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Avian vocal and object combination development

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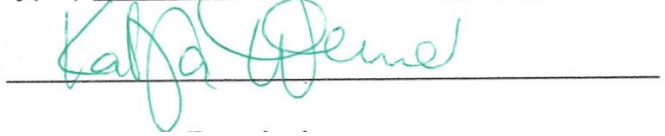
Faculty Approval Signature 

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HONORS THESIS ABSTRACT

In the past, research on animal language development has focused on primates. It has been recently examined that the avian species may show similar language development. A similar past study done by the same researcher analyzed the similarities in language and object development to past studies using an African Grey parrot, by using a Green Cheek conure. The results showed that the Green Cheek conure used a similar proportion of object and language combinations. This suggests that the development of verbal and object combinations is not limited to the African Grey parrot, and may be more general to the parrot species. This furthers the suggestion that combination language development is not limited to the primate line. In the current study, a survey is used to analyze the language and object combinations of a lager variety of parrots with a sample of 19 birds.

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In the past, research on animal language development has focused on primates. It has been recently examined that the avian species may show similar language development. A similar past study done by the same researcher analyzed the similarities in language and object development to past studies using an African Grey parrot, by using a Green Cheek conure. The results showed that the Green Cheek conure used a

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Research on language development has primarily focused on primates' development of language similar to humans. In a study looking at avian combination speech development by Pepperberg and Shive (2001), the hypothesis from Johnson-Pynn et al. (1999) was re-examined. This hypothesis involved the idea that parallel development of communicative and physical object combinatorial abilities exists in young children, that these abilities initially have a common neural base, that a shared ancestry base in great apes allows for similar parallel development, and that such abilities indicate a shared evolutionary history for communicative and physical behavior (Johnson-Pynn et al., 1999). A study by Greenfield (1999) looked at whether primates develop hierarchical organization of language and manual object combinations. It is thought that object combination is developed in a similar way to speech combinations. Greenfield (1991) explains that "grammar becomes increasingly complex in hierarchical structure", meaning that as a child develops speech they begin with one word, then two words are combined, and so on, forming "higher order grammatical relation[s]". This has been linked to the development of object combinations. Greenfield (1991) discusses the development of object combinations as such where pairing is used first "in which a single active object acts on a single static one", then potting develops where "multiple active objects act on a single static one", and last subassembly is used when "two objects are combined into a pair, which is then manipulated as a single unit in the next combination". This progression of development is increases in hierarchical order, in a similar way to grammar development. The research also examined the idea that the left frontal lobe is housing the means for hierarchical organization of speech and manual object combinations. It was found that development of object combinations and sound

combinations are based in Broca's area. They believe that advanced knowledge is needed for the correct phoneme and word combinations and that this is unique to primates. (Greenfield, 1991).

More research was done on primates in a study done by Johnson-Pynn, Fragaszy, Hirsh, Brakke and Greenfield (1999) examined strategies used to combine seriated cups by apes. The study used 2 sets of children's nesting cups that differed in height and color. It was predicted that apes would exhibit relatively more hierarchical combinations of cups than monkeys; inserting a sixth cup into a stack would show a subassembly strategy and would result in success, and apes would do this more often and effectively than monkeys. The subjects included 5 chimpanzees, 3 bonobos, and 4 capuchin monkeys. The research found that apes exhibited more hierarchically complex combinations with the cups than monkeys. They also found evidence that monkeys tended to work with the cups in the top portion of the set by removing cups and "potting" single cups into the bottom of the set. They also found that apes performed identically to 11 month old children, and capuchins performed between 11 and 12 month level. In another similarity to children, it was found that apes and monkey performed actions to correct their errors with comparable efficiency- similar to young children who correct errors by reconstructing cups. (Johnson-Pynn, 1999).

Research has begun to examine avian species' language development. In a study by Pepperberg, Sandefer and Noel (2001), the researchers examined whether or not 2 trainers are necessary for parrots to learn English labels. The study had two African Grey Parrots as the subjects. They used a M/R (adapted from Todt 1975) training technique (three way interaction between two humans and bird), solo training (one trainer), HAG

Dual (human- Alex- Griffin: two humans, where the adult parrot (Alex) was an additional model) and a HAG Solo (Alex and one human). They found results suggesting that the parrot learned most rapidly in the M/R and Hag-dual sessions, less quickly in Hag solo sessions (Pepperberg et al., 2000).

More research on the avian species was conducted by Colbert-White, Covington and Fragaszy (2011). They examined the effects of social context on parrots' spontaneous vocalizations. The subject was an African Grey Parrot. They had multiple conditions: alone- owner set recording and left house for duration of session, in- owner interacted as normal, out- owner was in adjacent room but interacted as normal, company- experimenter and owner sat in same room and simulated dialogue. The results showed that the parrot used English more than non-word units when the owner was in the room with her and reciprocated vocalizations. It was also found that the parrot produced sounds more often during the contexts when the owner was not in the room. Also, the content of vocalizations varied depending on the social context, and the vocalizations were usually amplified and persistently repeated when owner separated, (Colbert-White et al., 2011).

Pepperberg and Shive (2001) examined spontaneous object manipulation and compare avian vocal and physical hierarchical combinatorial abilities.. In the study, the subject was an African Grey Parrot, Griffin. They used bottle caps and jar lids for the object combination task. They recorded spontaneous vocal combinations, and observed object combinations. The results suggested that the parrot spontaneously combined physical objects in similar proportions to spontaneous label combinations this suggests combination behavior not restricted to primates. Also there is a possibility that brain areas

responsible for combinatory actions may be older than primate line (Pepperberg et al., 2001).

In a past study done by this researcher, a Green Cheek conure was observed. The results showed He showed a very comparable amount of two and three word combinations. This suggests that although he is a different type of parrot, his language is capable of comparable development. Jack did show more attempts at two object combinations than three object combinations, which is similar to his spontaneous speech. This further shows that spontaneous combined physical objects were combined in similar proportion to word combinations, suggesting the further correlation to primate behavior. This also suggests that if avian species shows comparable language development, this development may be older than the primate line. (Pepperberg et al. 2001). The ability of parrots to combine words in the same way as they combine objects is important to show that their language development is similar to that of humans and primates. The current study further analyzes the abilities of a variety of parrots to combine word and objects. It is questioned whether age or size impacts the parrot's ability to produce combination behavior.

Method

This study was conducted through a Qualtrics survey. Data was collected on 19 participants. Information was provided by human owners, who also provided consent for the study. Owners were allowed to complete the survey for up to 3 birds. Species of birds included African Grey, Cockatoo, Conure, Cockatiel, Quaker, Parakeet, and Macaw. The survey was administered online, and shared via social media. Owners were asked to complete both the demographic and observational surveys according to observations of

their bird. The development of these questions were used to gain a better understanding of specific characteristics of the birds, such as, their age, their species, and how long they have been living in the household. Other questions were directed at understanding the development of their word combinations, including how many individual words they knew, and how many two and three word combinations they used. The next set of questions was important for understanding how they combined objects. These questions included if they were able to combine two and three objects, and how often they used the different levels of combining objects (pairing, pot, and subassembly). Some questions asked include "How many two-word combinations does your bird use? (ex. Good+ Boy)" and "Does your bird combine two objects together during natural play?" (see Appendix 1 for the complete list of questions asked).

Results

This study consisted of 19 participants. The participants included 3 African Greys, 4 Cockatoos, 1 Cockatiel, 1 Parakeet, 1 Macaw, and 8 Conures (see Figure 1). The mean number of words known for the participants was 9.37 words (*SD*=11.98). The average amount of two word combinations bird's used was 3.74 (*SD*=5.39), the average amount of two object combinations was 3.68 (*SD*=11.73), showing similar development to the amount of two word combinations used. The average amount of three word combinations was 2.31 (*SD*= 3.43), the average amount of three object combinations was .11 (*SD*=.32).

The mean age for the participants was 8.26 years old (*SD*=7.73). To test the effect of bird age on language ability, two age groups were formed based on a median split. Since multiple birds were of the median age, the age groups were formed around the median into young birds as age of 5 and under, and older birds as those 6 and older. A t-

test was conducted to test whether the two age groups differed in the number of word combinations. The test revealed no significant difference for any of the language measures. The average number of words known by young birds was 10.27 words (*SD*=14.36), whereas for older birds the average was 8.13 words (*SD*=8.46). For two word combinations, the average number of combinations known was 4.36 words for young birds (*SD*=6.99), and 2.87 for old birds (*SD*=1.89). Young birds averaged 2.55 three word combinations (*SD*=4.37), and old birds averaged 2.00 three word combinations (*SD*= 1.69). Further, there was no significant correlation between age and language measures, all $p>0.55$. This suggests that there is no difference in bird's abilities to combine words based on their age (all $p>0.5$) (see Table1).

A t-test was conducted to test the difference between the bird's size and the number of object combinations. Small birds were defined as those the size of a Conure or smaller, whereas large defined as those the size of a Quaker or larger. Although this t-test was not statistically significant, a trend was found such that larger birds performed more two object combinations, and performed these combinations more frequently (see Figure 2). Specifically, the smaller birds had an average of 0.2 object combinations (*SD*=0.42), whereas the larger birds had an average of 7.6 combinations, suggesting that the larger birds more frequently combine two objects. There was a high variance for the large bird group (*SD*=16.66) suggesting a sample size issue. One possible cause for not finding significant results is the large difference in the variance within each group (smaller vs. larger birds), if the variance was closer there may be more significant findings. A possible result of the small birds having a low mean for the two object combination task is due to the size of the object being too large; this is examined more in the discussion.

Past research done by Pepperberg et al. (2001) showed Griffin, the African Grey Pepperberg studied, averaged 61-93% of two word combinations and 6-10% of three word combinations. For two object combinations, Griffin had 233 attempts recorded over a year, and only had 18 attempted three object combinations. These results are still similar to the African Grey parrots who participated in this test. This study's African Grey participants, showed that they more frequently combined two words than three words, and combined two objects more than three objects, showing similar word and object development to Griffin (see Table 2).

Discussion

It has been shown that birds develop their language and object combinations in a similar way to primates. Greenfield (1991) explained that grammar is developed in hierarchical order, this means that a child learns one word, then two word combinations, then three word combinations, and so on. He argues that this is similar to object development as it begins first "in which a single active object acts on a single static one", then potting develops where "multiple active objects act on a single static one", and last subassembly is used when "two objects are combined into a pair, which is then manipulated as a single unit in the next combination" (Greenfield, 1991, p.532). It was believed that this ability is housed in the Brocca's area, and is therefore unique to primates. More recent studies have revealed that parrots may also possess these abilities, suggesting that these skills are older than the primate line.

Consistent with Greenfield's proposal, overall this study found that birds formed two words and object combinations in a similar proportion, and three words and object combinations were used less. This study was able to replicate the finding in previous

research done with African Grey parrots. The three African Greys that participated in this study showed more two word- and two object- combinations, and less three word- and three object- combinations, which is consistent with past research done by Pepperberg and Shive (2001).

Beyond this, the present study expands the ability to form verbal and object combinations to all parrots. Specifically, I found that neither age nor size were a significant factor to the bird's word combination abilities. However, there is a trend for larger birds to use more two object combinations. The study of object combinations is important to understanding language development, because it is known that there is a parallel development of communicative and physical object combinatorial abilities in young children and it is thought that these share a common neural base. Due to the findings that birds do show parallel development of language and objects, it shows that the brain area responsible may be older than the primate line.

The fact that the ability to complete the object task depends on size raises difficulties for this research paradigm. The higher rate of object combinations for larger birds may indicate that they have advanced skill, but it is possible that it is the result of the task simply being too difficult for smaller birds. This second possibility is given weight by the finding that smaller birds showed an ability to combine words that was comparable to that of larger birds. Future studies could investigate a better task to represent the parallel between word combinations and object combinations. This could involve using smaller objects, more familiar objects, or adjusting the study to behaviors the bird already displays. Future studies should also investigate why all of the birds

showed more three word combinations than three object combinations. The birds show they possess the ability, but very few were able to complete the object task.

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Figure 1. Types of birds included in sample

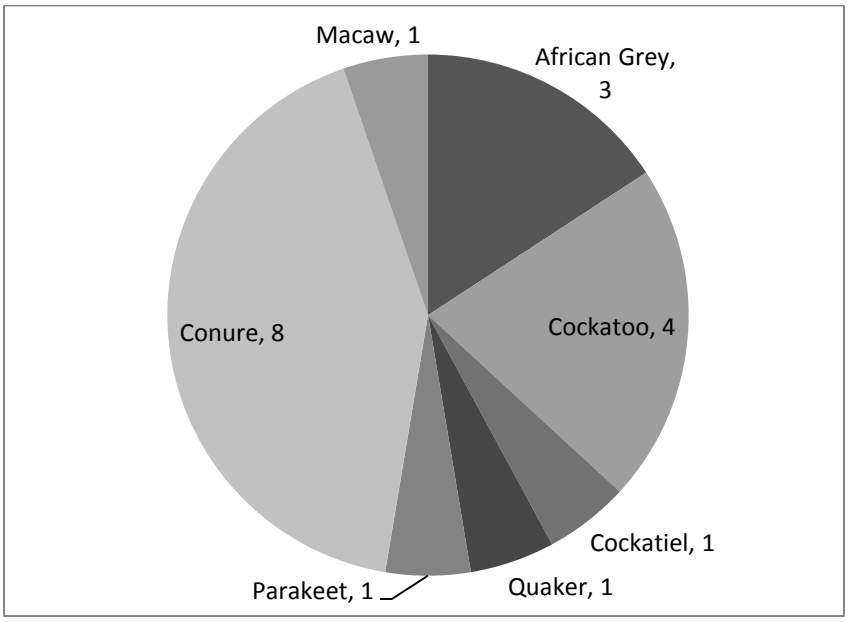
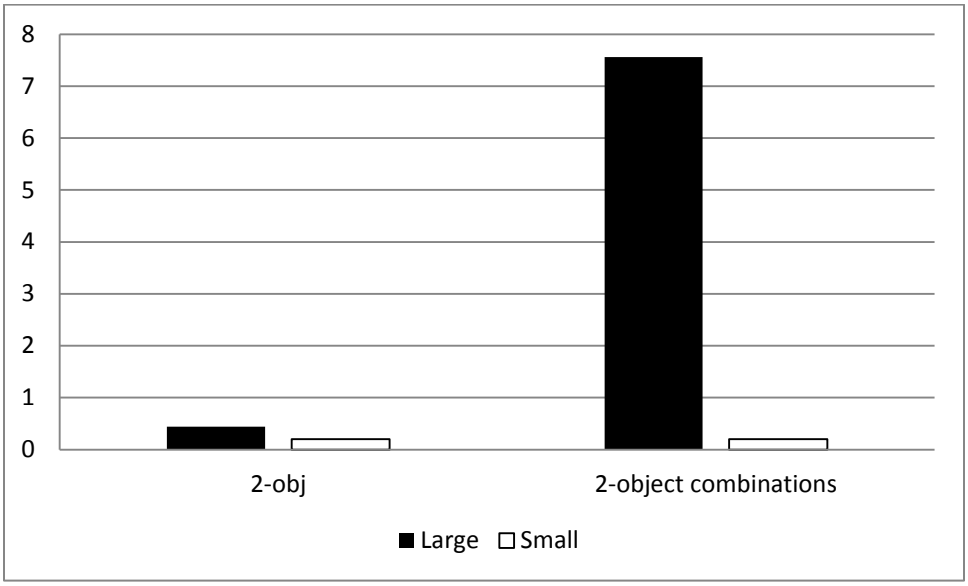


Figure 2 Object Combinations as a function of bird size



Appendix

Complete list of questions presented to participating bird owners

Demographics

1. Please report the state and county in which you currently reside
2. How many bird(s) are in your flock?
3. How long have you owned your bird (in years)?
4. What species is your bird(s)? (list all types
5. How many of your bird(s) speak words?
6. Please list the types of toys your bird plays with
7. When you offer your bird(s) a standard water bottle top, can your bird manipulate (hold, take apart, put back together, etc.)?

Observations

1. What species is your bird?
2. Please select your birds age (in years)
3. How long have you owned your bird (in years)?
4. How many individual words does your bird know?
5. How many two-word combinations does your bird use? (ex. Good+ Boy)
6. How many three or more word combinations does your bird use? (ex. I-Love-You)
7. Does your bird combine two objects together during natural play?
8. How many times in a play session does your bird pair two objects together (place one object on top or inside another)?
9. Does your bird combine three or more objects together during natural play?
10. How many times does your bird pot three or more objects together (two or more objects placed one at a time into or on top of a single object)
11. How many times does your bird subassemble three or more objects together (combining two or more objects, which are then placed as a unit onto one or more objects)?

Table 1

Age v. Word Combination Abilities

	Age	Mean	SD
Words Known	Young	10.27	14.36
	Old	8.13	8.46
Two Word Combinations	Young	4.36	6.99
	Old	2.87	1.89
Three Word Combinations	Young	2.55	4.37
	Old	2.00	1.69

$t<1$, $p \geq 0.5$

Table 2 African Grey participant results

	African Grey 1	African Grey 2	African Grey 3
Age (in years)	21	3	25
How Long Owned (in years)	12	3	3
Words Known	28	50+	1
Two Word Combinations	3	25	0
Three Word Combinations	1	15	0
Two Object	Yes	Yes	Yes
Two Object Combinations	0	3	15
Three Object	No	No	Yes
Pot	0	0	10
Sub assemble	0	0	0