles were switched within each training pair. This allowed to control for last experience (active or passive) in contrast to the overall active time.

2.1.3.1 Experience period

The experience period entailed accompanying the PhD student for her training, which was part of a separate cognitive study. Here the AT assisted the PhD student with the training while the PO took notes and kept themself in the background. For each training session the marmosets were led individually from their family group in the keeping room to the experimental room through a tunnel system. This was mostly done by the AT, with the PhD student occasionally assisting. The leading through the tunnel system was achieved by calling the marmosets, offering treats, and presenting a target object. In the experimental room, the PO had a fixed position and kept movement as well as talking to a minimum. The AT guided the marmosets in the experimental room towards the actual training site. The experience period included four trials per individual per phase, resulting in eight trials for each individual in total.

2.1.3.2 Transport Box Test

The transport box test was conducted by each experimenter individually with each marmoset after the experience period of each phase. The transport box test is a routine husbandry task, practiced on a regular basis with the marmosets. In case the marmosets need to be transported (e.g. for vet visits), they are transported in a pet carrier box. A better performance during transport box test meant less time to enter the box along with entering the box further. Each marmoset was individually guided into a smaller cage, called the cubicle, located in the keeping room. The experimenter then led the marmoset towards the entry of the box with the help of a target, and later into the box. The slits on the side of the box were used to enter the target and lead the marmoset into the box and further inside. The slits on the box were numbered from 1 to 16. For this study, the target was only entered through every third slit (3,6,9,15; see

Figure 2). These 4 slits (3,6,9,15) were used as markers to track how far the marmosets entered the box.

Figure 2

Transport Box Test Setup

Transport Box in the cubicle (left) and target through the numbered slits of the transport box (right). Photographs by the author.

2.1.3.3 Preference test

To check for an individual’s preference for a specific human or role, a preference test was conducted with the marmosets. The preference test followed the transport box test at the end of each phase. A marmoset, sitting in the middle of the cubicle, was presented with a treat by both experimenters of a training pair at the same time on opposite ends of the cubicle (Figure 3). One trial was over as soon as the marmoset took a treat from one of the two experimenters or 30 seconds passed without making a choice. The preference test was conducted in 8 trials in 1 session for each individual per phase. To control for a side bias, the experimenters switched sides after every trial. In some cases, the marmoset already moved towards a side of the cubicle before the presentation of the food, in this case I excluded the trial.

Figure 3

Preference test Setup

Before each trial, an accompanying trainer presented a treat to place marmoset in middle of the cubicle; during the trials, both experimenters presented a treat at the same time on the right and left (down). Photographs by the author.

2.1.4 Data collection

The whole study was documented with the help of observation protocols, designed for each part (experience period, transport box test, preference test). The PO filled out the protocols for the experience period. During the tests, the test protocols were filled out by an accompanying trainer (e.g. PhD student). Additionally, camera (Canon legria HF G25; Canon legria HF R806) recordings of the test sessions served as backup.

2.1.5 Analysis

All data processing and analysing was done in Microsoft Excel and R Statistical Software (R Core Team, 2023) using base R and packages including tidyr (Wickham, 2023b), dplyr (Wickham, 2023a) and ggplot2 (Wickham, 2016).

The significance level for all tests was set as $p < .05$.

Data was collected from all 15 marmosets during the study, however due to some external interferences some data points had to be excluded from certain analyses, resulting in varying sample numbers for different analysis (N = *10-15*).

2.1.5.1 Transport Box Test

Variables of interest for the transport box test were the maximum slit entered and the latency to first enter the box. Wilcoxon signed-rank tests were used to check for significant differences between the median scores within several conditions depending on the phase and role of the experimenter.

Additionally, a Wilcoxon signed-rank test was performed to see if there was a significant change in the latency to enter the box as well as the maximum slit entered in the two phases without any regard for the role as well as person.

2.1.5.2 Preference test

Variables of interest for the preference test were the count data of choice made for each role and of choice made for each person. To ensure a more thorough analysis only the first four responses from the preference test for used, as some marmosets did not complete all 8 trials of 1 session due to outside factors (e.g. staff in outside enclosure).

To investigate whether the marmosets show a preference for the AT or PO, Wilcoxon signed-rank tests were conducted to check for a significant difference between the medians of the count data of choices made for active or passive in each phase.

To investigate whether the marmosets show a preference for an individual experimenter within each pair, Wilcoxon signed-rank tests were conducted to check for a significant difference between the medians of the count data of choices made by one marmoset for each experimenter within a pair in each phase.

3 Results

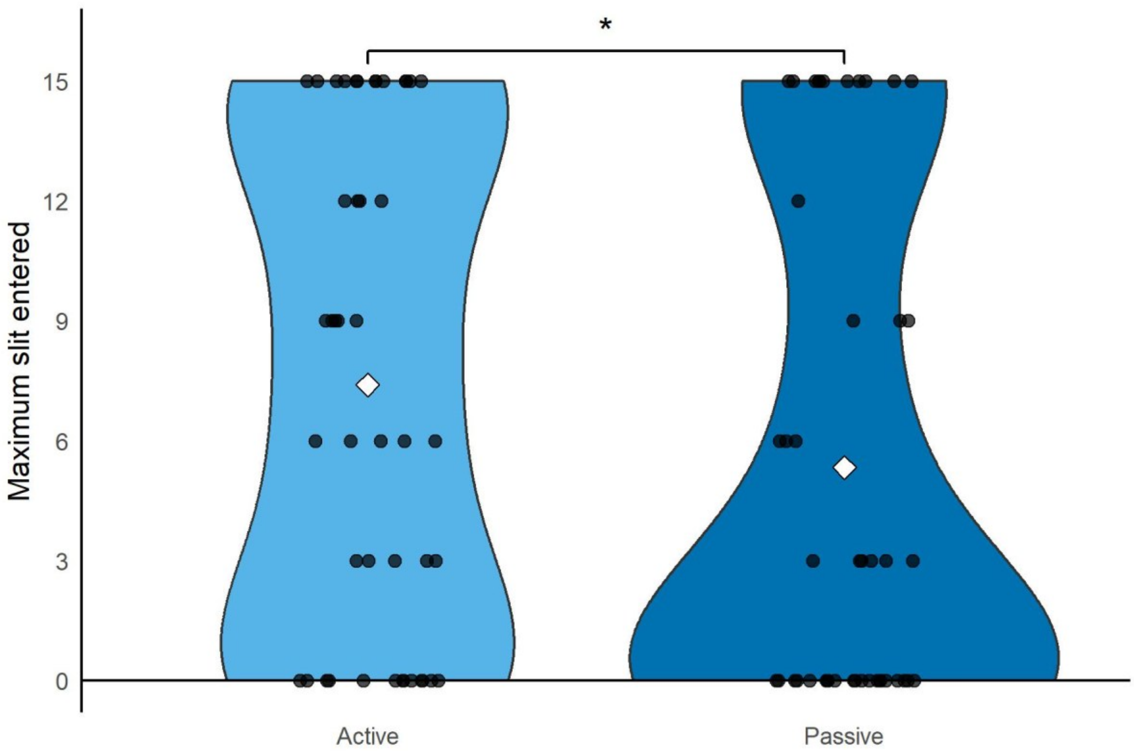
3.1.1 Difference in type of interaction in phase 1

3.1.1.1 Transport Box Test

The maximum slit entered with the AT and PO differed significantly in phase 1 (N = 15, w = 287.5, p = .017). The marmosets entered further into the transport box with the AT compared to the PO (Figure 4).

Figure 4

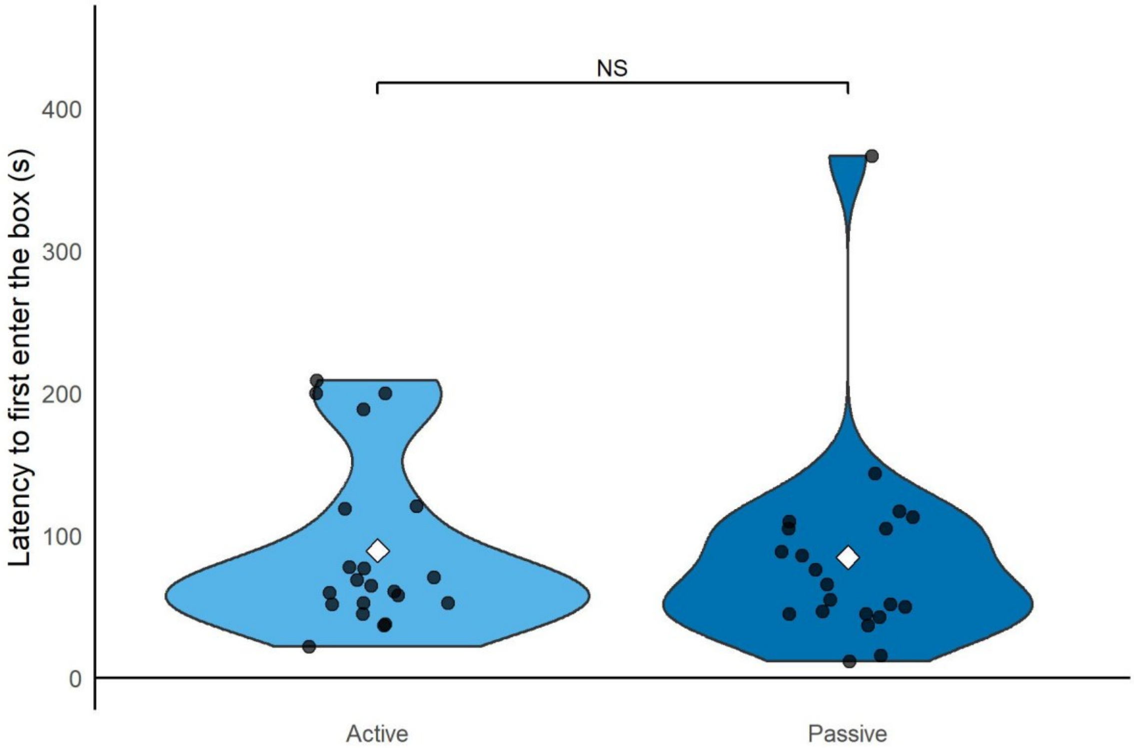
Maximum slit entered in transport box test with AT and PO in phase 1.



However, no significant difference in the latency to first enter the transport box was found between the AT and PO in phase 1 (N = 11, w = 114.5, p = .986, Figure 5).

Figure 5

Latency to first enter the transport box with the AT and the PO in phase 1.



3.1.1.2 *Preference Test*

No significant preference for the AT or PO was found in phase 1 (N = 14, w = 172.5, p = .792).

3.1.2 Difference in type of interaction in phase 2

3.1.2.1 *Transport Box Test*

The maximum slit entered with the AT and PO did not differ significantly in phase 2 (N = 15, w = 195.5, p = .194).

Furthermore, no significant difference in the latency to first enter the transport box was found between the AT and PO in phase 2 (N = 10, w = 117, p = .533).

3.1.2.2 *Preference Test*

No significant preference for the AT or PO was found in phase 2 (N = 15, w = 211.5, p = .899).

3.1.3 Difference between phase 1 and 2

3.1.3.1 Transport Box Test

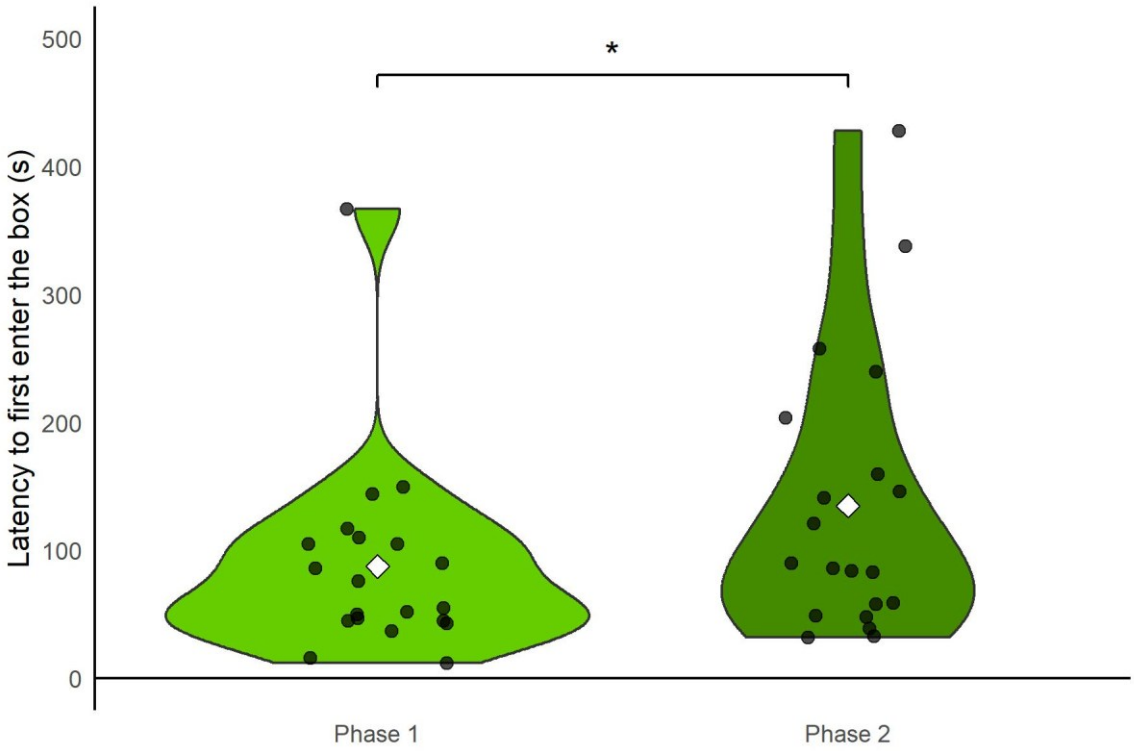
No significant difference was found regarding the maximum slit entered between phases for the AT (N = 15, $w = 84$, $p = .671$) or the PO (N = 15, $w = 287.5$, $p = .320$).

No significant difference in latency to first enter the transport box with the AT was found between phases (N = 12, $w = 129.5$, $p = .382$).

However, for the PO the latency to first enter the box across the phases differed significantly (N = 13, $w = 49.5$, $p = .040$). Individuals took longer to enter the transport box with the PO in phase 2 compared to phase 1 (Figure 6).

Figure 6

Latency to first enter the transport box with PO in phase 1 and phase 2.



3.1.4 Personal preference

No significant preference for any of the individual experimenter within a pair was found in phase 1 or phase 2 (

Table *2*).

Table 2

Results of statistical tests regarding preference for a individual experimenter within a pair.

Pair	Phase	*N*	Statistical results
JA	1	13	*w* = 25 *p* = .834
LL	1	14	*w* = 7.5 *p* = .298
CJ	1	13	*w* = 23 *p* = .516
JA	2	15	*w* = 21 *p* = .903
LL	2	14	*w* = 33 *p* = 1
CJ	2	15	*w* = 41 *p* = .160

3.1.5 Overall test performance

3.1.5.1 Transport Box Test

The overall maximum slit entered (i.e. disregarding role and person) showed no significant difference between phase 1 and phase 2 (N = 15, $w = 494$, $p = .237$).

The overall latency to first enter the transport box showed no significant difference between phase 1 and phase 2 (N = 13, $w = 363.5$, $p = .126$).

4 Discussion

The goal of the study was to gain further insight into human-animal connection (HAC), in this case specifically in common marmosets at the University of Vienna. Several areas could benefit from further insights into this topic, such as animal welfare and research (Boivin et al., 2003; Hosey & Melfi, 2014; Rault et al., 2020; Waiblinger et al., 2006; Zulkifli, 2013). The focus was kept on the type of human-animal interaction (HAI) and its impact on the animal's performance as well as on HAC. I defined two types of HAI, the active and passive, and assigned each type of interaction to one experimenter within a training pair. At the end of the experience period, a transport box test and preference test were performed to investigate the animals' performance and preference.

4.1.1 HAC formation depending on type of HAI

The first part of the study focused on whether it makes a difference to the marmosets if the HAI are active or passive. The hypothesis was that the marmosets form a stronger HAC with the active trainer compared to the passive observer in phase 1. Previously, Ward and Melfi (2013) recognized a change in animals' responses to cues and commands depending on previous training, which could be linked to a positive HAC formed during the training sessions. I predicted that this would show by the marmosets performing better with the active trainer in the transport box test, meaning that they would enter further into the box in a shorter time. Furthermore, in the preference test, they would show a higher preference for the active trainer, meaning choosing to get the treat from the active trainer more frequently than from the passive observer.

The results from the transport box test partially support my hypothesis that the marmosets form a stronger HAC with the active trainer than with the passive observer. While the latency to first enter the box did not show any difference between the two roles in phase 1 (Figure 5), the maximum slit reached did differ significantly (Figure 4). The marmosets entered further into the box with the active trainer than with the passive observer in phase 1. Thus, presenting a better performance in a routine husbandry task with the active trainer compared to the passive observer. This result might suggest that the marmosets feel more comfortable doing this task with the experimenter they had active interactions with. This could mean that the marmosets have a stronger HAC with the active trainer than the passive observer, leading to a better cooperation during husbandry task.

The number of studies on the effect of different types of HAI on performance and HAC in lab animals are limited, however several studies investigated the impact training, an active HAI, has on performance and HAC. In the past, Bassett et al. (2003) observed a change in marmosets performing husbandry tasks after being exposed to positive reinforcement. Non-trained individuals that experienced less human interaction did not only express more stress-related behaviour (e.g. self-scratching) but also failed to complete the task at hand (urine sample collection). Yet, the trained marmosets, not only managed to provide urine samples but also showed no change in excreted urinary cortisol, stemming most likely from the stress-reducing effect of positive HAC. Additionally, similar to my findings, McKinley et al. (2003) found a significant difference in collecting weights from marmosets between a group experiencing standard lab procedures and another one positive reinforcement training. A considerable reduction in time needed to collect the data with the trained animals was shown. The difference is most likely coming from the richer HAC that comes along with the positive reinforcement training as well as the marmosets reducing their fear of humans, making cooperation easier. Jamieson (2018) investigated the effect of familiarity on performance in scent detection dogs. He did not only detect a significant better performance with the familiar handlers compared to the unfamiliar handlers but also no significant improvement with the unfamiliar handling over time. Moreover, the dogs seemed to show more stress related behaviour and be more distracted with the unfamiliar handler. He suggests that this indicates that the difference in performance rather stems from a HAC between the familiar handler and the dogs rather than solely on familiarity. These findings support my hypothesis that the active HAI has a deeper impact on the HAC than the passive HAI leading to a better performance with the AT. Brajon (2015) observed a similar effect in piglets, the piglet's response to humans was evaluated in several conditions, varying in valence (positive or neative) and type (e.g. strokes, food, passive). The passive condition seemed to have a similar impact on the piglet's reactivity to a handler being present than to the positive active conditions. In the handler approach test, however, the piglets that experienced only passive HAI did react with avoidance to active physical contact. Possibly due to the novelty of the HAI experienced in the handler approach test.

Against my predictions, the preference test could not detect a significant preference for one of the roles in phase 1, opposing my prediction that they would have a preference for the active trainer. A previous study (Martin & Melfi, 2016) in zoo animals from different species detected a difference in approaching familiar and unfamiliar humans. The animals spent considerably more time approaching the familiar keepers compared to the unfamiliar ones, indicating that animals can show variance in approaching humans with different levels of familiarity. Moreover, a study found that gorillas are more likely to show more negative behaviour towards unfamiliar people than familiar ones (Salmi et al., 2022). Since I could not detect any difference in the preference test for one of the roles, the most probable explanation is that in this context, the type of HAI they experienced with a person does not matter to the marmosets. In horses the impact of brushing by unfamiliar and familiar humans was investigated by monitoring the horse's heartrate. Before the active interaction (brushing), the horse experienced a passive interaction with both unfamiliar and familiar humans, a motionless presence of the humans in the horse's stall. Brushing itself seemed to be a calming activity for horses in general, since the heartbeat lowered with both the familiar and unfamiliar human when brushed on the left side. Horses are commonly handled on the left side. On the right side, however, the horse seemed more comfortable with the familiar human (Scopa et al., 2020). The study suggest that depending on the conditions of the experience, here left and right, the level of familiarity might play a role for the animal or not.

On the other hand, even though the paired-choice method is the most frequent set-up in preference tests, it might not always be the most fitting (Turner et al., 2025). Here I paired the social interaction stimulus with food. The food stimulus might have been conflicting with the social interaction stimulus (Rault et al., 2020), meaning that the food might have overpowered the social interaction. Moreover, since the set-up comes with low risks, the marmosets might not pay as much focus as to which experimenter offers them a treat in this context. This could be different for the transport box test, a more daunting task, where I did find a difference between the type of HAI.

4.1.2 Effect of order of exposure on HAC

The second part of my study was of an explorative nature. The goal was to investigate if it makes a difference to the marmosets to which kind of HAI they are exposed to first, therefor I switched the roles within each training pair in phase 2. I established two alternative hypotheses for the second part of the study. According to my first hypothesis, I predicted, that it does not matter to the marmosets which type of HAI happened first, but only that they experienced both types with one person. This would show by them performing the same with both experimenters in the transport box test and no preference in the preference test in phase 2. The second hypothesis was that it does matter which type of HAI they experienced last with a experimenter. Meaning, they would show a better performance and a higher preference with the last active trainer, as the more intense HAC happened last with the active trainer.

The marmosets did not show a better performance or higher preference for the last active trainer in phase 2 or across the phases, leading me to consider the second hypothesis as unlikely. In support of my first hypothesis, the maximum slit reached did not differ in phase 2 or across phases. Additionally, no significant difference was detected during the preference test for any of the roles. The latency to first enter the box, however, did differ for the passive observer across phases, the marmosets entered the transport box faster with the passive observer in phase 1 than phase 2 (Figure 6).

The higher latency with the passive observer in phase 2 is quite surprising. These results are contradicting my expectations as the marmosets should only get more comfortable with a person over time, no matter which type of HAI they experienced first or second. Lange et al. (2020) observed such an effect while analysing the relationship between humans and cows over the course of time in three different treatments. First as a control treatment (CON), the human was merely in the presence of the cow without any interaction, representing a passive interaction. The second and third treatment involved stroking as a gentle interaction representing an active interaction, while in one treatment the cows were restrained (LOCKED) and in the other one they were free (FREE). The relationship score, taking for example approach and duration of contact into consideration, increased in all three treatments over time, that is in different degrees. The biggest effect was observed in FREE and then LOCKED and the lowest in CON. Still the results showed an improvement of the HAC over time no matter the type of interaction (active or passive). My results, however, indicate that the marmosets got less comfortable over time as they took longer to first enter the transport box in phase 2. It would need some more research to determine if this finding is due to my study design or if it is a general effect.

4.1.3 Personal preference

Additionally, to check for a personal preference of the marmosets for one of the experimenters within a training pair, I analysed the results of the preference test while disregarding the role of the experimenter. No personal preference for any experimenter was found in the preference test (Table 2).

A possible explanation for the lack of personal preference is the way experimenters were told to interact with the marmosets. The goal was to keep the interactions for each role as uniform as possible to keep the focus on the different types of HAI. This might not have left a lot of room for a marmoset to establish a personal preference for one of the experimenters within a training pair. Since previous interactions do matter (Proops et al., 2018; Rault et al., 2020; Salmi et al., 2022) and variance in interactions was kept minimal (except for between roles), a preference might not have been able to establish. On the other hand, the marmosets might have generalized their experiences to humans with whom they had similar experiences (Rault et al., 2020). Hence it is hard to say whether my results did not show a preference due to the experimental design or because the marmosets are not able to form a preference towards a person.

4.1.4 Overall test performance

Lastly, to have a better understanding of their overall performance in the transport box test throughout the study, I took a closer look at the results while disregarding the experimenter (i.e. both role and person). The analysis showed no difference in their overall performance in the transport box test, indicating that their performance was not affected by time, meaning that they did not improve in this task over time. This indicates that any significant differences in their performance are most likely coming from the type of HAI they experienced.

4.1.5 Complications

During the transition from phase 1 to phase 2, in one of the groups the switching of the roles got confused. This led the experimenters to stick to their previous roles for one additional session in the experience period with 4 individuals. Meaning that with one training pair, 4 marmosets experienced 5 active HAI with one experimenter and only 3 with the other one. Due to the limited sample number, the individuals and trials were handled as if this mistake did not occur. Furthermore, it seems unlikely that one wrong training session for 4 individuals within one training pair would have such a deep impact on my whole analysis, given that each individual, a total of 15, has 8 training session with 3 different pairs.

A number of trials did not run as smoothly as anticipated, due to a variety of loud disturbances (e.g. maintenance work) or special occurrences (e.g. individual escaping). The transport box test and preference test were conducted inside the keeping rooms, which other staff was prohibited from entering during the trials. The keeping rooms, however, are connected to the outside enclosure which is also restricted to other staff but not completely closed off, which allowed for some disturbances during the tests. Occasionally, one could observe some marmosets vocalizing more and being less focused on the target or treat. A study suggests that noise (by conspecifics or humans) has a greater impact on stress in rhesus monkeys than the mere presence of humans (Clay et al., 2009). Assuming that this also applies to common marmosets, these disturbances should not be ignored. In the future, trying to control the surrounding environment even more, especially for loud noises, should be considered.

4.1.6 Possible explanation for variance in results

Range and Huber (2007) investigated the attention span of common marmosets in an imitation set-up and found a great variance between individuals. The variation in attention span between individuals might explain the variance in my results, some individuals might have just been more distracted than others. Moreover, a study also found great variation in habituation to research staff in marmosets (Murai & Sukoff Rizzo, 2020). Additionally, to individual attention-span and habituation to staff comes a variation in learning. Previous studies found variance in learning speed in marmosets based on an animal's personality, age, sex and family group (Glavis-Bloom et al., 2022; Šlipogor et al., 2022; Takemoto et al., 2015). Especially in case of a small sample number, these kinds of personal variation can greatly impact the results. Individual differences and animal personality were not part of my focus and would have gone way beyond the scope of this study. However, a future direction could be investigating individual differences and traits of lab animals and take them into consideration when conducting studies on said animals.

Another possible explanation is to consider that there might be individual differences in time to reach the same level of habituation. For instance, in wild northern pigtailed macaques a domino effect was observed, some individuals habituated first and then functioned as a catalyst for not yet habituated individuals and thus sped up the latter's habituation process (Gazagne et al., 2020). Murai & Sukoff (2020) even mentioned the individual differences in habituation to staff members, the time period to reach their habituation criteria varied from 2 days up to 2 weeks in their marmosets. Moreover, there is the possibility of contextual habituation (Dissegna et al., 2021), in this case it would mean that the marmosets might be habituated to the experimenter in the context of the experience period. The transport box test and preference test, however, might be a new context that they need to get habituated to.

4.1.7 Future outlook

To gain further knowledge on this topic, one could prolong the length of the study, e.g. have the two types of HAI happen for a longer period of time before testing. In addition, one could consider investigating individual habituation and attention span before setting up such studies. While this study mostly focused on the results of the response tests, pairing them with behavioural observations before and after the HAI could give further insight into the overall impact of different types of HAI. Another factor worth considering in the framework of these studies, would be physiological indicators, such as cortisol as an indicator for stress.

5 Conclusion

My results indicate that the type of HAI does have an impact on common marmosets' performance in a husbandry task and suggest that it does not matter in which order they experience the types of HAI. In the context of the preference test I was not able to detect any preference towards a type of HAI or a person within a pair.

While the work focusing on animal welfare is on the rise, it is still in its early stages, especially when it comes to research animals. The impact HAC can have on an animal's wellbeing as well as the outcome of studies should not be ignored when it comes to animal research.

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Appendices

Appendix A: Zusammenfassung

Menschen und Tiere gehen in vielen verschiedenen Kontexten Beziehungen zu einander ein, die Art der Interaktionen kann unterschiedliche Auswirkungen haben. Im Rahmen dieser Studie, wurden die Auswirkungen verschiedener Typen von Interaktionen zwischen Labortieren und deren Trainer untersucht, genauer gesagt an Weißbüschelaffen (*Callithrix jacchus*) an der Universität Wien. Im Zuge dessen, wurden zwei Arten von Interaktionen definiert, aktives Trainieren (AT) und passives Beobachten (PO). Das Ziel war festzustellen, ob die Interaktionsart die Leistung und Präferenz der Affen beeinflusst. Nach einer Versuchsperiode, würde die Leistung anhand eines Transportboxtests und die Präferenz anhand eines Präferenztest untersucht. Die Affen waren in zwei Sets aufgeteilt mit unterschiedlicher Rollenaufteilung von AT und PO innerhalb eines Trainingpaars. Die Studie verlief in zwei Phasen, in Phase 2 wurden die Rollen innerhalb der Sets vertauscht, um so herausfinden zu können, ob die Reihenfolge welcher Interaktionstyp die Affen zuletzt erlebt haben, eine Rolle spielt. Die Annahme bezüglich Phase 1 war, dass die Affen eine höhere Leistung und Präferenz mit dem AT zeigen. Bezüglich Phase 2, erwarteten wir ebenso eine höhere Leistung und Präferenz mit dem letzten AT. In Phase 1, gingen die Affen signifikant weiter in die Transportbox hinein mit dem AT. Beim Vergleichen von Phase 1 und 2, zeigte sich, dass die Affen schneller in die Box hineingegangen sind in Phase 2 als in Phase 1 mit dem PO. Die Resultate zeigten keine Präferenz der Affen für eine Role oder Person. Die Ergebnisse deuten darauf hin, dass der Interaktionstyp die Leistung von Weißbüschelaffen beeinflusst, und unterstreichen die Relevanz für das Tierwohl und die Interpretation von Forschungsergebnissen.

Appendix B: Observation protocol – Experience period

Date:
Set:
Lab:

Trainer:
Active Trainer:
Passive observer:

slot: Morning/Afternoon
outdoor enclosure: open/closed
weather/Temperature/humidity:

Habituation to marmosets - Testsheet

Focal individual	Leaves homecage (hh:mm)	Time in tunnel (lab+hallway) (mm:ss)	Time in tunnel (exproom) (mm:ss)	Time in exp. cage (mm:ss)	Enters homecage (hh:mm)	Total time (in sec)	Comments

Appendix C: Observation protocol – Transport Box Test

Date:
Set:
Lab:

Trainer: Nadine/ Julia
Student:
Role: passive/active

slot: Morning/Afternoon
outdoor enclosure: open/closed
weather/Temperature/humidity:

Transport Box Training - Testsheet

Focal individual	**Time until cage is first entered (mm:ss)**	**Time until box is first entered (mm:ss)**	**Maximum slit entered**	**Total Time spend in training**	**Comments**

Appendix D: Observation protocol – Preference Test

Date:
Set:
Lab:

Trainer: Julia
Student A:
Student B:

slot: Morning/Afternoon
outdoor enclosure: open/closed
weather/Temperature/humidity:

Preference check - Testsheet

Focal individual:	First student A Latency (mm:ss)	First student B Latency (mm:ss)	No choice
1			
2			
3			
4			
5			
6			
7			
8			

Treat used:

Starting side Student A:

Starting time:

Comments: