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Manipulation of Same Sex Social Pair Bonds in Budgerigars, Melopsittacus undulatus

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MANIPULATION OF SAME SEX SOCIAL PAIR BONDS IN BUDGERIGARS, *MELOPSITTACUS UNDULATUS*

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Submitted in partial fulfillment of the requirements for graduation with Distinction

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Abstract

Same sex pair bonding can be found throughout various animal species. These relationships can be common in monogamous species, especially when there is a lack of members of the opposite sex. Budgerigars, *Melopsittacus undulatus*, are a socially monogamous species, which create strong pair bonds but are also known to engage in extra pair copulations. When looking at an all-male flock of budgerigars, the question arises, are these bonds easily broken or disrupted by a third party individual. After determining seven pair bonds in a flock of 32 males, these pairs were removed from an aviary and placed in separate lab cages where their social structure was manipulated using a third party male or female. Pairs were also categorized as strong, weak and control. Behaviors of affiliation and aggression were recorded before, during and after a third party individual was added and removed. It was found that there were no significant differences in the behaviors performed between strong pairs when the third party individual was present and after its removal. There were found to be significant differences in the behaviors between pairs during the presence and after the removal of the third party individual for weak and non-bonded pairs. It was concluded then that strong pairs were not disrupted by third party individuals regardless of the third party's sex.

Introduction

Social monogamy is found in diverse taxa, from birds such as zebra finches (*Taeniopygia guttata*), to mammals such as prairie voles (*Microtus ochrogaster*) (Klatt et al., 2013; Smith et al., 2011). Social monogamy is different than sexual monogamy in that the partners may form a pair bond and stay together or raise young together, but sexually they may copulate with other individuals (Birkhead, 2000). Why a species may be sexually monogamous or even socially monogamous as opposed to polygamous is widely debated (Klatt et. al., 2013). In terms of fitness and sexual reproduction, being monogamous doesn't always seem to have as many benefits as being polygamous, but still socially monogamous pairs are found occurring (Alcock and Farley, 2001; Birkhead, 2000).

Being monogamous (socially or sexually) does provide some benefits. For some species it is the benefit of always having an individual to mate with, and for many avian species it is the biparental care for raising young (Birkhead 2000). Socially monogamous pair bonds are typically only separated if one individual dies or disappears (Elie et al., 2001). Maintaining a pair bond can be crucial for immune health and over healing time, and the separation of bonded individuals can be very stressful (Martin et al., 2006). The stress of this occurrence can have multiple effects on immune systems, as well as other negative physical and behavioral effects (Martin et al., 2006; Smith et al., 2011).

It has been observed in captivity that socially monogamous species will form same sex pair bonds, often when there is a lack of the opposite sex (Elie et al., 2011; Murrary et al., 2013). These bonds, whether sexually based or not, have been seen widely throughout the animal kingdom from donkeys to dolphins (Murry et al., 2013). While these pair bonds don't have reproduction purposes necessarily, they do provide the same benefits you would find in a hetero pair bond and have been found to be just as strong (Elie et al., 2011).

As to why same sex pair bonds are formed is widely debated. There are multiple hypotheses as to the formation of same sex pair bonds or even as to why individuals are performing same sex behaviors such as copulating. It was suggested with some species, same sex behaviors are a product of dominance, individuals asserting themselves over other submissive individuals (Elie et al., 2011). 'Trial-and-error' theory is based on the idea that individuals may not be able to differentiate between males and females, though evidence has been found that this is not necessarily the case (Pincemy et al., 2010). It has been suggested that same sex pairs will form when there is a biased sex ratio, for psychosocial benefits, resource defense and biparental care (Elie et al., 2011; Murray et al., 2012).

Budgerigars (*Melopsittacus undulatus*) are a socially monogamous species known to have same sex pair bonds in captivity (Abbassi et al., 2012). These small parrots originated in Australia, where in the wild they form large flocks, but also maintain fission-fusion social dynamics (Abbassi et al., 2012). Fission-fusion is the constant moving of individuals in and out of flocks. Fission-fusion dynamics are significant in that individuals are also able to recognize others and maintain social relationships (Kerth et al., 2011).

This social species is easily obtainable at local pet stores and are known to make ideal pets for their hardiness and easy maintenance. It is suggested for social species such as budgerigars that they be housed with multiple individuals, often these birds are housed in same sex groups to avoid aggressive behaviors.

With the use of an all-male flock, it was hypothesized that non-random same sex pair bonds would not be disrupted by third party individuals regardless of that individual's sex.

Previous studies such as Elie et al., 2011 have found that with zebra finches, same sex pair bonds were just as strong as hetero pair bonds and were not disrupted by the opposite sex.

Methods:

Animals

This study used a flock of 32 male budgerigars. The birds are housed in an aviary at Otterbein University available to be viewed by the public that is on a twelve-hour cycle of light and darkness. The aviary (10'x4'x6') is cleaned daily and supplied with fresh seed and water *ad libitum*. When birds were housed in the lab, they were placed in wire mesh cages (60.9x70.1x48.8cm) with twelve-hour light cycles, food and water supplied ad libitum. The birds were housed in the lab during the second portion of the experiment for approximately six weeks.

These budgerigars have resided at Otterbein University since July 2013, and four additional males were added to the aviary in January 2014. Each bird can be identified using a numbered identification band around their leg, along with previous recordings of individual phenotypic characteristics. Individuals that were not definitively identified as males using male typical phenotypic and behavioral observations such as a dark blue cere, were sexed using PCR and blood samples. Birds found to be females were removed six months prior to the start of observations. All methods used in this experiment are within IACUC guidelines.

Aviary

Observations began with behavioral sampling of the entire flock with continuous recording for 60 minutes during each recording session. The behaviors that were recorded were affiliative behaviors used in courtship displays (Table 1). In order to count individuals as a pair in these recordings, both birds had to be interacting with each other and more than one affiliative behavior needed to be displayed; a series of affiliative behaviors need be seen, often times in rapid succession.

Behaviors	***Description***
Allopreening	Cleaning another bird's feather with their beak
Allofeeding	Transferring of seed between beaks
Beak touching	Touching of the beak to another individual's bill briefly
Head bobbing	One individual moves their head up and down rapidly, can be associated with directed warbling and eye flaring
Directed Warbling	A series of different call types uttered for more than 2 seconds, directed at another individual
Eye Flaring	Manipulation of the iris of the individuals eyes, often used in courtship
Mounting	One bird is on top of another, one wing wrapped around the individual, involves rubbing cloaca's together
Move Together	Flying from perch to perch together
Displacement	Walks or flies towards another bird's location and forces them to move
Feather pulling	Using beak or foot to grip another individual's feather and pull away from the body
Pecking/Lunging	Lunging at another bird and touches with any open beak to any part of the other individual's body
Kicking	Physical contact on another individual is made using foot
Threaten	Lunges at another bird with open beak but does not make contact, often associated with kicking.

Table 1: List of behaviors and their respective operational definitions used throughout observations. White boxes indicate affiliative behaviors and grey boxes indicates aggressive behaviors. Descriptions provided by Young, 2011. When birds were performing a specific behavior, to be considered multiple instances there needed to be at least two seconds between actions. This was determined if the individuals paused or moved away from each other

Once finished with behavior sampling of the aviary the number of behavioral instances were counted to find "suggested pairs". There were eight potential pair bonds based on there being more than one documented instance of interactions. One of these eight suggested pairs was not included due to one of the individuals dying prior to statistical confirmation of pair bonds.

A Chi-Squared test was performed to determine that the number of interactions between suggested pairs were greater than expected by random chance. Results from the Chi-Squared test showed that with five out of the seven pairs, each individual's actions toward the suggested pair mate was greater than expected by random chance. These five pairs were considered "strong pairs". In two of the suggested pairs, only one individual was found to interact with the pair mate more than expected by chance, the other individual did not. These were considered "weak pairs". Two control pairs were selected using a random number generator of the birds remaining in the flock. All nine pairs were removed from the aviary and placed into cages in a separate lab area (Figure 1). Each pair was randomly assigned an individual cage unable to view the other cages. Foam blocks were placed around the cages was used to slightly muffle bird vocalizations in the room.

Laboratory Observations

Once the pairs were moved to the lab they were given a week to acclimate to the new setting, and to prevent stress being a factor in the behaviors recorded. Behavioral sampling continued in the lab looking at affiliative and aggressive behaviors (Table 1) within each cage. Cages were observed for fifteen minutes each over a period of two and a half weeks.

After the period of two and a half weeks a third randomly assigned individual was added to each cage. Four females and five males were chosen using a random number generator (Table 2). The behavioral data collected during the aviary portion of the experiment was used to determine the third male to ensure novelty and that the members of the pair had not been recorded interacting with the new individual. After allowing the birds to acclimate for five days to eliminate stress being a factor of the behaviors recorded, focal behavioral observations were performed. Each individual was observed for five minutes for a total of fifteen minutes per cage. The same affiliative and aggressive behaviors recorded previously were used. This continued for two and a half weeks after which the third individuals were removed permanently. Five minutes focal observations continued of the original pairs for the next weeks recording both affiliative and aggressive behaviors. After observations were completed all male birds were released back into the aviary.

Cage Number	**Pair Mates**	**Third Bird**	**Third Bird Sex**	**Cage Type**
Cage 1	Batman (#34) Petrie (#36)	Kiwi (#38)	Male	Strong
Cage 2	Cloud (#2) Cotton (#24)	Robin (#49)	Female	Weak
Cage3	Zipper (#9) Rafiki (#45)	Emu (#47)	Female	Strong
Cage 5	Finnick (#20) Apollo (#25)	Ernie (#44)	Female	Strong
Cage 6	Perry (#14) Bingley (#51)	Smokey (#32)	Male	Strong
Cage 7	Tango (#31) Casanova (#50)	Twitter (#6)	Male	Control
Cage 9	Woodstock (#16) Darcy (#41)	Gimpy (#22)	Male	Weak
Cage 10	SevenUp (#7) Sundance (#28)	Dave (#46)	Female	Control
Cage 11	Albi (#23) Merlin (#26)	Basil (#29)	Male	Strong

Table 2. Laboratory setting, in which pairs were randomly assigned a cage and third party individual.

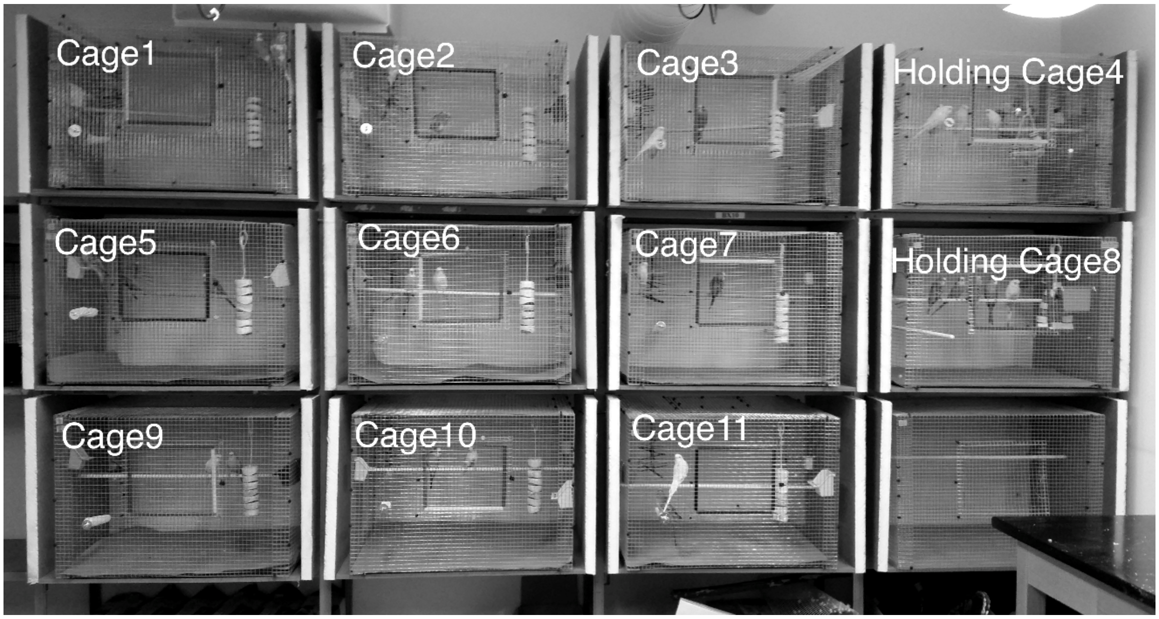
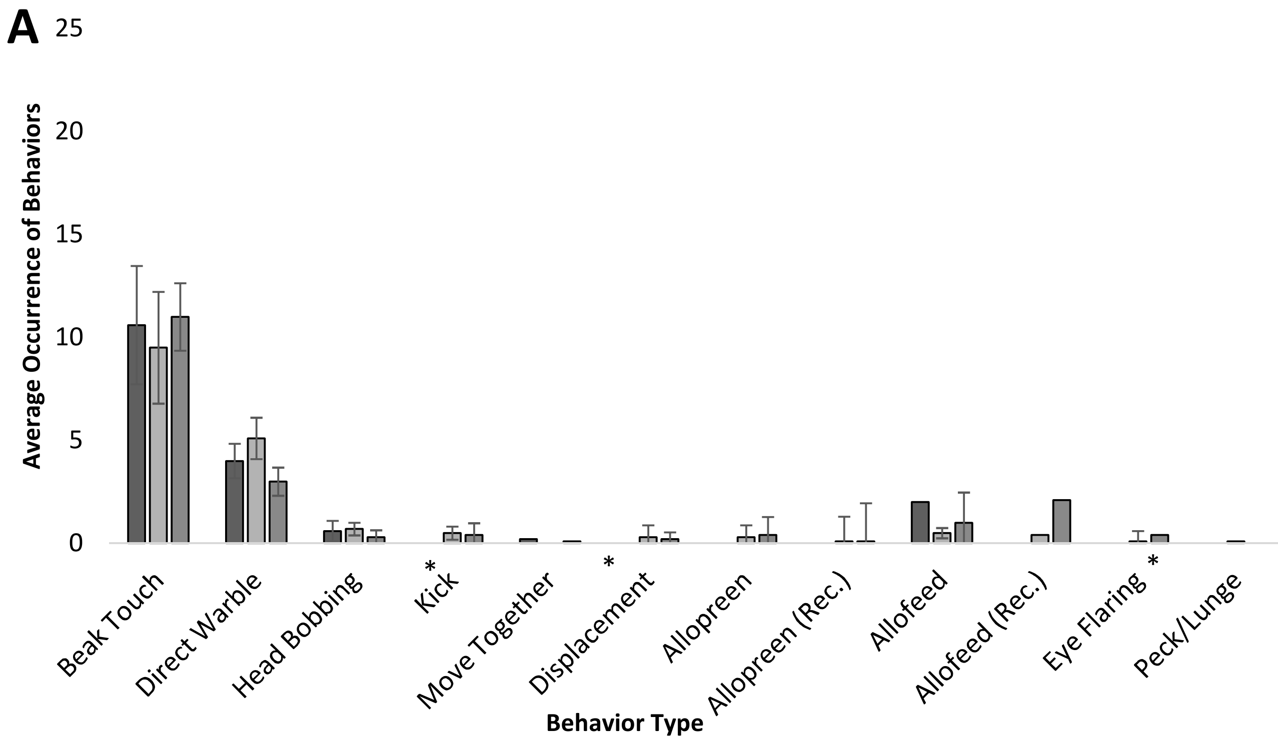


Figure 1. Laboratory setting, the wire mesh cages that housed the pairs. Cages were randomly assigned

Results

Based on the graphs presented in Fig. 2, the weak and strong cages' data looked very similar with type of behaviors and distribution during the presence of third party individual and after its removal. Strong pairs demonstrated on average more aggressive behaviors towards one another when the third party individual was present, and with weak pairs the average of aggressive behaviors performed within the pair was higher after the third party individual's removal. The control pair only displayed affiliative behaviors within the pair and on average showed these behaviors more after the removal of the third party individual.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Peck/Lunge
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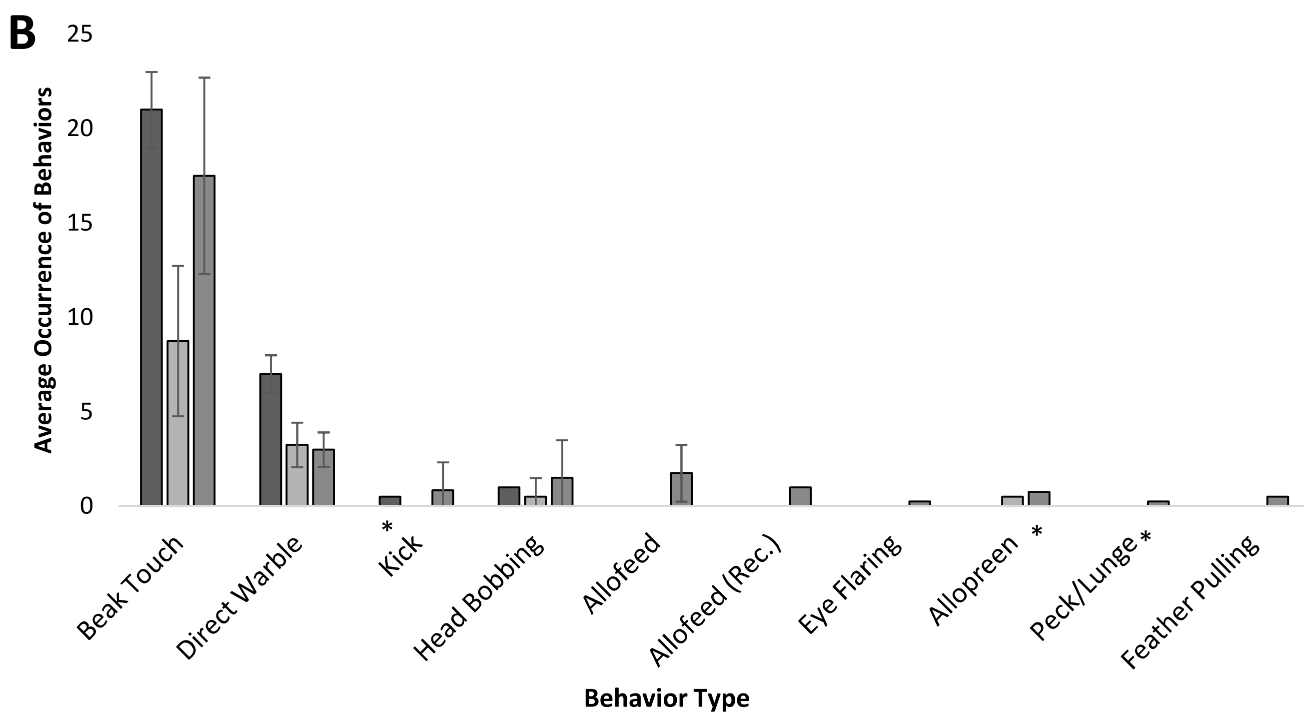
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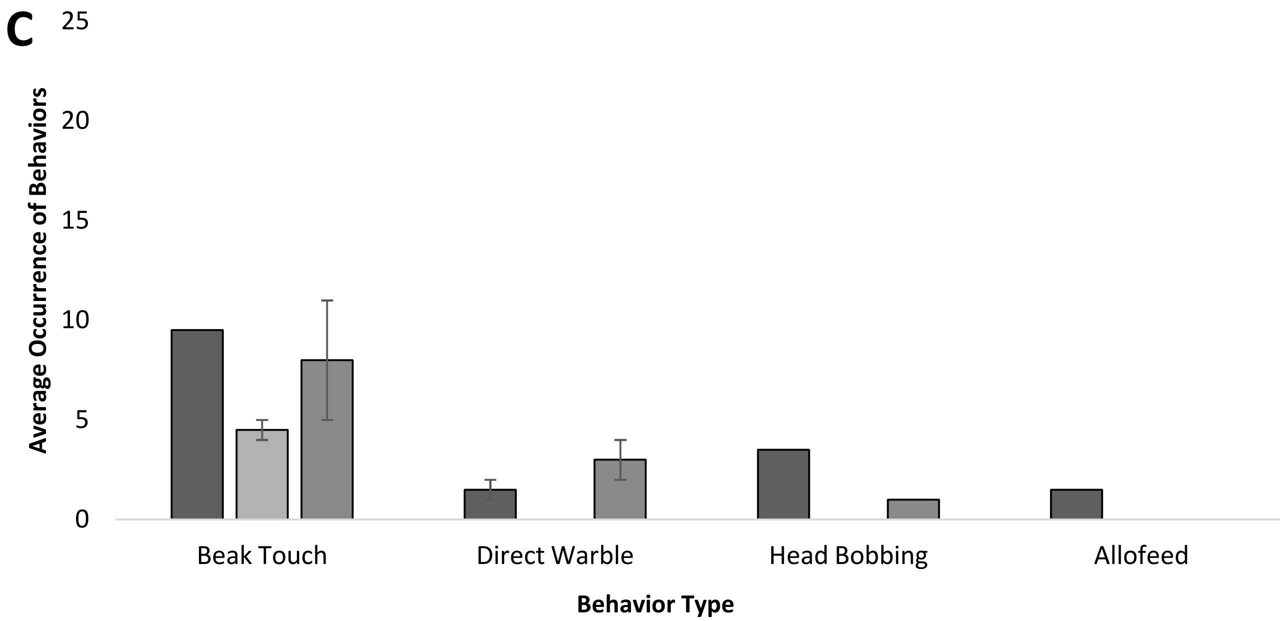

Figure 2. Series of behavioral averages based on type of cage: A is strong, B is weak, and C is control. Behaviors shown are those demonstrated between pair mates. The darkest grey represents behaviors before the third party individual was added. The lightest color represents behaviors when the third party individual was present. The medium grey color represents behaviors after the third party individual was removed. Aggressive behaviors are denoted with *.

Statistical analysis: T-tests

Results of the first t-test showed that overall there were no significant differences in the behaviors both affiliative and aggressive between the pairs during the time that the third party individual was present and after it was removed. Once broken down by individual bird, the t-test showed no significant differences in affiliative behaviors performed by the focal individual during the two occurrences. With most of the individuals in the pairs, there were no significant differences in aggressive behaviors during and after the third party individual's presence, except for one bird: Darcy (#41) in cage 9. This individual showed significantly more aggressive behaviors towards his pair mate Woodstock (#16) after the third individual was removed.

The next t-test performed showed there were significant differences in the overall interactions between pairs when the third party individual was a male rather than a female. The same results occurred when looking only at affiliative interactions between pairs were performed. There were no significant differences found between aggressive behaviors performed between the pairs when a male or female third individual was present. On average there were more total occurrences of overall behaviors performed between the pairs when a third male was present (Figure 3).

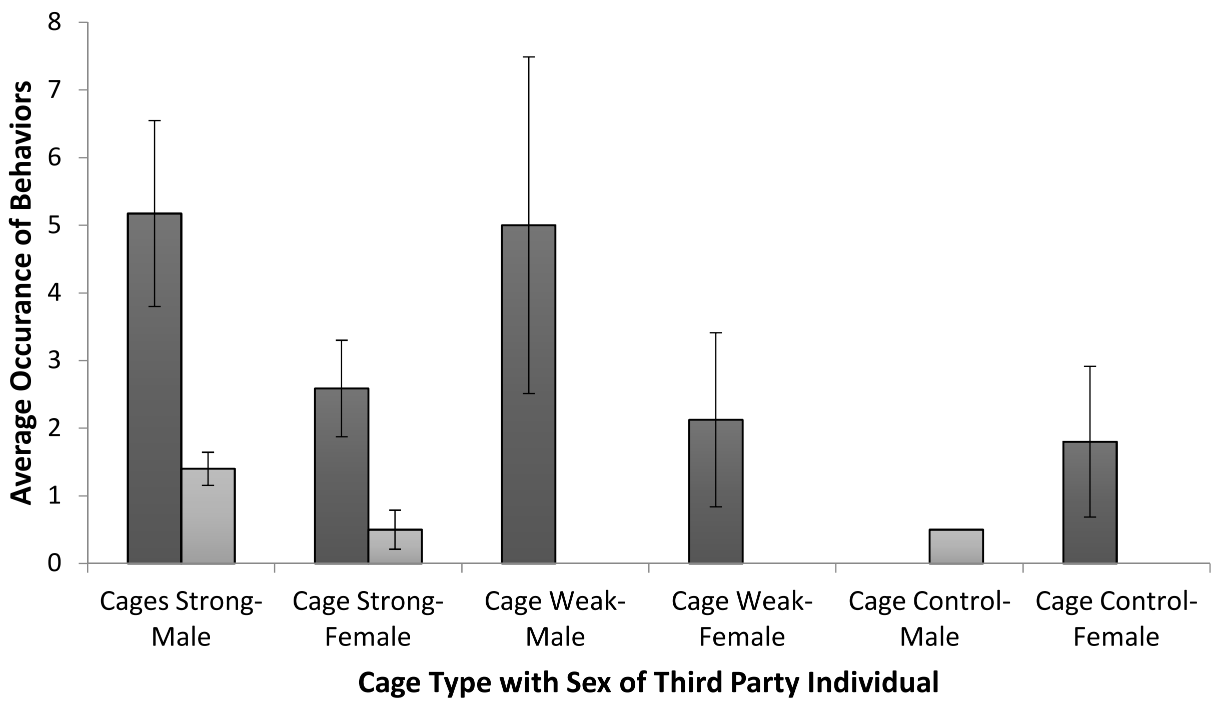

Figure 3. The averages of interactions between paired individuals once the third individual was added. Broken down by behavior type, sex of third party individual and strength of cage type. Affiliative behaviors are represented by the darker colored bars and aggressive behaviors are represented by the lighter colored bars.

Matched paired t-tests were performed to look at cage type and the sex of the third party individual during the presence of the third party individual and after its removal. For the control pair, there was found to be a significant difference in affiliative and aggressive behaviors performed by the pair during the presence of the third party female and after its removal ($t(4)=3.35$, $p=0.01$*). For the weak cages significant differences were found in affiliative and aggressive behaviors between pairs during the third party individual's presences and after their removal (t(18)=1.82, p=0.04*). For the weak cages, there were no significant differences in affiliative and aggressive behaviors between the pairs based on the third party individual's sex. For the strong cages there were no significant differences in behaviors performed by the pairs during the presence of the third party individual and after its removal (t(48)=0.52, p=0.30). For the strong cages, there were no significant differences in behaviors between the pairs based on the third party individual's sex.

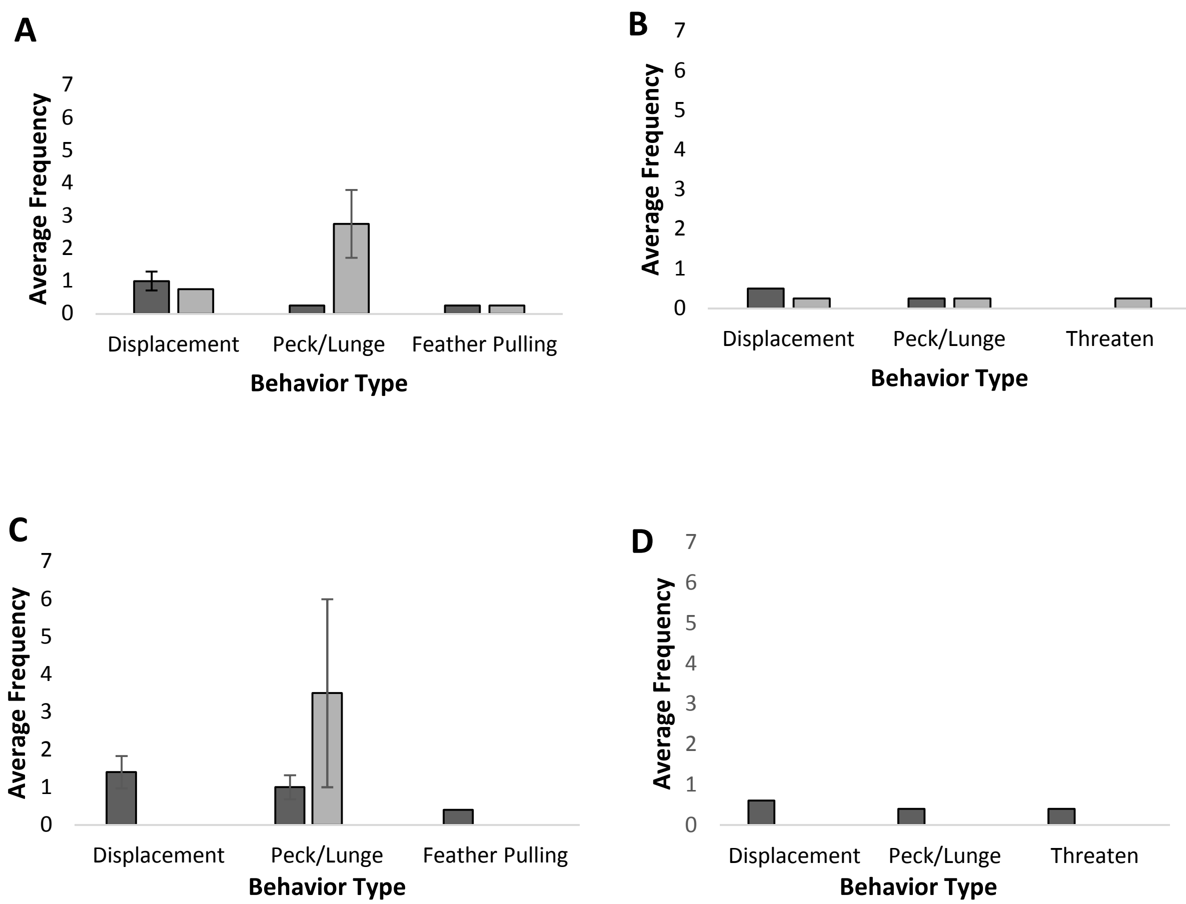

Figure 4. (**A**) Aggression directed towards the third individual by the pair members, averages based on third party **individual's sex**. (**B**) Aggression directed towards the pair mates by the third party individual, averages based on third party **individual's sex**. For graphs A and B, *male* is indicated by dark bars and *female* is indicated by light bars. (**C**) Aggression directed towards third party individual by the pair mates, averages based on **cage type**. (**D**) Aggression directed

towards the pair mates by the third party individual based on **cage type**. For graphs C and D, *strong* cages are indicated by the darkest color, *weak* cages are indicated by the lightest color and *control* cages are indicated by the medium color.

Discussion

The results of this experiment provided support for the hypothesis that non-random same sex pair bonds are not disrupted by third party individuals regardless of that individual's sex. Some reports believe that sex-ratio biases have to do with an increase in these same sex pair bonds, even when seen in the wild (Pimcemy et al., 2010). This is applicable to this study because the birds are housed in an all-male flock. It is important to note however, that even though a sex-ratio bias may have influenced the formation of the same sex pair bonds, the results of this experiment gave support that these bonds are still strong and stable enough to not be disrupted by third party individuals (Elie et al., 2011).

Results from the matched pair t-test showed that the strong pairs' behaviors were not significantly different between the time the third party individual was with the pair and after its removal regardless of that individual's sex. This along with the results of the Chi-squared test that showed that these suggested pairs were non-random supports the hypothesis. Weak pairs in which only one individual's behaviors were greater than those by chance were disrupted by a third party individual, regardless of sex of the third party. A significant difference in affiliative and aggressive behaviors was seen during the presence of a third party individual and after its removal. The individual Darcy (#41) from cage 9 was a part of a weak pair. In the case of Darcy (#41), he showed more aggressive behaviors directed at his pair mate after the third party individual's removal. Interestingly enough Darcy (#41) was the individual in this weak pair that was considered to show affiliative behaviors that were non-random towards Woodstock (#16).

There were complications found within the control pairs. Cage 7, the control pair in which a third party male was added, had to be eliminated due to the death of the focal individual Casanova (#50). For the other control pair, significant differences were found in the behaviors between the pair mates during the presence of the third party individual and after its removal. However, further investigation into this pair showed that over the course of the experiment it was possible that the control pair SevenUp (#7) and Sundance (#28) became bonded. Their behaviors from when the third party individual (Dave #46; female) was present were calculated using a Chi-Squared test to see if these interactions were random occurrences or not. SevenUp (#7) and Dave (#46; female) both interacted by chance with each other and Sundance (#28), however Sundance's (#28) directed behaviors towards SevenUp (#7) were greater than those determined by chance. Which suggests that they could be considered a weak pair.

Some instances of strong affiliative behaviors were seen outside of the data collection time periods. Many of the strong and weak pairs were observed allofeeding and allopreening on multiple occasions. Only in one pair was mounting observed, a rare behavior not seen by other pairs. This was for the pair Perry (#14) and Bingley (#51) in cage 6.

Along those lines, copulation between a male and female occurred in cage 3. Rafiki (#51) was viewed copulating with Emu (#47), outside of the data collection time periods. Four eggs were found in cage 3 and one was found in the cage once the female Emu (#47) were removed. All eggs were removed to prevent chicks from hatching. Even with these observed copulations, affiliative behaviors between the same sex pair were maintained. It was also observed that Emu (#47) and Rafiki (#51) both acted aggressively towards each other outside of copulating. Lindtedt et al., 2006, raised the idea that individuals can be constrained by their social mate choice and participate in extra pair copulations in order overcome these constraints and benefit genetically. This can be related to the case of Rafiki (#45). Even though he was seen still performing affiliative behaviors with his considered pair mate Zipper (#9), he was seen copulating with the third party female. Rafiki (#45) was maintaining his same sex pair bond while benefiting genetically by copulating with a female.

Same sex pair bonds are formed and maintained, but without an exact answer as to why. It is seen that even within the presence of a member of the opposite sex, the same sex pairs are still maintaining their relationships. With this research supporting the hypothesis that a female did not disrupt strong pairs and research by Elie et al., 2011, showing same sex pair bonds are as strong as hetero pair bonds it is apparent that these pair bonds are somewhat significant. This research can have implications on maintaining wild populations or managing captive social species. For instance with wild populations, if the sex ratio is skewed and there aren't enough females to pair with males and males are pairing off, these same sex male pairs could help raise young in order to stimulate more growth within the population. When looking at captive social species, this research shows that same sex pairs can be kept together if the opposite sex in unavailable because they will maintain the same type of relationship as with a member of the opposite sex. This research gives a little more insight into these same sex pair bonds, a topic still filled with questions.

For future directions, it would be interesting to see this experiment done again with a few changes. The observations first done when the pairs were moved to the lab were strictly behavioral per cage and did not look at the individuals. This made it difficult to compare these data to those taken during the presence of the third individual and after the third individual's removal. It would also beneficial to use large sample sizes if possible. Other future directions would be to repeat this type of experiment using heterosexual pair bonds to compare the strength of those bonds to the same sex bonds, as was studied by Elie et al., 2011.

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