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„Local versus stimulus enhancement: The influence of social relationships in Goffin Cockatoos (*Cacatua goffini*)“

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Abstract

Socially living animals have to cope with a highly unpredictable and complex environment in which the individuals compete for limited resources. In most social groups the access to these resources is regulated by a dominance hierarchy established through repeated agonistic interactions. The more dominant and higher ranking an individual the better its resource holding potential.

Social living involves not only agonistic relationships but also friendships between affiliated individuals and often also relationships between kin. These diverse social dynamics can influence information transmission between individuals and also social learning like local and stimulus enhancement.

I tested positive effects of social dynamics on object manipulation in a social living bird species, the Goffin cockatoo (*Cacatua goffini*). Using observational data I first calculated a dominance hierarchy and affiliated relationships and then test dyads of dominant, affiliated and akin pairs in a simple choice task using different object sets. My results show, that dominance hierarchy is highly linear, with males at higher ranks than females. No social learning, neither on individual nor on group level irrespective of the social condition (dominance, affiliated or akin) could be detected. However, subjects showed a significant side bias and strong individual preferences for particular objects.

My results on dominance hierarchy and its effects on behaviour are so far in accordance with what has been found in other avian species. Contrary to previous studies on birds, the current lack of social learning suggests that at least in this species social learning seems rather unimportant.

Furthermore, individual preferences seem to overpower the social influence of a demonstrating individual. However, further investigation is necessary to ensure if this is a general finding or based on the methodology used in this study.

Zusammenfassung

Sozial lebende Tiere müssen in einem unvorhersehbaren und komplexen Umfeld mit anderen Individuen um limitierte Ressourcen konkurrieren. Der Zugang zu diesen Ressourcen wird in den meisten Fällen durch eine Dominanzhierarchie geregelt, welche wiederum durch wiederholte agonistische Interaktionen etabliert wird. Die höher rangigen Tiere haben dabei den besseren Zugang zu den Ressourcen und können diese auch besser monopolisieren. Neben agonistischen Beziehungen kommen jedoch auch Freundschaften oder Familienverbände vor. Dieses vielschichtige soziale Umfeld kann den Informationstransfer zwischen den Individuen beeinflussen und somit auch einfache Formen von sozialem Lernen wie „local“ und „stimulus enhancement“.

In dieser Studie wurde das soziale Lernen von Goffin Kakadus (*Cacatua goffini*) untersucht. Anhand von Verhaltensbeobachtungen wurde eine Dominanzhierarchie so wie Freundschaften berechnet und basierend auf diesen Ergebnissen Paare der Vögel in verschiedenen Kategorien (Dominanz, Freundschaft, Verwandtschaft) vor eine simple Objektwahl gestellt.

Die Resultate zeigen, dass in der hier getesteten Gruppe eine stabile lineare Dominanzhierarchie vorliegt, in welcher Männchen höhere Ränge einnehmen als Weibchen. Das Ergebnis der Lernexperimente war überraschend. Die Vögel zeigten kein soziales Lernen unabhängig davon in welcher Kategorie sie getestet wurden, auch nicht als Gruppe. Was jedoch auffallen war, waren konstante Seiten- und individuelle Objektpräferenzen.

Die Ergebnisse dieser Studie zeigen eine lineare Dominanzhierarchie welche auch bei anderen Vogelarten zu finden ist. Im Gegensatz zu früheren Studien an Vögeln scheint soziales Lernen bei dieser Vogelart eine untergeordnete Rolle zu spielen, was darauf hinweisen könnte, dass individuelle Präferenzen wichtiger sind als von anderen bereitgestellte Informationen. Weitere Tests sind jedoch notwendig um Genaueres herauszufinden.

Local versus stimulus enhancement: The influence of social relationships in Goffin Cockatoos (*Cacatua goffini*)

By Birgit Szabo

Introduction

Sociality, as it is generally known, bears costs and benefits. On the one hand, it increases the risk of being spotted by predators or transmitting diseases and parasites and it increases competition for resources (Alock, 2006). On the other hand, living within a group of conspecifics can improve foraging and predator defences (Alock, 2006). In order to cope with these problems most social animals develop a hierarchy in which some animals have better access to limited resources than others (Ficken et al., 1990; Fraser & Bugnyar, 2010). Animals may determine their dominance rank by a repeated exchange of agonistic interactions (Drews, 1993; Paz-y-Mino et al., 2004; Kappeler, 2006) in combination with transitive inference (inferring that A is dominant over C by knowing that A is dominant over B and B is dominant over C; Bond et al., 2003) or even inherit their position in the hierarchy from their parents (Bergstrom & Fedigan, 2010) or mating partners (Röell, 1978). The term dominance was first established by Schjelderup-Ebbe (1922) by studying the “Peck-order” in domestic chicken. Drews (1993) proposed a modification of Schjelderup-Ebbe’s initial definition: “Dominance is an attribute of the pattern of repeated, agonistic interactions between two individuals, characterized by a consistent outcome in favour of the same dyad member and a default yielding response of its opponent rather than escalation. The status of the consistent winner is dominant and that of the loser subordinate.”

Besides agonistic relationships, despotic societies may also be characterised by affiliative relationships (Coussi-Korbel & Fragaszy, 1995), where individuals spend much time together and tend to show high levels of reciprocal removal of parasites (Bonnie & de Waal, 2006; Schwab et al., 2008). Affiliated animals may profit from such relationships by gaining support in agonistic interactions or valuable information and thus are more likely to share resources (Fraser & Bugnyar, 2010). Yet another factor influencing group life is kinship. By being raised together kin tend to spend more time with each other and as a result they may be more willing to share information. Furthermore, helping akin conspecifics may increase inclusive fitness (Hamilton, 1964). Therefore, it can be assumed that in a complex and unpredictable social environment the identity of and

relationship between individuals influences the behavioural patterns of others (Katzir, 1982; Coussi-Korbel & Frigaszy, 1995; Stöwe et al., 2006). This information may frequently be shared through social learning (Russon & Galdikas, 1995) because learning offers a shortcut to gaining important information and to avoid the costs of asocial learning (where information is acquired through an animals own interaction with its surroundings; Heyes, 2012; Laland, 2004).

Social learning can be defined as “learning that is influenced by observation of, or interaction with, a conspecific, or its products” (Heyes, 1994) and is involved in numerous aspects of life. Examples are predator recognition (e.g. Seyfarth & Cheney, 1986; Griffin, 2004; Heather et al., 2012), mate choice (e.g. White & Galef, 1999; White & Galef, 2000), learning about food sources and foraging (e.g. Aisner & Terkel, 1992; McQuoid & Galef, 1992; Huber et al., 2001; Caldwell & Whiten, 2003; Bugnyar & Heinrich, 2006; Bonnie & de Waal, 2007), about the social environment (e.g. Bond et al., 2003; Paz-y-Mino et al., 2004; Grosenick et al., 2007), or other useful behaviours (e.g. Bonnie & de Waal, 2006).

Galef (1995) states that the adaptiveness of social learning can only be accomplished through selective use. Therefore, he presumes that individuals should depend on asocial learning and only revert to learning from observation when the benefits outweigh the costs and if the observed behaviour is productive and the outcome is certain (Galef, 1995; Laland, 2004; Zentall, 2012). Furthermore, social learning should become more valuable when confronted with difficult novel tasks (Laland, 2004). Nevertheless, socially acquired information is often more beneficial than trial-and-error learning (Zentall, 2012).

Social dynamics could favour different forms of social learning, among them stimulus and local enhancement are known to be the simplest forms (Coussi-Korbel & Frigaszy, 1995; Hoppitt & Laland, 2008). In accordance with Hoppitt and Laland (2008) stimulus enhancement occurs when the observation of a demonstrator (or its products) exposes the observer to a single stimulus at a time t_1 and that single stimulus exposure effects a change in that observer’s behaviour, at a second time t_2 . Local enhancement occurs when, after or during a demonstrator’s presence, or interaction with objects, at a particular location, an observer is more likely to visit or interact with objects at that location (Hoppitt & Laland, 2008). Based on the definitions the difference seems clear but nevertheless it is crucial to design experiments carefully in order to be able to separate both and exclude other forms of social learning such as observational conditioning (Pavlovian conditioning, where an observer learns about a relationship between an unconditioned stimulus and a response experienced by a demonstrator and subsequently makes the same response; Heyes, 1994) or contextual imitation (the acquisition of a novel task by observation of a model involving goal-directed mental mechanisms; Heyes, 1994) (Hoppitt & Laland, 2008).

A prominent example of stimulus enhancement was given by White and Galef (1999); they could show that female quail (*Coturnix japonica*) tended to associate more with males they had previously seen near another female. Additionally, they found that this effect was not location-specific and not focused on one particular male but generalized (White & Galef, 2000). Stuffed females in close proximity to a male would lead to the same effect, ruling out local enhancement and observational conditioning (Akins et al., 2002). Another interesting example of stimulus enhancement is the work of Schwab et al. (2008). They investigated stimulus enhancement in sibling and non-sibling dyads of ravens (*Corvus corax*). Subjects watched a demonstrator manipulate an object in an adjacent room. Thereafter the subject was confronted with a set of five objects including the object it saw the demonstrator manipulating just moments before. They could show that related subjects manipulated the target object significantly longer than the other four objects, whereas non-related birds showed no preference for one of the five objects. This clearly indicates that the relationship between observer and subject influences stimulus enhancement.

An example for a setup that separates local from stimulus enhancement is the work of Heyse et al. (unpublished data) on ravens and kea. They presented a group of subjects with four pairs of items arranged in a square. The objects used were obtained from a given set of categories (e.g. squares and tubes of different colors), but varying in color or shape within the pair. Subjects could either choose the same location or a similar object as a demonstrator, clearly separating the two forms of enhancement. In both species stimulus enhancement was the most frequent form of learning, followed by going for the same object (a combination of both local and stimulus enhancement) and pure local enhancement was observed least often. Furthermore, affiliative relations favour stimulus enhancement in both species, whereas only in ravens frequency of local enhancement was rank correlated with higher ranking individuals showing more local enhancement. Investigating the extent to which the quality of a relationship influences learning is important, because attention and the value of the information gained may depend on the relationship between individuals (Coussi-Korbel & Frigaszy, 1995).

As mentioned above, depending on the social status one form of learning could be more beneficial than the other. A subordinate individual, for example, benefits more from stimulus enhancement when learning from a dominant individual by avoiding close contact and therefore aggression (Baker et al., 1981). This is of no relevance for a dominant animal learning from a subordinate. The dominant may gain more by learning via local enhancement or even go for the same object, because it has the power to monopolize a resource (Ficken et al., 1990). Similar rules may apply for affiliations or even related individuals. Affiliated animals may learn from each other by local enhancement, because the risk of aggression is small and the information gained by visiting the

same location may be of more use than just going for a similar resource elsewhere (Heyse, unpublished data).

Goffin's cockatoos or Tanimbar Corellas (*Cacatua goffini*) are endemic to the Tanimbar Islands in Indonesia. These parrots live in social groups in tropical dry forests and are likely to be foraging generalists feeding on a wide variety of fruits, seeds, berries and insects on the forest floor as well as in the canopy (Cahyadin et al., 1994). In spite of their inconspicuous appearance this parrot species is common in aviculture, perhaps because of their interesting play behaviour (Auersperg, van Horik, Bugnyar, Kacelnik, Emery, von Bayern, unpublished data; Forshaw & Cooper, 2003).

In captivity they show a wide range of social interactions as well as complex and intrinsically structured object play and manipulative exploration behaviour (Auersperg, van Horik, Bugnyar, Kacelnik, Emery, von Bayern, unpublished data). Furthermore, they previously exhibited high level performances in a number of cognitive tasks such as impulse control (Auersperg et al., 2013), sequential problem solving (Auersperg et al., 2013), Piagetian object permanence (Auersperg et al., 2013) and even showed the capacity to innovate tool use as a solution to a novel problem (Auersperg et al., 2012). These attributes make the Goffin's cockatoo an interesting subject for ethological and cognitive studies.

Although it is a common representative in aviculture, so far there are not many studies conducted on Tanimbar Corellas (e.g. Brown & Toft, 1999; Astuti et al., 2006; Jepson et al., 2001; Zinke et al., 1999; Flammer et al., 2001; Flammer & Papich, 2005; Johnston et al., 2006). Until this day investigation of their social interactions and object related behaviours is still in its infancy.

My aim was first to examine their social group structure and later to apply my findings to a simple social learning experiment, incorporating both, local and stimulus enhancement in this species and compare it to other findings in birds and mammals. Furthermore the knowledge obtained during this study could provide information about the social structure of the group under investigation, which could later be used for testing other questions on how sociality and dominance can influence social learning in this species.

Material and Methods

Subjects

14 Goffin's cockatoos (*Cacatua goffini*), seven males and seven females, were involved in this study: all subjects were subadult, ranging in age from 20 months to five years of age at the time of

the study. All were individually marked with a unique combination of coloured leg bands. All birds were hand reared by accredited German breeders and purchased with documentary evidence of origin and CITES papers. All had previous experience, participating in various experiments (e. g. object permanence, Auersperg et al., 2013; food exchange, Auersperg et al., 2013; lockbox, Auersperg et al., 2013). They are housed together as a social group in an aviary consisting of an indoor (45m² ground space, 3-6m high wall to gable, Fig. 1, B) and outdoor part (150 m² ground space, 3-4.5m high; Fig. 1, A). The indoor part is enriched with wooden, free hanging perches, artificial ponds and wooden chew toys; the outdoor part is equipped with wooden, free hanging perches and trees. The indoor compartment is kept at 20°C from October to May. All birds are fed a diet of two to three sources of fresh fruit, soy yoghurt and either cooked grains, noodles, vegetables or eggs fried in red palm oil in the morning as well as basic food (Australian Parrot Loro Parque Mix supplemented with dried fruits) and fresh drinking water ad libitum. The described housing conditions comply with the Austrian Federal Act on the Protection of Animals. Furthermore, as this study was strictly non-invasive and based purely on behavioural tests, it is not classified as an animal experiment under the Austrian Animal Experiments Act.

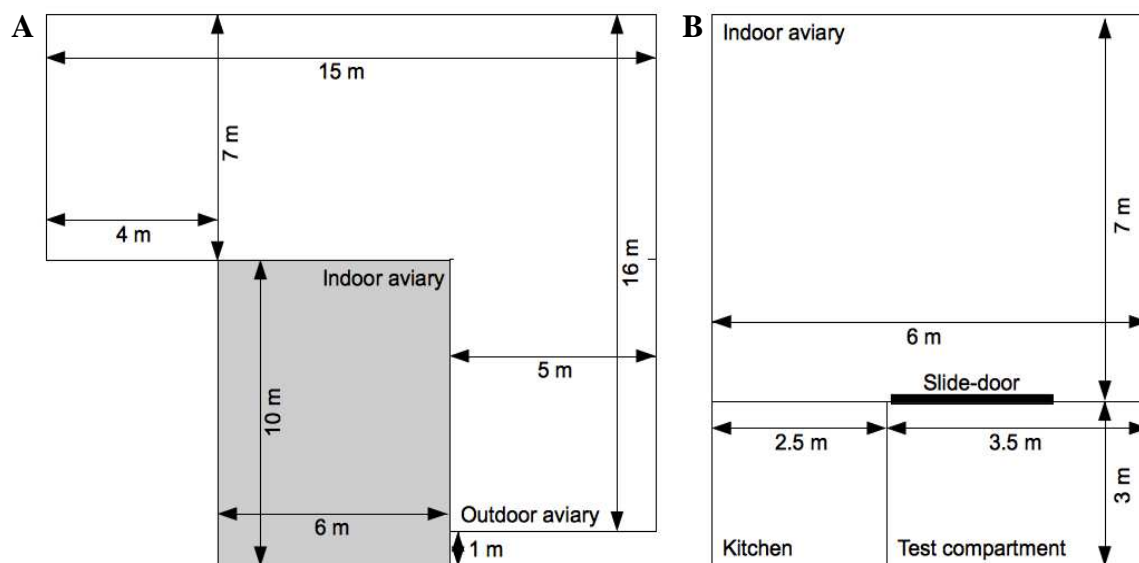


Figure 1. Simplified scheme of the whole aviary (A) including indoor and outdoor parts. Indoor aviary (B) including the test compartment as well as the food kitchen.

Behavioural monitoring

Two cycles of behavioural observations were conducted. Focal observations of each subject were

recorded once a day in the morning, from outside the outdoor aviary for four days a week from June to September 2012 and from outside the indoor aviary once a week from November 2012 to February 2013. Observations consisted of a 10-minute focal per individual and nearest neighbour observations of all birds between every two focals, resulting in an average observation time of 292 min \pm (range: 36 min) per bird, a total observation time of 4090 min and 245 nearest neighbour records. Eight super-categories of behaviours were recorded: affiliative, agonistic, non-directional, self-directed, play-related, object-related behaviours as well as displays and vocalizations (Appendix A). Being 'nearest neighbour' was defined as two individuals being within a range of 40 cm of one another. The summer observations were videotaped (JVC HD memory Camcorder, GZ-E10) as well as voice recorded (Sony Digital Dictation Machine, ICD-PX312). The winter observations were conducted through a Plexiglas ® window (55x35cm) in the sliding door separating the experimental compartment from the indoor aviary (Fig. 1, B). Due to the size of the window focals could not be videotaped indoors.

Enhancement Test

Material

27 sets of objects were used. Each set consisted of two object pairs. Each set was approximately of the same size and material, but varied in colour and exact shape: Each pair had some categorical similarities (e.g. shape, colour) but did not look exactly the same (see Appendix B). Some objects were familiar (10 objects were parts of wooden chewing-toys they had encountered before, as well as the two "Tigger" figures of pair 2) to the birds, others they had never encountered before.

Based on the results from the behavioural observations, 12 dyads of subjects in three conditions were selected: six dominance dyads which were counterbalanced for sex (there were at least three rank positions between paired subjects in this group), three kinship dyads (individuals were siblings) and three affiliation dyads (based on analysis below; Table 1). As each bird served as a demonstrator as well as an observer it was possible to look for effects of dominance up and down the hierarchy. The experiment was conducted from September 2012 to February 2013. Each dyad received up to 10 trials (some birds showed high levels of fear and were not forced to participate, therefore one dyad received six trials, one dyad five trials, one dyad two trials and one dyad one trial), one trial per day at least two times a week and with at least one day in between trials using each set of objects just once per bird. Trials were randomly chosen (from all possible pairs and

conditions) for each testing day.

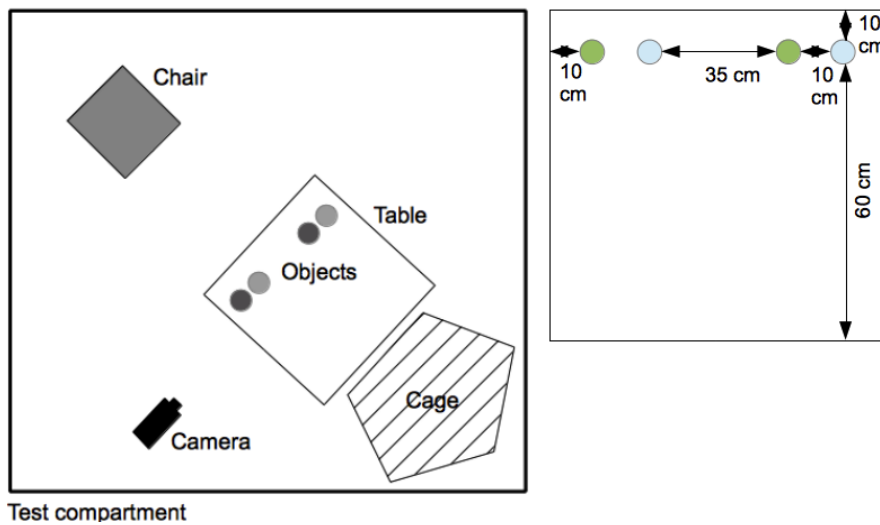


Figure 2. Simplified scheme of the setup of the enhancement test. Left: Whole setup; Right: Setup of the objects on the table.

Procedure

Each dyad was separated from the group and brought into the testing compartment. The subject (observer) was placed into a large parrot cage or on top of it and the demonstrator on the experimenters shoulder. Testing was conducted on a plain, white table (1x1m), with the parrot cage being on one table end, the experimenter's chair on the other (Fig. 2). The demonstration phase started by placing a set of four objects in full sight of both individuals, two on the left and two on the right side of the table on the experimenters end (Fig. 2) always starting from left to right (from the observing subject's perspective). Thereafter, the demonstrator was placed in the centre of the far end of the table and was allowed to pick up one item and explore it in view of the observer (Fig. 3) for as long as it was interested in it but not longer than 10 minutes. Furthermore, if the bird flew away with the object, lost it, or touched more than one object the demonstration phase was terminated. As soon as the demonstrator let go of the object he was picked up by the experimenter and placed back into the group area. The testing phase began by putting the items on the table back in the same order, again placing each item from left to right. The subject was then released from the cage and was allowed to choose an item for itself. Trials were stopped if a bird did not touch any object for 15 minutes. During testing the experimenter wore mirrored sunglasses, avoided lateral head movements and did not touch or speak to the bird until the trial was over. A bird would be

excluded from the experiment after showing no motivation to participate in five consecutive trials (which translates to two weeks of low motivation). All trials were videotaped (JVC HD memory Camcorder, GZ-E10).

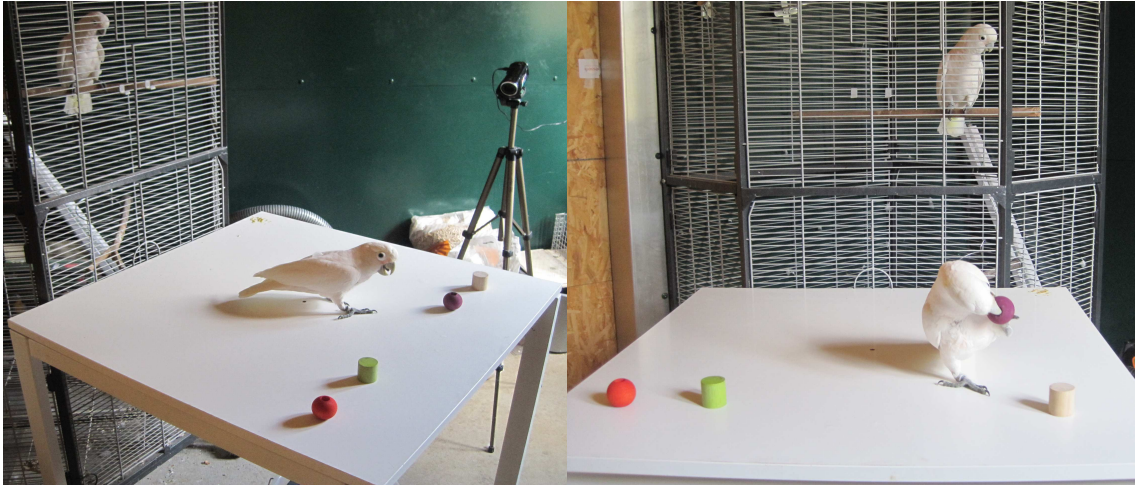


Figure 3. Testing situation during the demonstration phase in the experimental compartment. Subject (Mayday) in the cage, demonstrator (Dolittle) on the table (left picture) and manipulating the chosen object (right picture). Used object set ZB, pairs number 37 and 38 (Appendix B). Position of the video camera visible in the left picture.

Enhancement Controls

To control for side preferences two sessions á 10 trials of perseverance tests were conducted pre and post the enhancement experiment (with four to five months in between sessions). For this, two $\frac{1}{4}$ s of a cashew nut were placed on the experimenters end of the table on opposite sides, then covered with two identical pieces of paper (7 x 4.5 cm). The subject was allowed to pick one side and consume the reward.

To control for individual preferences among the object sets used, each bird received a session of 12 trials for each objects set of a preference test after the enhancement test. These were conducted from December 2012 to February 2013 at least three times a week and at least once a day. Each bird received between three and 22 sessions depending on the number of object sets it received during the enhancement test. The set of objects was placed in front of the bird from left to right in the same order as in the enhancement test but equally spaced (about 15 cm in between objects). The bird was allowed to choose one item and explore it for one minute. Only the first object touched by the subjects (with the bill or foot) was recorded.

Analysis

Statistical analysis was done with IBM SPSS Statistics Version 19. Because data violated assumptions of parametric analysis nonparametric tests were used and all p-values are two tailed.

Behavioural monitoring

Dominance hierarchy was determined using unidirectional agonistic behaviours (challenged displacements and displacements, see Appendix A) and affiliations were determined comparing unidirectional affiliative behaviours (allo-preening) with nearest neighbour data from both observation cycles. Data was arranged into a matrix, with the actor in rows and the recipient in columns and analyzed with MatMan 1.1. Individuals were ranked from highest to lowest ranking bird (Table 2). The strength of the inconsistencies within the linear rank refers to the difference of the rank positions between the two involved individuals (de Vries, 1995, 1998).

To make the behavioural records comparable, relative frequencies were calculated dividing absolute frequencies by the amount of recorded focals for each observation cycle and each bird. These were analyzed for effects of dominance rank and sex using Spearman correlations and Mann-Whitney-tests respectively. Differences in the amount of recorded behaviours were analyzed using a Friedman-test with Bonferroni corrected (new $\alpha=0.007$) PostHoc Wilcoxon signed rank-tests. Changes in the amount of recorded behaviours between the first and second cycle of observations were calculated using a Wilcoxon signed rank-test.

Enhancement Test and Controls

In the analysis of this experiment I defined stimulus enhancement as choosing an object that matched the same object category the demonstrator had chosen during the demonstration phase. Local enhancement was defined as choosing an object on the same side at which the demonstrator had manipulated an object during the demonstration phase. Go for the same object (gftso) was defined as those instances when the subject chose the same object the demonstrator had been manipulating during the demonstration phase (Heyse, unpublished data). I had to exclude one female (LadyBird) from testing because she lost motivation some weeks into the experiment. Another female (Pims) participated in only five trials because she could not be used as demonstrator (she would not step on the table without seeing another bird step on it first). Furthermore, due to

pair formation during the mating season in February 2013 one dominance pair (Figaro and Fini) could only be tested in 6 trials.

I analyzed the effects of dominance rank, affiliation, kinship and sex on the relative amount of choices (absolute frequency divided by number of sessions per dyad) shown during the test using GLMMs controlling for the effect pair (random effect). To find out which category was favoured I used Tukey HSD PostHoc tests.

To analyze if the birds showed any differences in choices between participation as a demonstrator or as subject a Bonferroni corrected (new $\alpha=0.02$) Wilcoxon signed rank-test was used. To analyze side biases the binomial-test was used and to test for consistency over time I used the Wilcoxon signed rank-test. To look further into any side or place preferences I used the preference test data. The modus was calculated for each session to see which object was chosen most frequently. If it was consistent over time it would mean that the bird showed a side bias for one specific place. To analyze this effect the Friedman-test was used. To go even further into detail, I compared the modus for each object set with the respective object chosen during the test using a Wilcoxon signed rank-test. To see if the subjects showed any preferences for a specific object pair (pair: first and third, or second and fourth object) or side (left/right), objects were divided into those categories and again analyzed with Wilcoxon signed rank-tests.

Finally to rule out effects of me touching one object first and one last I counted the number of times a demonstrator chose a position during the enhancement test in each condition and compared it with a Friedman-test for overall differences and to find out which positions were preferred I counted the number of choices for each pair and used a Wilcoxon signed rank-test.

Results

Observations

I could find a significant difference referring to the relative frequency of recorded behaviours (Friedman-test, $N=14$, $\chi^2=77.425$, $df=7$, $p<0.001$). Birds showed more object-related behaviours than any other behavioural super-category (Wilcoxon-test, $N=14$, $p<0.007$); second are self-directed behaviours (Wilcoxon-test, $N=14$, $p<0.007$) and third agonistic behaviours (Wilcoxon-test, $N=14$, $p<0.007$; Fig. 4). During the second cycle of observations subjects showed significantly more affiliative behaviours (Wilcoxon-test, $N=14$, $Z=-2.103$, $p<0.05$) and less object-related (Wilcoxon-test, $N=14$, $Z=-3.296$, $p<0.01$), play behaviours (Wilcoxon-test, $N=14$, $Z=-3.043$, $p<0.01$) and

vocalizations (Wilcoxon-test, N=14, Z=-3.170, p<0.01) than in the first cycle (Fig. 5).

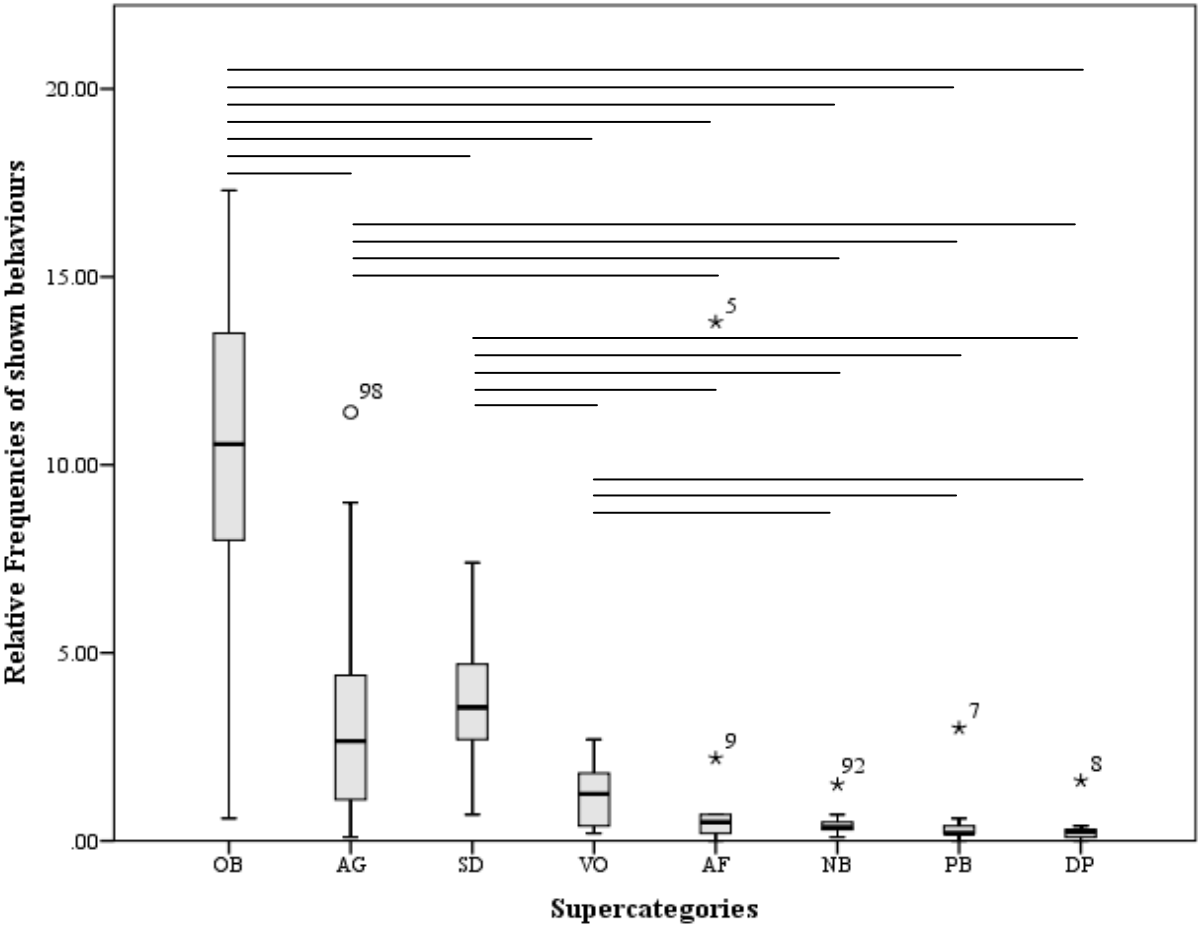


Figure 4. Relative frequencies of behaviours recorded in each super-category trough both cycles of observations. OB, Object-related behaviours; AG, Agonistic behaviours; SD, Self-directed behaviours; VO, Vocalization; AF, Affiliative behaviours; NB, Non-directional behaviours; PB, Play behaviours and DP, Displays. Lines indicate significant differences of p<0.007.

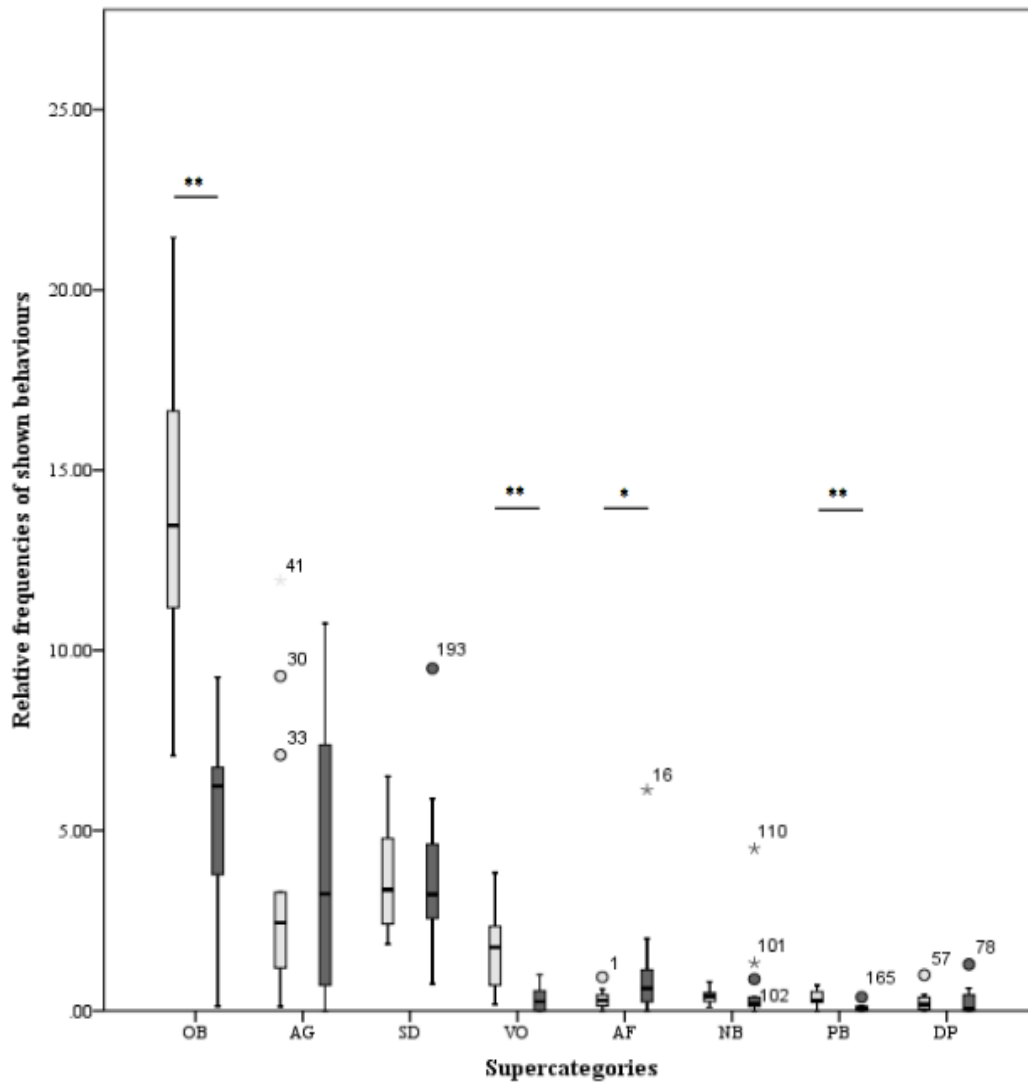


Figure 5. Relative frequencies of recorded behaviours (within each super-category) during the first (light grey) and second (dark grey) circle of observations. OB, Object-related behaviours; AG, Agonistic behaviours; SD, Self-directed behaviours; VO, Vocalization; AF, Affiliative behaviours; NB, Non-directional behaviours; PB, Play behaviours and DP, Displays. * significant difference of $p<0.05$, ** significant difference of $p<0.01$.

There were no differences in recorded unidirectional agonistic (row-wise matrix correlation, $\tau_{\text{displacement}}=0.495$, $p_{\text{displacement}}<0.001$) and affiliative behaviours (row-wise matrix correlation, $\tau_{\text{allo-preening}}=0.342$, $p_{\text{allo-preening}}<0.01$) between the first and second cycle of observations and in nearest neighbour records (row-wise matrix correlation, $\tau_{\text{nearest neighbour}}=0.247$, $p_{\text{nearest neighbour}}<0.01$). Therefore, respective records of both observational runs were used to calculate rank hierarchy and affiliated pairs.

I could assess a significant linear dominance hierarchy (de Vries, 1995, 1998) throughout the group (row-wise matrix correlation, $h'=0.886$, $p<0.001$) which was stable over the testing period and where males generally occupy higher rank positions than females (Mann-Whitney-test, $N=14$, $Z=-2.747$, $p<0.01$; see Table 1). Within the hierarchy there were no tied relationships but some inconsistencies around one juvenile male (Dolittle). The strongest inconsistency exists between Dolittle and LadyBird (low ranking subadult female), second strongest inconsistency between him and Zozo (high ranking subadult male), third place takes Olympia (middle ranking subadult female) and fourth with Heidi (higher ranking subadult female).

Table 1. Name, sex and age of the subjects within the study group as well as the evaluated dominance hierarchy and dyads chosen within every enhancement test condition,

Name	Sex	Age (years)	Rank position	Condition	Partner
Pipin	male	4	1	Dominance	Dolittle/Olympia
Figaro	male	5	2	Dominance	Konrad/Fini
Zozo	male	2,75	3	Affiliation	Olympia
Kiwi	male	2,75	4	Kinship	Heidi
Heidi	female	2,75	5	Dominance /Kinship	Mayday/Kiwi
Konrad	male	2,75	6	Dominance/Affiliation	Figaro/Lady
Dolittle	male	1,75	7	Dominance/Kinship	Pipin/Mayday
Muppet	male	2,75	8	Kinship	MoneyP.
MoneyP.	female	2,75	9	Dominance/Kinship	Lady/Muppet
Olympia	female	2,5	10	Dominance/Affiliation	Pipin/Zozo
Fini	female	5	11	Dominance/Affiliation	Figaro/Pims
Mayday	female	1,75	12	Dominance/Kinship	Heidi/Dolittle
LadyBird	female	2,75	13	Dominance/Affiliation	MoneyP./Konrad
Pims	female	4	14	Affiliation	Fini

I found a statistically significant correlation between allo-preening incidents and nearest neighbour data (row-wise matrix correlation, $\tau=0.231$, $p<0.01$). Furthermore, to determine affiliated pairs for the enhancement test, reciprocal allo-preening as well as nearest neighbour frequencies (bidirectional nearest neighbour frequencies above the third quartile) were used. Three pairs could be identified (see Table 1).

Only a few recorded behaviours were rank correlated or differed between the sexes. I could find a significant rank correlation of agonistic behaviours in general (Spearman's correlation, $N=14$, $r_s=-0.924$, $p<0.001$), the object-related behaviour snatching (Spearman's correlation, $N=14$, $r_s=-0.600$, $p<0.05$) and vocalizations clicking (Spearman's correlation, $N=14$, $r_s=0.552$, $p<0.05$) and play calls (Spearman's correlation, $N=14$, $r_s=0.547$, $p<0.05$). Males showed significantly more simultaneous touches with the beak (Affiliative behaviour; Mann-Whitney-test, $N=14$, $Z=-2.328$, $p<0.05$), agonistic behaviours (Mann-Whitney-test, $N=14$, $Z=-2.622$, $p<0.01$), namely 'kicking' (Mann-Whitney-test, $N=14$, $Z=-2.664$, $p<0.05$), 'biting' (Mann-Whitney-test, $N=14$, $Z=-2.366$, $p<0.05$), 'visual threats' (Mann-Whitney-test, $N=14$, $Z=-2.380$, $p<0.05$) and 'displacements' (Mann-Whitney-test, $N=14$, $Z_{CLD}=-2.524$, $p_{CLD}<0.05$; $Z_{CLP}=-2.678$, $p_{CLP}<0.05$; $Z_{DMP}=-2.619$, $p_{DMP}<0.01$; $Z_{DVT}=-2.492$, $p_{DVT}<0.05$) as well as object related behaviours: 'snatching' (Mann-Whitney-test, $N=14$, $Z=-2.610$, $p<0.05$) and 'rostral exploration' (Mann-Whitney-test, $N=14$, $Z=-2.305$, $p<0.05$).

Enhancement Test and Controls

I could find no significant differences between the two learning forms within the conditions: dominance (GLMM, $df=4$, $F=0.901$, $p=0.469$; PostHoc Tukey-HSD, $N=5$, $p=0.361$, Fig. 6, A), kinship (GLMM, $df=3$, $F=0.217$, $p=0.881$; PostHoc Tukey-HSD, $N=3$, $p=0.813$, Fig. 6, B) and affiliation (GLMM, $df=3$, $F=0.524$, $p=0.682$; PostHoc Tukey-HSD, $N=3$, $p=0.519$, Fig. 6, C), where pair as random effect had no influence (GLMM, $F=0.000$, $p=1.0$). Comparison of the learning forms between conditions revealed no significant differences as well (Wilcoxon-test, $p>0.05$). After pooling all categories and analysing the data again for effects I still could find no significant effect of condition (GLMM, $df=2$, $F=0.0$, $p=1.0$), pair (GLMM, $df=6$, $F=0.0$, $p=1.0$) or form of learning (GLMM, $df=3$, $F=1.870$, $p=0.150$; PostHoc Tukey-HSD, $N=11$, $p=0.129$).

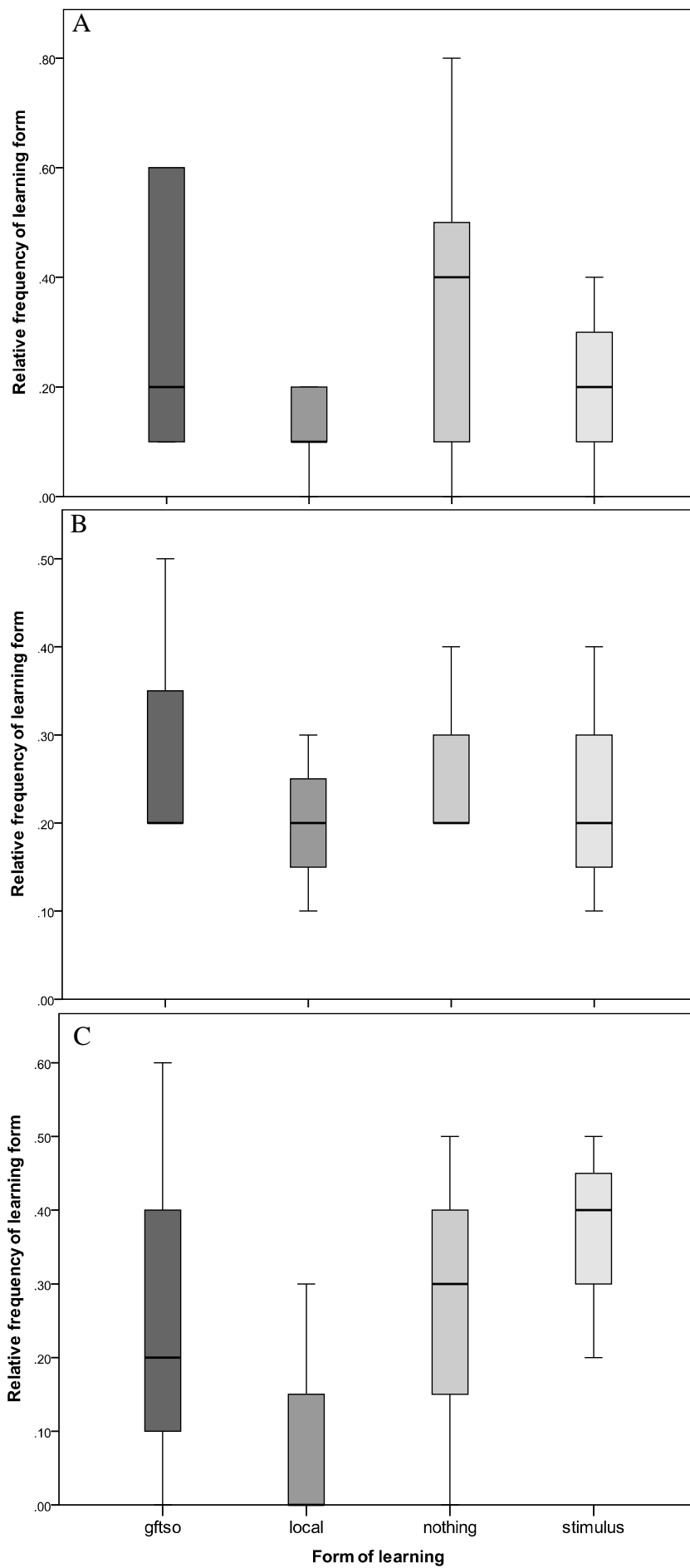


Figure 6. Relative frequencies of shown learning categories during A, Dominance condition; B Kinship condition and C, Affiliation condition. Gftso, go for the same object; local, local enhancement; nothing, neither stimulus, local or gftso; stimulus, stimulus enhancement.

More than half of the subjects showed a significant side bias during the test (Chi-square-test, $p < 0.05$, Table 2) which was consistent with the results from the perseverance test (Wilcoxon-test, $N = 7$, $Z = -1.857$, $p > 0.05$). In the perseverance test we found a significant individual side bias in 11 out of 14 subjects (Binomial-test, $N = 10$, $p < 0.05$, Table 2) which remained constant over four to five months (Wilcoxon-test, $N = 14$, $Z = -0.179$, $p > 0.05$). Six out of 14 birds also showed a side preference during the preference control task (Chi-square-test, $p < 0.05$, Table 2).

Table 2. Evaluated dominance hierarchy and results concerning the side bias from both sessions of Perseverance control, Enhancement test and Preference control; * $p > 0.05$, ** $p < 0.01$, *** $p < 0.001$; - no bias/to few data points.

Rank position	Name	Perseverance Session 1	Perseverance Session 2	Enhancement	Preference
1	Pipin	left **	left **	left **	left *
2	Figaro	right *	right **	right **	left **
3	Zozo	right *	right **	-	left *
4	Kiwi	right	right *	-	-
5	Heidi	right **	right	-	right **
6	Konrad	right	left *	left **	-
7	Dolittle	left *	left	-	right *
8	Muppet	both	left *	-	left *
9	MoneyP.	left **	left *	left **	-
10	Olympia	left	right	left *	-
11	Fini	right *	right *	-	-
12	Mayday	both	both	right ***	-
13	LadyBird	left	left	-	-
14	Pims	right **	left	right *	-

Subjects choices of object, pair or side (left/right) did not differ between individuals participating as subject or as demonstrator during the experiment (Bonferroni corrected Wilcoxon-test, $p > 0.02$).

Furthermore, during preference controls subjects showed no bias for a specific position (Friedman-test, $p>0.01$), but when comparing object, pair and side choices during enhancement test with preferred choice during preference control we found that eight out of 14 birds significantly preferred the same object (Wilcoxon-test, $p>0.05$), ten of them the same pair (Wilcoxon-test, $p>0.05$) and eight of them the same side (Wilcoxon-test, $p>0.05$) during both tests.

I could find no effect in relation to touching the left object first and the right object last but I could find that the demonstrators chose the two objects near the edges of the table more often than the middle two objects (Friedman test, $N=3$, $df=3$, $\chi^2=8.200$, $p>0.05$, PostHoc Wilcoxon test, $N=12$, $Z=-2.947$, $p<0.01$).

Discussion

Analyses of behavioural observations show that Goffin cockatoos spend most of their time manipulating objects, cleaning themselves and fighting. The dominance hierarchy in the group is highly linear where males occupy higher ranks than females. Accordingly, males show higher levels of aggression. The results of the enhancement test show no significant learning effects, neither on individual, nor on group level independent of the condition (dominance, kinship or affiliation). However, I could show that subjects had strong individual preferences for specific objects and a strong side bias (left/right).

Behavioural monitoring

The dominance hierarchy in this study group of hand reared Goffin cockatoos turned out to be highly linear with males occupying higher rank positions than females. Similar sex effects were reported in other avian families such as corvids (e.g. Izawa & Watanabe, 2008; Chiarati et al., 2010). Although sex dimorphism is not very strong in Goffins, males are generally slightly bigger and heavier (males weight ca. 300 gram and females ca. 250 gram) and bolder in novel object approach (at least within this study group). It is likely that competition between males is greater than between females and therefore males should show higher aggression levels (Izawa & Watanabe, 2008). Accordingly, male Goffin cockatoos do show higher frequencies of agonistic behaviours in general, especially in 'kicking', 'biting', 'visual threats' and 'displacements'. Furthermore, higher ranking individuals show more 'snatching' behaviour (taking over a resource from a conspecific) which supports the assumption that high ranks translate to a greater recourse-

holding potential. Additionally, this aspect may explain why we could not find any affiliated male-male pairs. The competition between males may prevent them from forming bonds. Chiarati et al. (2010) propose that dominance ranks do not only regulate access to food but also to other limiting factors such as mates. Based on observations in corvids (Röell, 1978) female rank could change after forming pair bonds inheriting the males rank (dependent rank). This was not the case during this study, birds were still too young to form stable pair bonds, but nevertheless, could have an effect on dominance hierarchy in the future.

However, in most cockatoo species the males are responsible for nest and territory defence (Forshaw & Cooper, 2003), which could also be an ecological explanation for higher aggression levels. Why clicking and play calls are rank correlated is yet unclear. We do not know the function of clicking sounds while play calls were frequently recorded during technical problem solving and/or during object exploration. One explanation could be that these calls contain informational content related to dominance. How far age and weight do play a role in dominance status acquisition within this group is not clear.

Linear dominance hierarchies can be found in other social birds such as corvids (e.g. Braun & Bugnyar, 2012; Chiarati et al., 2010; Izawa & Watanabe, 2008) and social mammals such as primates (e.g. Schino & Aureli, 2008). They are in theory only stable over time in groups of 10 or less individuals and an increase in number is thought to result in inconsistencies (Drews, 1993; Kaufmann, 1993, cited by Chiarati et al., 2010; Jameson et al., 1999). My results concerning the dominance hierarchy found in this study are consistent with this theoretical assumption. The focus-group consists of 14 individuals and coherently I found some minor inconsistencies based on one juvenile individual. Although natural populations of Goffin cockatoos form large nomadic groups of hundreds of individuals (Cahayadin et al., 1994), reports (Neo, 2012) show them foraging in smaller groups. This indicates a kind of fission-fusion society in which hierarchies could be useful in more or less fixed subgroups.

Overall, subjects spend most time manipulating objects, agonistic interactions follow on third place after self-directed behaviours. The high rate of object manipulation is not surprising taking into account their sophisticated object play and manipulative exploration behaviour. Other studies (Auersperg, van Horik, Bugnyar, Kacelnik, Emery, von Bayern, unpublished data) showed that Goffin cockatoos and Kea contrary to African Grey Parrots Hahn's macaws, caiques and burrowing parakeets do show a more complex and structurally more advanced object play. Such advanced abilities could help generalist species inhabiting difficult environments to expand their behavioural repertoire and to develop a neurological readiness for novel situations (Diamond & Bond, 1999).

There are only a few differences between the first and the second cycle of observations and these

can be explained by the conditions during behavioural recording. The first cycle was conducted in the summer, when birds had the opportunity to spend time in the outside area of the aviary. The outdoor part has a sand floor and sticks and foliage can fall in from the surrounding trees. Although a selection of parrot and toddler toys was constantly available throughout both observation cycles, subjects additionally spent a lot of time manipulating sticks and stones, dig in the ground or pull out little plants from the soil when outside. This was not possible during the second cycle of observations as it was too cold to let them outdoors throughout the day (only about 1.5 hours during cleaning, when temperatures were above -2°C). Vocalizations also decreased from summer to winter. It is likely that play calls were more frequent during the first cycle going along with higher frequencies of respective behaviours. Alarm calls, where produced more frequently outside as a response to the sight of predators and other disturbances (e.g. planes or tractors). Another important change may have been caused by the start of the mating season during winter time which was associated with an increase in affiliative behaviours.

Enhancement

Information exchange in social groups is at least to some extent based on social learning (Hoppitt & Laland, 2008). Although there are undoubtedly many other non-social means to explain changes in behaviour, social learning has been the focus of numerous studies (e.g. Fritz & Kotrschal, 1999; Templeton et al., 1999; Fritz et al., 2000; Heyes, 2000; Midford et al., 2000; Bugnyar & Kotrschal, 2002; Caldwell & Whiten, 2003; Reader et al., 2003; Caldwell & Whiten, 2004; Gajdon et al., 2004; Laland, 2004; Schwab et al., 2008; Thornton, 2008; Mikolasch et al., 2012; Heyse, unpublished data).

So far evidence on other avian species such as kea (Gajdon et al., 2004; Heyse, unpublished data), common ravens (Schwab et al., 2008; Heyse, unpublished data) and jackdaws (Schwab et al., 2008) suggest that simple forms of social learning such as local and stimulus enhancement play a major role in the respective species' exploration mode. In both ravens and kea the frequency of social learning increases when affiliated birds are present and stimulus enhancement is most frequently shown, whereas a correlation between local enhancement frequency and rank position could only be shown in ravens (Heyse, unpublished data). Jackdaws (*Corvus monedula*) in contrary to ravens and kea rather learned from non-affiliates than from affiliated birds (Schwab et al., 2008).

In this study, I tested enhancement in three social conditions (dominance, kinship and affiliation) and, in contrast to all previous avian studies, I could find no significant social effects on choice in

neither of these conditions, not even on a group level. It seems that at least in this methodological context the Goffins' explorative behaviour is largely uninfluenced by other group members. This does not necessarily mean that they do not use social learning in other contexts (such as during foraging) but it can infer that its importance is less than in other socially living species (e.g. ravens, kea, apes). However, more tests are necessary to confirm this assumption.

There are some possible explanations for this finding. First, like Templeton et al. (1999) suggested for their findings in pinyon jays (that showed high levels of social learning in a motor task but not in a discrimination task), the subjects attention could have been enhanced to the demonstrator's action rather than to the details of the objects themselves. Therefore, they could have learned from observation of the model (what to do) but not the anticipated information (with what to interact). Schwab et al. (2008) discuss a similar effect on why non-siblings of ravens did not learn socially contrary to siblings.

Another possible explanation could be that the presented task was too simple to switch from asocially sampling of the objects to socially influenced choices (Laland, 2004). The cost of exploring the presented objects compared to the benefits of using information provided by the choice of a before seen model might have been too small. Furthermore, as social learning was not food rewarded in any way the direct benefit of the socially acquired information did not differ from that of an asocial choice. As Galef (1992; 1995) states and Nicol (1995) refers to, a new behaviour will only spread if it is better rewarded than its alternatives. Although play behaviour can be rewarding in itself it does not mean that a new behaviour socially facilitated through play will always be favoured over its alternatives. Concerning this assumption Lefebvre & Palameta (1988) tested two groups of pigeons where one group observed a demonstrator pierce a paper cover to get to a food reward in a food well, whereas the other group observed a demonstrator presenting the same motor task but unrewarded. Pigeons that observed the unrewarded demonstration did not learn the task.

Our controls suggest that the birds exploration is influenced intensively by individual object and side preferences rather than by social enhancement. Since the demonstrator was not present during the subjects choice phase, thus the source of influence was gone, the impact on the subjects choice could have been too little to change from individual preferences to a socially influenced choice. Moreover, the exposure to the demonstrator was quite short (a maximum of 10 minutes) therefore, it may not have been enough to elicit a change in behaviour. A parallel setup, where demonstrator and subject get to be tested at the same time but physically separated could possibly lead to different results.

Another explanation for the lack of social influence on the choice pattern could simply be the

dyadic setup. Testing in dyads and therefore seeing just one conspecific handle an object may not have enough power to change choice based on individual preferences to socially influenced choices. Testing them in a group context may lead to different results. Laland (2004) proposed a theory he called “copy-the-majority strategy”. Thus some amount of social learning should be based on the behaviour of the majority because the more conspecifics show a specific behaviour the more likely it is to produce a productive outcome. Moreover, a more group like setup with more than one demonstrator would permit each individual to choose its own demonstrator and handling time during demonstration would increase (and strengthen the quality of the demonstration, Schwab et al., 2008) improving the probability of social learning effects (Schwab et al., 2008).

Considering the results found by Gajdon et al. (2004) in free living and captive kea, where the free living animals did fail to show any indications for social learning (although they all were interested in the presented task and were able to watch a trained conspecific) contrary to the captive group in which three out of the five tested kea immediately solved the same task. Gajdon and his colleagues explain their surprising findings with the captive keas experience with other tasks. Their findings are a striking example of how performing in numerous demanding tasks can improve the abilities of certain individuals and mask the natural capacity of the species. The animals used in this study, though hand reared, had no experience in social learning tasks.

Summary

My findings regarding dominance hierarchy and its effects on behaviour are so far in accordance with what has been found in other avian species. Although I can not be certain if my results in respect to social learning are attributable to methodological difficulties or to ecological constraints, I found that at least in this species non-food-type object exploration does not seem to be socially influenced. This suggests that, individual preferences overpower the social influence of a demonstrating individual. However, further investigation is necessary to ensure if this is a general finding or based on the setup used in this study.

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Appendix A

Ethogram

Affiliative Behaviours		
Behaviour	Code	Description
Allo-Preening	apr	One bird touches (for longer than 2 seconds) the feathers of another bird with its beak (who->whom).
Allo-preening request	apq	One bird touches/scratches its back-neck-feathers with its foot, or presents its back of the neck to another bird, while sitting next to another bird. Sometimes accompanied by a cheeping vocalization (who->whom).
Contact sit	cos	Two birds sit next to each other in a reaching distance (who initiates contact, who terminates contact).
Intervention on affiliative		One bird interferes in an affiliative social interaction between two or more birds (who interferes which birds).
Passive	iap	The third party approaches (< 1m) and watches the others.
Active	iav	The third party actively gets involved in the affiliative interaction. At the same time or shortly (< 30sec) afterwards.
Touch with beak	twb	One bird touches another one's body with its beak (who->whom).
Touch-touch	tbt	Two birds touch each other simultaneously with their beaks (who).
Touch-touch foot	tft	Two birds touch each other simultaneously with their feet (who).
Agonistic Behaviours		
Biting	bit	The bill surrounds a part of the opponent's body tightly, usually some feathers (who->whom, what body part).
Challenged displacement	cld	One bird approaches and the other retreats with defensive vocalizations. (who is Included). The submissive bird retreats without physical contact.
	clp	One bird approaches and the other retreats with defensive vocalizations. (who is included). The submissive bird retreats after a physical contact.
Chase	cha	One bird pursues another one in flight or on foot (e.g. after a fight, who->whom).
Displacement	dmp	One bird approaches and the other retreats within two seconds. This occurs without vocalizations from the receiver (who approaches, who retreats).
	dvt	One bird approaches and the other retreats within two seconds. This occurs without vocalizations from the receiver (who approaches, who retreats). The submissive bird retreats after being visually threatened.
Intervention on agonistic		One bird interferes in an agonistic social interaction between two or more birds (who interferes which birds).
Passive	ias	The third party approaches (< 1m) and watches the others.
Active	iaa	The third party actively gets involved in the interaction (includes taking turns in a chase flight). At the same time or shortly (< 30sec) afterwards.
Fight	fgt	Two birds hitting each other. One/Both jumping in the air, hitting with feet and beaks.

	fgg	Two birds hitting each other. One is down on the ground; one is sitting on top, both hitting with beaks.
Touch with foot (kick)	kck	One bird touches another one's body with its foot (who->whom).
Bill gaping	tbg	One bird threatens another one by bill gaping and making physical contact without the other one retreating (which 2 birds).
Threat	tvi	One bird threatens another one by bill gaping and not making physical contact without the other one retreating (which 2 birds).
Non-directional Behaviours		
Approach	app	One individual goes in the vicinity of another individual, not necessarily resulting in a contact sit (who->whom).
Defecation	kak	Dropping waste (defecation).
Standing alert	sta	Standing with head stretched upwards. The breast is held in a steeper position than during normal standing.
Sitting on one foot	sof	Only one foot touches the substrate, the other is retracted into the body. The bird is inactive, the neck is withdrawn.
Wait and watch	wam	Approach and watch another one handling an item without any attempt to get it (who->whom). In presence of the manipulator.
Self-directed Behaviours		
Auto-preening	atp	A bird touches its feathers with its beak. Sometimes small objects or food is used.
Bathing	bat	An individual steps into a water body in the attempt to clean its feathers. Wings are slightly opened, often accompanied by wiggling the tail and dipping the breast into the water.
Beak wipe	bwi	An individual wipes its beak on the substrate to clean it.
Scratch	scr	An individual scratches itself with its foot (what body part, with which foot).
Stretch	str	An individual stretches its wings and/or legs in the air (side of the wing(s) and/or leg).
Shake	sha	An individual shakes itself (whole body/head/wings/tail).
Jumping Jack	jja	An individual jumps up &/or back when exploring new environment/object.
Gulp	glp	An individual makes a swallowing movement, typically in response to strong emotion.
Play Behaviour		
Bat-hanging	bha	The bird hangs head downwards while holding itself with one or both feet on the substrate above. More acrobatic, the bird is swinging back and forth and flapping wings to rotate, often while uttering play calls.
Belly-jumping	bjp	The bird jumps on the belly of the opponent, who is lying on its back, and may stamp on its belly several times (who->whom).
Contort	con	The bird uses exaggerated movement of a body part without locomotion.
Dancing	dan	Hopping in one place in front of another bird while facing the opponent. Wings can be slightly extended (who->whom).
Dive flight	dif	The bird glides with outstretched wings very close to the ground so that the breast feathers may touch the ground.
Diving	div	The bird submerges its head into water so that the eyes are under the water.

Duet pirouette	dup	The bird performs <i>pirouette flight</i> with another bird within a distance of one body length (which 2 birds).
Hanging	hag	The bird is hanging feet downwards while holding itself with the bill on the substrate above.
Head stand	hst	The bird touches the ground with the top of the head while feet do not, or only slightly, touch the substrate and serve for balance.
Jumping on back	jbk	The bird is jumping on the back of its opponent (who->whom).
Lying on the back	lob	The bird is lying on its back, wings are closed and feet held straight up (may make wrestling movements). Head is oriented toward a conspecific. The bird may try to grasp a conspecific nearby. Sometimes the bird is not lying on its back but on its side.
Pirouette flight	pif	The bird suddenly changes its flying direction downwards and rotates around the body axis. The wings are closed and opened during this manoeuvre.
Pirouette	pir	The bird quickly turns around its vertical body axis.
Somersault	ssa	The bird rolls forward after head stand, lying on its back at the end.
Water probing	wpr	Only the bill is inserted into the water for a short time, without drinking.
Object/food related Behaviours		
Balancing	bal	The bird is lying on its back and is balancing an object with its feet.
Begging	bea	One individual touches another's beak and/or vocalizes with/without a seesawing movement, head down and fluffed feathers (who->whom).
Carry	car	Holding an object in the bill while the bird is moving along ground, or holding an object in its feet while flying (a subject can also carry two or three objects together).
Co-feeding	cfe	Two or more birds feed next to each other but not on the same food piece (who with whom).
Co-manipulation	cma	Two or more birds manipulate on the same fixed object or the ground (who with whom).
Combining	cmb	Basically, placing one object into physical contact to another.
	pot	An object is placed on top of another, it is called 'put on'.
	ins	Into another object (e.g. putting a ball into a ring), it is called 'inserting'.
	stc	Stacking together (e.g., stacking a ring onto a stick), it is called 'stacking'.
Cereing	cer	The forehead is held to an object so that the cere is touching it. This position is maintained for a period of time.
Chewing	chw	An object is held against the palate with the tongue. The mandible is then repeatedly pressed against it, reducing the material to a bulb.
Circular reaction	cir	Repeating a peculiar new motor action over and over again; Note the behaviour and then add that it was a circular reaction and specify the number of times it was repeated (if it was more than five times just not >5).
Digging	dig	The bill is inserted into the soil and then pulled out, bringing with it items of soil, leaves or other items.
Dipping	dip	Inserting and retrieving an object from an open cavity without releasing it (without a tool).
Dragging	drg	Once an object is grasped in the bill, the bird exerts leverage through the back and legs, pulling the object toward itself. Both feet are planted on the ground and sometimes the bird moves backwards. If the object is held down with a foot and the bill, the bird will quickly jerk the head upward to tear the object.
Dropping	dro	Releasing a picked up/lifted object from the bill or the foot so that it is subjected to gravity.
Giving	giv	The owner gives the item to another bird (who to whom).
Grab with foot	gwf	An object is grabbed with the foot and held up to the bill. Can also happen with more than one object.

























Inserting into an opening	iop	An object is inserted into an opening or a hole and is released.
Levering	lev	The tip of the maxilla reaches into a crevice and is pulled and twisted so that the opening is widened and pieces of the object are broken off.
Manipulation small object	mso	An individual manipulates a portable or draggable object in its beak by using the tong as well as maxilla and mandible.
Manipulation big object	mbo	An individual manipulates a non-portable object with its beak by using the tong as well as maxilla and mandible.
Manipulation food	mfo	An individual eats or manipulates food.
Nibbling	nib	To nibble (repeated, forceps-like movements of the bill, of the opposing tips of the mandible and maxilla) or lick a big, non portable object (e. g. the fence or a wall).
Offering	off	One individual visually presents another individual an item (who to whom).
Peeling	pel	One edge of the maxilla is drawn forcefully over the surface of an object or substrate so that parts are peeled off.
Pecking	pek	The bird softly pecks or vigorously hammers at a surface/object.
Pick up	piu	An object is sized with the bill and lifted.
Pushing with beak	phh	The bird pushes an object around with its beak.
Pushing with head	phb	The bird lowers its head and presses its forehead against an object then the head is raised and the object moved. This may be done repeatedly by trotting or hopping after the object. The object can also be rolled from one side to the other.
Put on water surface	pws	A bird places an object (carefully) onto the water surface. Sometimes the bird pushes the object with the bill so that it drifts off.
Recover	rec	An object is inserted into a cavity or placed behind another object and after a short time (<1min) retrieved by the same individual.
Rostral exploration	rex	Nibbling accompanied by in-and-out movements of the tongue.
Holding down with foot	ref	If the bird holds the object against the substrate with a foot while rostral exploration.
Rummage	rum	An object is picked up with the bill and let go with a quick lateral movement of the head, so that the item is flung for some distance.
Scraping	scp	The maxilla is hooked onto an object, the mandible is then placed a small distance away and drawn against the maxilla, eventually lifting small pieces off the surface. Alternatively, the tip of the maxilla is moved along the surface of an object or substrate towards the body.
Stealing	stl	Making use of a resource in possession of somebody else. One bird approaches another bird with an object/food, takes it and stays (who from whom).
Snatching	snt	Making use of a resource in possession of somebody else. One bird approaches another bird with an object/food, takes it and goes away (who from whom).
Stealing Attempt	ast	Failure of making use of a resource in possession of somebody else. One bird tries to take it but other bird leaves with item/food (who from whom).
Snatching Attempt	asn	Failure of making use of a resource in possession of somebody else. One bird tries to snatch but gets threatened away (who from whom).
Sitting Manipulation	sim	The object is manipulated with both feet (and possibly the beak), while the animal is supporting itself onto the substrate on its buttocks.
Sharing food	shf	Two birds feed on the same food piece (who with whom, distance).
Share	sob	Two birds manipulate one portable object together (who with whom).


























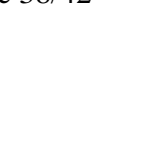
object		
Shovelling	sov	In contrast to digging, soil is removed with the bill by lateral movements of the head.
Submerge	sub	Putting/dropping an object into water and submerging it.
Tear off	tof	A part of an object is torn off while scraping, tearing, levering or chewing.
Tolerated theft	tth	The bird with the item allows it to be taken by another individual (who from whom).
Tossing up	tou	While an object is held in the bill, the head is jerked up vertically, tossing the object into the air (sometimes accompanied by hop or flap of wings).
Touch with bill	tbo	An object is briefly touched with the tip of the maxilla.
Turn over	tov	An object is turned over using the bill exposing its reverse side.
Displays		
Begging display	bgd	Two birds touch each other with opened beaks by inserting the beaks into each other 90° shifted. The plumage of the beggar is erect, the head is laid backwards and it makes begging calls while vertically swaying. Usually done by juveniles to beg for food.
Boasting display	bod	Several short, jerky circular movements of the head usually from down to up with highly erect crest and plumage and slightly opened wings, usually with vocalizations, sometimes with hopping around on the ground or perch.
Dominance display	dod	The bird is standing with open wings facing an other bird. Usually the dominant bird jumps up and down on the spot or chases the other one by jumping forward.
Threat display	thd	Crest erected, plumage of entire head neck and wing tops and breast erected, wings slightly opened upward posture with long neck, slow lateral swaying movements; without vocalizations (Scary snowman).
Twee display	twd	Horizontal body posture, neck plumage erected, lateral swaying movements of the head only, usually with crying or cheeping sounds. Mainly between affiliates or human. Possibly used to appease and/or to trigger patronizing behaviours such as allo-feeding and -preening.
Fear display	frd	Crest erected, plumage attached very close to body, long neck, fanned tail, feathers below beak erected.
Vocalization		
Crying for e.g. food	bff	Stretched snarling call like a cry accompanied by a swaying movement, horizontal body posture and fluffed neck feathers.
Cheeping	cep	A short high pitched whistle accompanied by a seesawing movement, horizontal body posture and fluffed neck feathers. Sometimes request for Allo-preening and/or food.
Alarm Call	cca	A raspy medium long very loud call similar to the typical police call of a Eurasian jay.
Defensive Call	dca	A short loud crowing sound produced when threatened or attacked by another individual.
Hissing	his	Hissing sound almost exclusively with bill gaping.
Play call	pca	Request to play. Short sequence of soft quiet raspy calls. During testing or while playing with objects.
Perching call	rca	While resting or shortly before perching the night quarter. Consists of several high pitched short sequential chipmunk like calls (in German keckern).
Creak with beak	kna	Rasp lower mandible against upper, as if chewing, but without food, resulting in a creaking noise.
Toot	tot	A short single low call, produced in the throat to express discomfort.



































Contentment call	coc	A short quiet hoarse call produced when comfortable or happy.
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Appendix B

Objekt List

Picture	Pair	Set	Description	Picture	Pair	Set	Description
	1	TS	Überraschungsei® shark toy, hard plastic, 42mm		28	OC	Soft plastic chicken toy, 32mm
	1	TS	Überraschungsei® shark toy, hard plastic, 33mm		28	OC	Soft plastic chicken toy, 32mm
	2	TS	Überraschungsei® Tigger toy, hard plastic, 36mm		29	SS	Littlest PetShop® spider toy, soft plastic, 47mm
	2	TS	Überraschungsei® Tigger toy, hard plastic, 42mm		29	SS	Littlest PetShop® spider toy, soft plastic, 47mm
	3	LH	Überraschungsei® HappyHippo toy, hard plastic, 41mm		30	SS	Littlest PetShop® snail toy, soft plastic, 42mm
	3	LH	Überraschungsei® HappyHippo toy, hard plastic, 38mm		30	SS	Littlest PetShop® snail toy, soft plastic, 50mm
	4	LH	Überraschungsei® lion toy, hard plastic, 38mm		31	SD	Littlest PetShop® salamander toy, soft plastic, 60mm
	4	LH	Überraschungsei® lion toy, hard plastic, 48mm		31	SD	Littlest PetShop® salamander toy, soft plastic, 60mm
	5	PC	Überraschungsei® cat toy, hard plastic, 40mm		32	SD	Littlest PetShop® dragonfly toy, soft plastic, 65mm
	5	PC	Überraschungsei® cat toy, hard plastic, 32mm		32	SD	Littlest PetShop® dragonfly toy, soft plastic, 65mm
	6	PC	Überraschungsei® penguin toy, hard plastic, 50mm		33	PB	Littlest PetShop® panda toy, soft plastic, 42mm
	6	PC	Überraschungsei® penguin toy, hard plastic, 45mm		33	PB	Littlest PetShop® bear toy, soft plastic, 50mm

Picture	Pair	Set	Description	Picture	Pair	Set	Description
	7	FF	Überraschungsei® Frodo Lord of the Rings toy, hard plastic, 41mm		34	PB	Littlest PetShop® racoon toy, soft plastic, 50mm
	7	FF	Überraschungsei® Lord of the Rings toy, hard plastic, 49mm		34	PB	Littlest PetShop® racoon toy, soft plastic, 45mm
	8	FF	Überraschungsei® frog toy, hard plastic, 35mm		35	CA	Littlest PetShop® crocodile toy, soft plastic, 50mm
	8	FF	Überraschungsei® frog toy, hard plastic, 40mm		35	CA	Littlest PetShop® crocodile toy, soft plastic, 50mm
	9	TD	Überraschungsei® dwarf toy, hard plastic, 45mm		36	CA	Littlest PetShop® armadillo toy, soft plastic, 55mm
	9	TD	Überraschungsei® dwarf toy, hard plastic, 39mm		36	CA	Littlest PetShop® armadillo toy, soft plastic, 55mm
	10	TD	Überraschungsei® tortoise toy, hard plastic, 39mm		37	ZB	Wooden cylinder, 30mm
	10	TD	Überraschungsei® tortoise toy, hard plastic, 38mm		37	ZB	Wooden cylinder, 30mm
	11	KH	Playmobile® hay toy, medium hard plastic, 35mm		38	ZB	Wooden ball, 40mm diameter
	11	KH	Playmobile® hay toy, medium hard plastic, 35mm		38	ZB	Wooden ball, 40mm diameter
	12	KH	Littlest PetShop® Cactus toy, soft plastic, 40mm		39	CT	Wooden cube, 22mm
	12	KH	Littlest PetShop® Cactus toy, soft plastic, 40mm		39	CT	Wooden cube, 22mm
	13	CP	Playmobile® cat toy, medium hard plastic, 25mm		40	CT	Wooden ring, 30mm

Picture	Pair	Set	Description	Picture	Pair	Set	Description
	13	CP	Playmobile® cat toy, medium hard plastic, 25mm		40	CT	Wooden ring, 30mm
	14	CP	Playmobil® plant wart, medium hard plastic, 25mm		41	BD	Wooden dice, 20mm
	14	CP	Playmobil® plant wart, medium hard plastic, 25mm		41	BD	Wooden dice, 20mm
	15	CM	Playmobile® cat toy, hard plastic, 38mm		42	BD	Wooden ball, 30mm diameter
	15	CM	Playmobil® cat wart, hard plastic, 38mm		42	BD	Wooden ball, 20mm diameter
	16	CM	Playmobile® milkcan toy, hard plastic, 20mm		43	GD	Wooden giraffe, 42mm
	16	CM	Playmobile® bucket toy, hard plastic, 15mm		43	GD	Wooden giraffe, 36mm
	17	FP	Playmobile® food toy, hard plastic, 35mm		44	GD	Wooden zebra, 32mm
	17	FP	Playmobile® food toy, hard plastic, 35mm		44	GD	Wooden donkey, 32mm
	18	FP	Playmobile® plant toy, medium hard plastic, 32mm		45	FT	Wooden turtle, 30mm
	18	FP	Playmobile® plant toy, medium hard plastic, 27mm		45	FT	Wooden turtle, 29mm
	19	SG	Playmobile® salamander toy, hard plastic, 37mm		46	FT	Wooden fish, 29mm
	19	SG	Playmobile® salamander toy, hard plastic, 37mm		46	FT	Wooden fish, 26mm
	20	SG	Playmobile® guinea pig toy, hard plastic, 20mm		47	EB	Wooden elephant, 31mm
	20	SG	Playmobile® guinea pig toy, hard plastic, 23mm		47	EB	Wooden elephant, 31mm
	21	BF	Littles Petsnops® food toy, medium hard plastic, 21mm		48	EB	Wooden bear, 38mm
	21	BF	Littles Petsnops® food toy, medium hard plastic, 22mm		48	EB	Wooden bear, 38mm

Picture	Pair	Set	Description	Picture	Pair	Set	Description
	22	BF	Littlest PetShop® bottle toy, medium hard plastic, 26mm		49	DW	Wooden dolphin, 40mm
	22	BF	Littlest PetShop® bottle toy, medium hard plastic, 29mm		49	DW	Wooden dolphin, 40mm
	23	HC	Soft plastic tiger toy, 45mm		50	DW	Wooden wolf, 40mm
	23	HC	Soft plastic horse toy, 40mm		50	DW	Wooden fox, 40mm
	24	HC	Soft plastic horse toy, 40mm		51	OF	Wooden owl, 30mm
	24	HC	Soft plastic panther toy, 42mm		51	OF	Wooden owl, 30mm
	25	CL	Soft plastic cow toy, 40mm		52	OF	Wooden frog, 33mm
	25	CL	Soft plastic cow toy, 40mm		52	OF	Wooden frog, 30mm
	26	CL	Soft plastic leopard toy, 40mm		53	MM	Überraschungsei® knight toy, metal, 45mm
	26	CL	Soft plastic lion toy, 36mm		53	MM	Überraschungsei® knight toy, metal, 48mm
	27	OC	Soft plastic cat toy, 20mm		54	MM	Überraschungsei® Puss in Boots toy, metal, 30mm
	27	OC	Soft plastic cat toy, 20mm		54	MM	Überraschungsei® Rupelstielzchen toy, metal, 30mm

Curriculum vitae

Personal Data

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Education

Since 03/2010	Master's studies, Behaviour, Neurobiology and Cognition, University of Vienna, Austria
10/2006 – 01/2010	Bachelor's degree in behavioural biology, Karl-Franzens-University Graz, Austria, Grade point average: B
09/2001 – 07/2006	Higher technical education institute for information technology, Ybbs, Austria, Grade point average: B
09/2000 – 07/2001	Stiftsgymnasium Melk (sixth form), Austria, Grade point average: A
09/1996 – 07/2000	Jakob Prandtauer Secondary school, Melk, Austria, Grade point average: A
09/1992 – 07/1996	Jakob Prandtauer Elementary school , Melk, Austria, Grade point average: A

Qualifications and internships

07-09/2013	Internship , LoroParque, Teneriffa; Marin Mammal department and bird department (Baby station)
04/2013	Workshop , Hands-on Animal Training
07-09/2011	Internship , "Waldrapteam", human-led migration of <i>Gericus eremita</i> , Austria
02/2010	Observer , Field Station La Gamba, Costa Rica
10/2009	Assistant , Seminar: Neuronal mechanisms, Karl-Franzens-University Graz, Austria
03/2009	Assistant , Zoological proseminar, Karl-Franzens-University Graz, Austria
07-08/2005	Internship , GWS IT Consulting GmbH, Melk, Austria

Language and other Qualifications

English	Advanced school knowledge, IELTS certificate level 7.5
Spanish	Basic school knowledge plus extended courses at the language school Urania Graz, Austria

Scientific communications

Bachelor theses:

1. Analysis of the surfacial temperature of ants and their formicary as well as the temperature gradient above ant trails in *Formica* sp., Grade A
2. Literature research: Spatial learning and the relevance of the median cortex in the turtle *Pseudemys scripta*, Grade A

Posters

Object permanence in the Goffin cockatoo (*Cacatua goffini*). 3rd Transfer of knowledge conference of comparative cognition (CompCog), 3-5 July, 2013, Vienna, Austria.

Scientific Publications

Auersperg, A. M. I., B. Szabo, A. M. P. von Bayern, A. Kacelnik (2012). Spontaneous innovation in tool manufacture and use in a Goffin's cockatoo. *Current Biology*, 22, R903-R904.

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