Pair Bond Behavior in the Budgerigar
Melopsittacus undulatus

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Abstract

Like most members of the parrot family, budgerigars (*Melopsittacus undulatus*), very popular as pet birds, choose life-long mates. As many other permanently monogamous birds do, budgies perform various activities relating to this life-long pair bond. Pet guides stress that in order to be happy, budgies need constant companionship, a role fulfilled by a life-long partner. This experiment attempts to study the importance of the pair bond relationship in a budgerigar's daily life. Five birds were observed under three different conditions in order to find the overall time budget of the budgerigar, and the importance of pair bond activities in it. It was found that the budgies spend 58.52% to 69.73% of their time with their chosen partner, as well as 8.01% to 32.59% of their time engaged in the various pair bond activities. The time spent on pair bond activities increased significantly when there were more males than females present and after a time of partner separation. One pair was separated for a period of 32 days with other potential mates present. The old pair bond remained intact after the two birds were reunited. All in all, the pair bond relationship was shown to play an important role in the daily life of the budgerigar.

Introduction

Background Information

About 90% of the world's 8,800 bird species practice one form of monogamy or another (Dennis 1993). Due to the huge energy cost of raising young, a monogamous lifestyle is advantageous for the reproductive success of the birds. Firstly, egg-laying takes an enormous energy toll on the female. Then she must guard and warm the eggs 24 hours a day until they hatch. Before they can fly, the young birds require that all food be brought to them. In most environments, the female cannot do all this by herself, which is why only 10% of birds are not monogamous. In the interests of passing on her genes, the female needs a mate who will help. The male must bring her food while brooding, or at least take over so that she can go eat. He must also then help feed the nestlings while they are growing. In the interests of passing on his genes, the male must take up half the responsibility in raising the young. He is better off devoting all his time to one brood, thus ensuring their survival, rather than fertilizing lots of eggs haphazardly and leaving their survival up to chance (Burton 1985). For most species of birds, having the care of two parents is vital to the survival of the young. For this reason, mated pairs will stay together at least until the nestlings are fully fledged, sometimes much longer.

The length of time a pair will stay together is influenced by the environment. Pair bonds, as they are called, can last as briefly as the time it takes for one clutch to be fledged or as long as the bird's lifetime. It may seem that switching mates every season can lead to the best possible genetic combinations and the healthiest offspring, and indeed this is true for some species. Yet in other species, reproductive success is best when pairs stay together year after year, or even for

life. Birds that practice permanent monogamy include ravens, storks, swans, cranes, some owls, and most parrots, among others. Life-long monogamy becomes advantageous when the optimal breeding time is short or unpredictable. In arid climates, for instance, as soon as it rains, birds must take advantage of the resulting plant growth. Pairs will get right down to the business of mating and nesting, rather than wasting time on competing for and choosing a mate. Also, large birds, like Canada geese, exert so much energy in flight, especially during migration to summer nesting sites, that they have little to spare for the flashy courtship games of some smaller birds. Instead, they take advantage of the good weather and abundant food, giving their offspring a chance to mature before the fall migration (Dennis 1993).

Increased reproductive success seems to be the underlying reason for the development of permanent monogamy, but pair bonds have become important social relationships outside the breeding season. Most species that practice life-long monogamy choose their mates even before they are reproductively mature. Canada geese can have a year-long "engagement" period before a pair even mates (Dennis 1993). "In extreme cases of monogamy, the bond can last well into old age, when they are no longer capable of reproducing. . . . An old or sick animal stops all courtship and sexual activity and the young or healthy partner is often overwhelmed with offers from other members of the species who have not yet mated. Nevertheless, it quite often adheres to its mate, which shows clearly that the pair bond is not based on the sexual activity between the two partners" (Wickler 1972). Known examples of devoted birds like this include Bourke's parrots, violet-eared waxbills, and bullfinches. It is obvious that the pair bond is important to the birds for more than just reproductive reasons. "Firm monogamy with a partner who is too old or sick prevents the healthy partner from reproducing too. This shows that pair bonding is independent of reproduction and can even come into conflict with it" (Wickler 1972).

Many species form "practice" bonds while still young. Species of the African parrot genus *Agapornis*, for example, form bonds while still in juvenal plumage, before the sexes are distinguishable. Some of these bonds may be homosexual, but when the birds reach adulthood, the homosexual pairs spontaneously break up and true pair bonds are formed (Dilger 1977). Seven-week old nestling bullfinches "affiance" themselves with a brother or sister in the nest, also while in juvenal plumage. "Sibling pairs cling together just as firmly as adult pairs, but not as long" (Wickler 1972). After about three months the young birds molt, and sexual markings become apparent. These sibling marriages are dissolved by the end of the year, the homosexual ones more quickly than the heterosexual ones. Once the gonads are fully functioning, the young bullfinches seek out and pair up with members of the opposite sex who are not siblings. The biological significance of these "practice" pair bonds is not known. "We do not know whether, if one removed the opportunity for sibling bonds, these individuals would later have difficulty in their relations with their marriage partner" (Wickler 1972). Of course, these early practice bonds do not involve mating, but rather only the other activities that members of a pair usually engage in. The fact that young birds form these early bonds suggests that the social skills involved in the pair bond are important to the birds' future success.

The devotion a bird exhibits toward its partner is not always an advantage. An unfortunate example of pair bonding without the possibility of reproduction involves the Spix's macaw of South America. Due to habitat loss and the illegal pet trade, the wild Spix's population has been reduced to one lone male. Out of a need to form social bonds, he has become the constant companion of a female Illiger's macaw, another species which lives in the same area. In a last-ditch effort to save the wild population, environmentalists have attempted to release a female Spix's into the wild. But the old pair bond has held, even when the two are not

of the same species and therefore cannot have offspring (Margolis 1996). The strength of the pair bond can be impressive at times.

Pair bonds are generally formed quickly and strongly. Since many bird species live in flocks, individuals have many prospective partners to choose from. "The exact mechanisms of pair formation are obscure. If a group of unpaired adults (of *Agapornis* species) are liberated into a large flight cage, they will form a rather well-knit flock. They tend to perform their various maintenance activities in concert. Each bird attempts to interact socially with a number of others. This consists of attempts to preen others and to sit closely with others and so forth. Soon it becomes apparent that certain combinations seem to be more fortunate than others and the two birds tend to seek each others company in preference to other birds. The bond becomes progressively stronger until in just a few hours, the pair bonds seem to have become firmly established" (Dilger 1977). Exactly why and how certain bonds are formed over others is not known. The pair bonds simply develop as a normal feature in flock life.

Once a bond is formed, the two members will spend most of their time together. Pair formation in the bearded tit occurs along the same lines as that of the Agapornis parrots. Young bearded tits live together in flocks which often contain groups of siblings. They all interact socially, but soon each male tends to concentrate his efforts on one female. She may reject him by hacking at him with her beak and chasing him away. If she does like him, however, the two will spend all their time together, rather than with their brothers and sisters as before. "During cleaning, drinking, foraging, bathing, and sleeping, the one will hardly leave the side of the other, and they continually preen each others ruffled feathers. . . If one loses sight of the other, it will call loudly until they have found each other again" (Wickler 1972).

Obviously, this closeness between partners is important during the breeding season. If

they are to be successful in raising their young, they must be able to get along. But many pairs live together the entire year through. "In most (of these species) special behavior patterns have been developed that serve to maintain the pair bond" (Immelmann 1973). Many of these behaviors seem to have come from the breeding season, but have taken on different purposes outside of breeding.

The first of these behaviors is courtship feeding. Males regurgitate food from their crops and feed it o the female, who may be acting out begging motions. This is how both parents would feed nestlings. In certain species, the female doesn't ever leave the nest while incubating the eggs. The male must bring her all the necessary food. In these cases, the purpose of the feeding and begging is obvious. But what about when it is removed from any nesting situation? Often before a pair mates, males will use courtship feeding to impress the female, showing her that he will be a good father. The behavior has also been further removed to have nothing to do with nesting or breeding. In gulls, females returning home from feeding will beg from the male who has been guarding the territory. "The amount of food passed between these birds is less important than the cementing of the bond between the pair"(Burton 1985). "Feeding the young has become partner feeding for the bullfinch while the female broods. In addition, tenderness feeding has come into being outside this period" (Wickler 1972).

Beaking or billing is another example of a pair bond behavior. It is thought to be an abbreviated form of courtship feeding that has found a purpose outside the breeding ceremony. Beaking only occurs between members of a pair, and not with other flock members. In the masked lovebird, beaking occurs while the two birds are quietly resting near each other. Beaking also increases when the pair has been disturbed, when a stranger has been introduced into the group, or when an outside danger has passed. Beaking is used as a greeting after a time of

separation, as well. Quarrels between partners often end with one attempting to beak flirt with the other, and the other will usually immediately agree. "The appeasing or pair-bond strengthening function of billing is just as evident here as in the relaxed, neutral situations." In the bullfinch feeding "has evolved into a beak flirtation without the transmission of food, which serves the partners as greeting"(Wickler 1972).

Allopreening is another behavior reserved for just members of the pair bond. Here, one of the birds will preen the head and neck feathers of its partner. Although it serves a function, allopreening is not necessary to feather maintenance, since individuals without partners or members of a species that does not exhibit this behavior do not suffer for it. Allopreening, like billing, increases after two partners have been separated. An argument between partners might end with one of them offering up ruffled neck feathers to the other for allopreening. Here, the function of appeasement and pair-cementing is apparent (Wickler 1972).

So the pair bond is a complex social relationship. Although its origins may have been for the purpose of increased reproductive success, it has become much more than that. Healthy individuals need to have healthy pair bond relationships if they are to raise healthy offspring. In species that practice permanent monogamy, the pair bond starts before they are reproductively mature, and lasts until old age and death. Several behaviors have developed in order to maintain the strength of the pair bond. These behaviors may have started out with certain purposes in relation to raising young, but they have become independent of the breeding and nesting times. A wide range of birds, from different habitats, sizes, and lifestyles, form life-long bonds characterized by these pair bond activities. Members of a pair bond are more than just mates, they are constant companions to one another.

Study Organism

Most members of the parrot family are known to choose life-long mates. The budgerigar, or parakeet (*Melopsittacus undulatus*), is one such monogamous species. Parakeets originally come from the shrubby grasslands in central Australia. Living conditions in this arid climate are harsh. Daily temperatures can range from 110 F during the day to below freezing at night. Budgies live in large flocks, moving wherever there is enough food and water to support them.

Their difficult, nomadic way of life is one reason why budgies are permanently monogamous. When the flock comes to a place that has just had rainfall, the birds change their entire way of life. The rain ensures that there will be plenty of ripe and half-ripe seeds to feed the young. The males begin courtship displays, and the females start hollowing out a suitable nest hole. These birds, and many others who live in such harsh conditions, need to mate, brood, and raise young in a short period of time. Having a mate already chosen for each bird is one way to cut down on the long rituals of mate competition and selection.

Choice of a partner begins at an early age, even before the first molt and before the birds are reproductively mature. Whether or not a bond is formed depends on whether the female likes the male. In 1926, Cinat-Thompson found that female budgerigars choose males to which they are most attracted on the basis of color pattern and song (as cited in Dilger 1977). The male will attempt to preen the female and sing to her. If she likes him, the female parakeet will allow the male to feed her and preen her. If she doesn't like him, she will aggressively chase him away. Once a bond has been formed, it usually lasts for life. The two members will be constant companions to one another, even when not involved in mating or raising young.

In captivity, budgerigars may also form a life-long bond. The rituals of the pair bond are helpful during long hours in captivity. If there are only two birds of the same sex, one will

assume the role of the missing sex in the bond. Budgies will occupy themselves by displaying, feeding, and preening. If it is a true pair, and a nest box is provided, the parakeets may mate and raise young.

A budgie kept alone will not be happy unless there is a human willing to devote a lot of time to it. The human serves as a surrogate partner. These parakeets kept singly make the best pets, trainable and tame. But budgies are social creatures, and keeping them singly will deprive them of flock-living and the possibility of a life-long partner. Single birds that do not receive enough attention from a human will become frustrated and depressed. They may even peck out their own feathers from boredom. Many pet guides stress that budgerigars are most happy when kept with at least one other member of their species, preferably more. This is because the amount of time they devote to pair bond activities and to other social interactions is considerable. "A parakeet needs a partner to share all its doings, including rest and sleep. All birds that live in flocks are stimulated to activity by their partners and by the other birds around them. If one bird starts preening itself, soon all the others will be busy cleaning their plumage. If one flies off in search of food, most of the rest will follow. If one wants to rest and sleep, its partner, if no other bird will get sleepy too" (www.inforamp.net/~dhansen/partner.html 1998). Few studies have been done on the budgerigar and just how much time it devotes to pair bond activities.

In this study, the pair bond activity of the budgerigar was observed, with the assumption that pair bond activities take up a certain important amount of their time. The dynamics of the pair bond were also observed, how males treat other males, how females treat females, and how the two members of the bond treat each other. Observations were made under three different conditions: 2 males, 2 females; 2 males, 1 female; and 3 males, 2 females, to see how this effected the amount of time devoted to pair bond activities. An attempt to break an established

pair bond was also made, by separating the pair for 32 days with other potential mates present. All these observations were made in order to gauge the strength and importance of the pair bond relationship in a budgies' daily routine.

Methods

Originally, four birds were purchased. Lucy, Ricky, Fred, and Ethel, all probably about 4-6 months old, were kept in the animal room in Heim starting in mid-September of 1997. At first, they were kept in a small cage, but by the end of October, a larger cage was built for them. The new cage has multiple perches and food cups, two nest boxes, and is large enough for the budgies to fly around. The birds' behavior was observed in order to determine categories of behavior. Actual recording of data began on November 14, 1997. The method of observation used was instantaneous sampling (Altmann 1979). The instantaneous location and activity of each bird was recorded every minute for varying time spans and at varying times of the day. By mid-February, the time span between samplings was shortened to 30 seconds. Observations were made through a two-way glass wall.

The experiment consisted of three parts. First, Lucy, Ricky, Fred, and Ethel were observed. Lucy and Fred acted as a pair, as did Ricky and Ethel. Observations for these four birds were made from November 14, 1997 to January 31, 1998, excluding Thanksgiving and Christmas breaks. In total, 43 days of observations were made. Observations on these four birds make up Stage 1, as indicated on tables in the Data and Observations section. Anytime Stage 1 is referred to, it means the balanced situation of 2 males, Ricky and Fred, and 2 females, Ethel and Lucy.

On February 2, 1998, a fifth budgie, named Skippy was purchased. Ethel was removed from the large cage and placed in a cage with Skippy. The two birds were kept in a separate room and could not see or hear the other three birds. Observations were made on Lucy, Ricky, and Fred in the big cage just as before. This set of observations makes up Stage 2, with 2 males, Ricky and Fred, and 1 female, Lucy. Days of observation total 13. The separation of Ricky from Ethel lasted 32 days, while Ethel was isolated with Skippy, the new budgie.

Ethel and Skippy were then reintroduced into the large cage on March 6, 1998. The five birds were observed the same way as in the previous parts of the experiment. Stage 3 consists of observations made on these 5 birds; 3 males: Ricky, Fred, and Skippy; and 2 females: Ethel and Lucy. Observations were made from March 6 to April 2 in the same way as for the other two stages of the experiment. The total number of days observations were made is 41.

The categories of behavior recorded include some activities that must be defined:

Maintenance activities- include behaviors which are necessary to the survival of the bird, like eating and drinking. Preening one's plumage is also included, as it helps keep the bird clean, healthy, and able to fly.

Gravel- at the bottom of the cage, there is a pan containing gravel. Eating this gravel helps the birds digest their food. Anytime one of the budgies was down on this pan, its location and activity was recorded as "gravel."

Neutral activities- includes flight and rest, as no other specific action can be attributed to these instances. Rest is a broad category that includes sleep, actual rest, and instances where the birds may have just been momentarily between activities, as is often the case when using instantaneous sampling methods.

Pair Bond related, both members- either of the partners may initiate the behavior

Allopreening- when one budgerigar preens the head and neck feathers of its partner.

Begging- when the female, standing directly in front of the male, crouches down slightly, tilts her head, and opens her beak to receive food from the male.

Feeding- the male regurgitates food into the female's open beak.

Beaking- the two members of the bond briefly touch their beaks together.

Courting/ Being courted- the male acts and the female responds. Courting consists of singing, head-bobbing, and beak-touching and can also sometimes include begging and feeding. Often, the males' pupils contract and his head feathers stand up while courting.

Pair Bond related, males only

Display- involves the same behaviors as courting, but the male is not directing them at the female. It may be towards a mirror or other object. Usually, he will display and then attempt to court the female. If the female gives no response, the male will just go back to displaying.

Guarding- a male stands near his partner while she drinks, eats or plays in order to discourage any interference from another bird.

Fighting (pair-related)-

For females- males fighting for females can be an extension of guarding. Another bird attempted to disturb the female and the male fights for her.

Over females- when one male courts the female who is not his partner. The real partner of the female in question will fight off the intruding male.

Play - This especially includes chewing of things like nest boxes, perches, and mineral block, but also includes activities like banging the mirror to make the attached bell ring.

Fight (not pair-related)- this type of fighting can occur between any sexes and individuals, not just between males.

Over food- two or more birds fight over a food or water cup

Over toy/place- two or more birds fight over a particular toy, like a mirror, nest box for chewing or mineral block. They may also fight over sitting in a particular place, like on one of the swings or one of the nest boxes.

Results

The overall time budget of each budgerigar was calculated from the data. The number of times each category of behavior occurred for each bird was counted up and divided by the total number of samplings. This gave the percentage of time each bird spent on a certain activity. Percentages were calculated for every activity recorded. The location of each bird recorded during sampling was used to determine the percentage of time two partners spent together rather than apart, as shown in Table 2. Statistical analyses were also performed (see Table 7). This was done using the percentiles of time budget for each day of observation in a Rank Sum test. Since Stage 2 only had 13 days of observation, 13 random days were chosen out of the other two stages for comparison. The total number of samplings was 674 for Stage 1, 270 for Stage 2, and 836 for Stage 3. This means there are 674 sets of recorded location and activity for each of 4 birds for Stage 1, and so on. For detailed data descriptions, see the included tables.

Table 1 shows the overall time budget for each bird in each of the three stages. Note that time spent in pair bond activities increases at the expense of rest. Times spent in other activities remain relatively constant in each of the three stages. In Stage 1, Ethel is the least active bird as

Table 1 Overall Time Budget

Stage 1 Total data sets-674

	Lucy	Ricky	Fred	Ethel
Maintenance	**16.32%**	**16.77%**	**17.66%**	**13.20%**
Drink	1.04	1.19	1.48	.59
Eat	2.97	3.86	5.04	2.52
Gravel	1.78	1.93	2.37	.89
Preen	10.53	9.79	8.75	9.20
Neutral	**67.06%**	**58.30%**	**61.42%**	**72.26%**
In Flight	2.67	3.26	4.01	.75
Rest	59.94	55.04	57.42	71.51
Pair Bond	**10.39%**	**19.44%**	**16.62%**	**8.01%**
Play	**6.97%**	**2.08%**	**1.63%**	**3.56%**
Fight	**3.71%**	**3.41%**	**2.67%**	**2.97%**

Stage 2 Total data sets -270

	Lucy	Ricky	Fred
Maintenance	**20.00%**	**21.85%**	**21.48%**
Drink	1.48	.74	.74
Eat	5.56	6.30	6.67
Gravel	.74	.74	1.48
Preen	12.22	14.07	12.59
Neutral	**50.00%**	**43.33%**	**42.22%**
In Flight	1.48	2.22	2.22
Rest	48.52	41.11	40.00
Pair Bond	**18.52%**	**27.78%**	**32.59%**
Play	**9.26%**	**2.97%**	**1.11%**
Fight	**2.22%**	**4.07%**	**2.59%**

Stage 3 Total data sets - 836

	Lucy	Ricky	Fred	Ethel	Skippy
Maintenance	**16.75%**	**16.15%**	**17.11%**	**15.31%**	**16.75%**
Drink	1.44	1.08	1.79	.84	1.32
Eat	3.47	3.83	4.31	3.59	3.95
Gravel	1.32	1.56	1.67	.96	1.32
Preen	10.65	9.69	9.33	9.93	10.41
Neutral	**57.76%**	**46.89%**	**55.86%**	**57.89%**	**64.59%**
In Flight	2.27	2.27	2.51	1.07	1.67
Rest	55.74	44.62	53.35	56.82	62.92
Pair Bond	**13.04%**	**29.55%**	**20.81%**	**16.27%**	**9.81%**
Play	**8.73%**	**3.35%**	**2.99%**	**6.94%**	**4.67%**
Fight	**3.95%**	**4.07%**	**3.22%**	**3.46%**	**4.19%**

Table 2

Pair Bond Relationship

Time Spent with Partner-

	Stage 1	Stage 2	Stage 3
Lucy&Fred	60.24%	58.52%	58.73%
Ethel&Ricky	68.99%	X	69.73%

Pair Bond Activities-

	Stage 1	Stage 2	Stage 3
Lucy	10.39%	18.52%	13.04%
Fred	16.62	32.59	20.81
Ricky	19.44	27.78	29.55
Ethel	8.01	X	16.27
Skippy	X	X	9.81

Table 3

Pair Bond Activities

Lucy - 10.39%

Ethel - 8.01%

Fred - 16.62%

Ricky - 19.44%

Both members-

	Lucy&Fred	Ricky&Ethel
allopreen	3.12%	2.52%
beg/feed	1.34	.74
beaking	.45	.15
courting own/ being courted	5.49	4.60

Males only-

	Fred	Ricky
display	1.93%	4.30%
guarding		
food	.89	1.34
toy/place	0	.59
courting other	0	1.78
fighting		
over females	1.48	1.48
for females		
food	1.19	1.19
toy/place	.74	.74

Table 4

SECOND STAGE

Pair Bond Activities

Lucy - 18.52%
Fred - 32.59%
Ricky - 27.78%

Both members-

	Lucy&Fred
allopreen	4.07%
beg/feed	1.11
beaking	.74
courting/ being courted	9.26

Lucy's response to Ricky's courting-

accept - 1.11%
reject - 2.22

Males only -

	Fred	Ricky
display	6.30%	13.70%
guarding		
food	2.22	X
toy/place	1.11	X
fight over Lucy	7.77	7.77

Ricky attempts to court Lucy- 6.30%

Table 5 THIRD STAGE

Pair Bond Activities

Lucy - 13.04% Fred - 20.81%

Ethel - 16.27% Ricky - 29.55%

Skippy - 9.81%

Both members-

	Lucy&Fred	Ricky&Ethel
allopreen	3.23%	4.19%
beg/feed	1.91	2.51
beaking	1.32	.96
courting own/ being courted	6.58	8.61

Males only-

	Fred	Ricky	Skippy
display	3.47%	5.50%	6.46%
guarding			
food	1.32	2.39	X
toy/place	.60	.83	X
court Lucy	X	1.67	.36
court Ethel	0	X	1.08
fighting			
over females	.84	1.31	.72
for females			
food	.95	.95	.72
toy.place	.59	.59	.48

Table 6

Fighting

(not pair related)

Stage 1- Total Fights=42

	Over Food	Over Toy/Place	
Lucy-Fred	0	2	
Lucy-Ricky	2	4	
Lucy-Ethel	6	11	
Fred-Ricky	9	5	
Fred-Ethel	0	2	Female v. female- 17
Ricky-Ethel	0	1	Male v. male- 14
			Male v. own partner- 3
			Male v. other female- 8

Stage 2- Total Fights=12

	Over Food	Over Toy/Place
Lucy-Fred	1	0
Lucy-Ricky	2	3
Fred-Ricky	4	2

Stage 3- Total Fights=79

	Over Food	Over Toy/Place	
Lucy-Fred	0	3	
Lucy-Ricky	2	4	
Lucy-Ethel	6	12	
Lucy-Skippy	2	4	
Ricky-Fred	10	3	
Ricky-Ethel	1	1	Female v. female- 18
Ricky-Skippy	8	5	Male v. male- 35
Ethel-Fred	0	2	Male v. own partner- 5
Ethel-Skippy	2	5	Male v. other female- 21
Skippy-Fred	5	4	

TABLE 7

Statistical Analyses

Rank Sum Test used for all tests.

Difference inTime Spent doing Pair Bond Activities for each bird-

Significant Difference

	Lucy		Ricky		Fred		Ethel	
alpha level=	.05	.01	.05	.01	.05	.01	.05	.01
Stage 1 vs. Stage 2	+	0	+	0	+	+	NA	
Stage 1 vs. Stage 3	0	0	+	+	0	0	+	+

Difference in Time Spent in Neutral Activities-

Significant Difference

	Lucy		Ricky		Fred		Ethel	
alpha level=	.05	.01	.05	.01	.05	.01	.05	.01
Stage 1 vs. Stage 2	0	0	0	0	+	+	NA	
Stage 1 vs. Stage 3	0	0	0	0	0	0	+	+

Difference in Time Spent in Pair Bond Activities between males and females-

-Significant difference at the .01 alpha level for all three stages

TABLE 7

Statistical Analyses

Rank Sum Test used for all tests.

Difference inTime Spent doing Pair Bond Activities for each bird-

Significant Difference

alpha level= .05	Lucy	Ricky	Fred	Ethel
Stage 1 vs. Stage 2	+	+	+	NA
Stage 1 vs. Stage 3	0	+	0	+

Difference in Time Spent in Neutral Activities-

Significant Difference

alpha level= .05	Lucy	Ricky	Fred	Ethel
Stage 1 vs. Stage 2	0	0	+	NA
Stage 1 vs. Stage 3	0	0	0	+

Difference in Time Spent in Pair Bond Activities between males and females-

-Significant difference at the .01 alpha level for all three stages

can be seen by her amount of time spent at rest and her lack of time spent in flight. Stage 1 shows that pair bond activities take up a varying amount of time for each bird. For Ricky, they take up 19.44% of his time, which is more than all maintenance activities combined. For Ethel, they only take up 8.01% of her time. But it is the third most time-consuming activity for her, after rest and preening. Ethel is interesting because of the change in her time budget from Stage 1 to Stage 3. Her pair-bond activity more than doubles, a significant difference at alpha level .01, and her time at rest decreases significantly as well.

For a more in depth discussion of the pair bond relationship, see Table 2. The first part shows how much time each couple spent next to each other, whether engaged in pair bond activity or some other activity. It's interesting that this percentile remains relatively constant throughout the stages, even when pair bond activities double. This suggests that the birds have an allotted amount of time to spend with their partners, whether it is active time or resting time. Lucy and Fred spent about the same amount of time together for all three stages, ranging from 58.52% to 60.24%. Ethel and Ricky spent more time together, ranging from 68.99% to 69.73%. These percentiles include the pair bond activities in the second part of the table. The increase in pair bond activity is quite noticeable when there is an imbalanced situation, like 2 males and 1 female, or 3 males and 2 females. Fred's pair bond activities double from Stage 1 to Stage 2, which is a significant difference, when his is the female in question. Lucy's time spent in these activities also increases significantly. The time Ricky spends involved in pair bond activities increases by about 8%, a significant change at the .05 alpha level, which is quite a feat considering that he no longer has a partner to interact with. In Stage 3, Lucy and Fred's pair activities calm down a bit, probably because Lucy is no longer the only female. Ethel's pair bond behaviors more than double from Stage 1, and Ricky's increase again, perhaps because they feel

their relationship threatened by Skippy's interest in Ethel.

Tables 3, 4, and 5 show pair bond behavior broken down into individual activities. All these activities increase in an environment of imbalance, like Stage 2 or Stage 3, but three behaviors increase the most: allopreening, courting, and display. Allopreening and courting cement the bond between two birds in many other species, as mentioned in the Background section, so it's natural that these would increase for budgies as well during times of imbalance. Display is really just an extension of courting, and perhaps males feel they must impress their females more if competition for females is great. Ricky's display behavior increases drastically from Stage 1 to Stage 2, since he no longer has his own female to court. Fighting between males, too, increases. This is because, with fewer females, the males attempt to court female members of established bonds, like when Ricky courts Lucy, or Skippy courts Ethel. The male who is the female's true partner will fight with the intruding male. Fred never attempted to court Ethel, in any of the stages. Ricky tried to court Lucy often, especially in Stage 2. It was only in Stage 2 that Lucy was ever receptive to Ricky's attentions. Skippy attempted to court both Ethel and Lucy in Stage 3, especially Ethel, since he may have felt some sort of bond to her from their time in isolation together. Neither of the females ever responded to Skippy's advances.

Table 6 shows the instances of fights between certain individuals. This fighting does not include the pair-related fighting from Tables 3, 4, and 5. Of interest here is the low number of fights between two members of a pair. Often, the male will just let the female have her way, and thus, a fight is avoided. Females fight most often over a toy or a place, like the best spot to chew on a nest box, while males most often fight over food.

There were also several instances of longer observations not using instantaneous sampling. Although these are not as scientifically recorded, they are still interesting because they

are noticeable changes in particular behaviors from stage to stage. When the 4 birds were originally purchased, the aspect of behavior that would be studied was not yet known. They were in the smaller cage at this point, with not many places to sit. At first, there was no noticeable pattern to how they sat, but about 3 weeks after they were purchased, Ricky and Ethel always sat together, and that Fred and Lucy always sat together. At the pet store, males were separated from females. So, it can be concluded that the birds had chosen their favorite companion in about 3 weeks.

At the beginning of Stage 2, Ricky's behavior changed in a way that could not be accounted for in the categories of behavior already defined. There was a noticeable increase in the frequency and intensity of his contact calls. Contact calls are loud, high-pitched whistles used to locate other budgerigars. Although there is nothing to compare this observation to in Stage 1, other than memory, this increase in contact calls is probably significant to Ricky's situation of separation from his mate.

Stage 3 started with Ethel and Skippy being introduced back into the large cage. During the first few minutes, instead of taking instantaneous observations, everything the birds did was recorded, particularly the actions of Ricky, Ethel and Skippy. Ethel entered the large cage first, because Skippy couldn't quite figure out how to get out of his smaller attached cage and into the large one. So when Ethel flew in, the other three birds were on the opposite side of the cage. All the birds were in the alarmed, alert stance, with slicked feathers and upright postures. Ethel and the other three looked at each other for some time in silence. Skippy was still struggling in the smaller cage, and he occasionally whistled and fluttered. On one such occasion, the other birds were startled so that they flew about the cage. Ricky and Ethel wound up landing right next to each other, at which time they immediately started beaking, courting, allopreening, and

begging/feeding. Ethel was so excited that her pupils were dilated, her head feathers were standing up, and she was doing a head-bob. All of these indicate the more aggressive role usually taken on by the male. Skippy finally entered the cage and began exploring, as he had never had such a large cage before. He seemed to be following Ethel around for a while, but Ricky and Ethel were too involved with each other to even notice. Later that day, both Ethel and Ricky were chasing and fighting with Skippy, for no apparent reason other than the fact that he was sitting near them.

None of the birds were ever witnessed mating. Both the females did explore the insides of the nest boxes several times during the month of December. But that exploration soon stopped. The closest either pair ever came to mating was in March, after Ethel and Ricky were reunited. Ricky was courting Ethel quite a lot, and she began to take on the posture needed for copulation. But when Ricky tried to follow through, she backed away. Why neither pair ever mated is not known. They each had nest boxes available, which is basically the only requirement, besides having a true pair, mentioned in pet guides.

Conclusion

Budgerigars do indeed spend a certain percentage of their time engaged in pair bond activities. Depending on the individual and the situation, this percentage can be as low as 8.01% or as high as 32.59%. Pair bond activities, particularly allopreening, courting, and displaying, increase when the pair feels threatened, either by outside interference from another bird or by a period of separation. Allopreening increases because it is an appeasing, pair-cementing activity,

as discussed by Wickler (1972). Courting and display probably increase because of increased competition for females. The striking increase in pair bond activities from balanced situation to imbalanced situation is the most interesting trend shown in the data. Reinforcing the pair bond is important enough for Fred to spend 32% of his time and effort on, or for Ricky to spend 30% of his time and effort on. All this effort was spent on preserving a relationship where mating and raising young was not even part of the picture.

The fact that neither of the pairs mated even further reinforces the hypothesis that the pair bond is important to the birds for more than just reproductive reasons. In the wild, budgies choose their partners before they are reproductively mature and remain with them for life. Whether they remain devoted to an old or sick mate, like Bourke's parrots, violet-eared waxbills, and bullfinches do (Wickler 1972), is not known. The term "life-long," when referring to animals, seems variable, especially in the wild where one partner of a pair bond could die at any time due to predation or accident. Studying the strength of the pair bond is therefore best done in captivity. Morris studied the pair bond behavior of zebra finches in 1970. First, a superior male was put into a cage with an established pair of finches. At first, both the male and the female were hostile towards the intruder, especially when he attempted to court the female. For about a week there was a continual state of tension between the birds. Soon, the female did not act aggressively toward the new male anymore. The two males continued to fight, but the new male began to be the dominant one. The old pair bond started to break up, and a new one formed. This particular experiment shows that the female looks for the male who will have the healthiest children, since the new male was superior to the old one. In zebra finches at least, a divorce can occur if a better male is available.

Morris did another experiment with zebra finches. Two established pairs A and B were

separated, so that they could not hear or see each other. The males were each allowed to keep their own territories. After a few weeks, new females were placed in with each of the males. At first, male A acted aggressively toward the new female, and then he just ignored her. Male B reacted violently to the new female, chasing her and giving her no rest. She finally had to be removed for her own safety. The old female A was placed back in the cage with male A and the new female. She violently chased the new female around, and this female also had to be removed. In all, the two members of each pair were separated for over a month, and new potential mates were present. Yet both the old pair bonds remained intact.

A similar study was done on "marital fidelity" in budgerigars by Fritz Trillmich (as cited in www.inforamp.net/~dhansen/choice.html). He found that after a seventy-day separation, parakeets will resume their old pair bonds if they have been kept in the meantime with birds of the same sex. He also found that after a twenty-day separation with new potential mates available, the old pair bond will still hold. Ricky and Ethel remained together after a 32-day separation, with other potential mates present. Perhaps if Skippy had been a clearly superior male, as in the case of the zebra finch study, Ethel would have chosen to get a "divorce." Skippy was younger than the other budgies, probably by about 4-5 months. This could have contributed to her preference for Ricky. In order to make any real conclusions about this longer 32-day period of separation, further studies with a larger sample size, containing both superior and inferior males, are needed.

All in all, this study shows that the pair bond is an important part of a budgie's life. As the pet guides say, a budgie kept singly and deprived of the chance to interact socially with members of its own species, would indeed be missing an important part of its natural potential. The study pairs spent from 60 to 70% of their time with their partner. What pet owners spend 60

to 70% of their time with their budgies? Humans could never interact with a budgie the way another budgie would. A budgerigar kept singly would also be deprived of flock stimulation, and hence would have no real impetus to do anything, other than out of boredom. The data shows that the study birds spent similar percentages of their time doing the same thing. This is because they did indeed follow what the others were doing. If one wanted to eat, so did all the others. If one started singing, so did all the others. Performing daily activities together provides the budgies with opportunities for social interaction, which is important in flocks.

The study parakeets have shown that the pair bond is important enough for them to spend up to 30% of their time on it. At least one of these bonds was strong enough to withstand 32 days of separation and increased male competition for females. All of the observed pair bond behaviors took place independently of mating, nesting, and rearing young. Why these birds exert such effort on maintaining the pair bond relationship is an interesting question. Surely, the answer is not just for increased reproductive success. Why then would pair bonds remain when reproduction is not possible? But making the pair bond sound too much like a marriage can lead to anthropomorphism. Perhaps with further studies, a better understanding of the mechanisms and advantages, both reproductive and social, of avian pair bonds can be reached.

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