The effects of hatch-order, gender and clutch sex ratios on the behaviour of Burrowing Owls (*Athene cunicularia*)

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Acknowledgments

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Abstract

The Burrowing Owl (*Athene cunicularia*) builds its nests in burrows made by various types of mammals. These owls have an asynchronous hatch. Females typically lay one egg per day for 8-12 days, incubation of each egg beginning as soon as it is laid. As a result, earlier laid eggs hatch earlier than those laid later. This asynchronous hatch results in age and thus size differences between the first and last hatched chicks of a clutch. Due to the size advantage, the earlier hatched chicks within a clutch may not need to fight to get food. In contrast, later-hatched chicks may be more aggressive since they must compensate for their size disadvantage. Burrowing Owls mate monogamously, and the members of a pair have different roles. Males spend the majority of the time outside of the burrow, guarding, the nest and hunting for themselves and their mates. Females, on the other hand, spend more time inside the burrow, incubating and caring for the young. As a result of their different roles, males may be innately more dominant and aggressive (to protect their nest from intruders), compared to females. In this study, I examine the possible effects of both asynchronous hatch order and gender on behaviour of young Burrowing Owls

Introduction

The Burrowing Owl (*Athene cunicularia*) is a species of small, ground-dwelling owl that breeds mainly in western and central North America, (from south-central British Columbia to Mexico), although they are also found in the Caribbean. They live in arid-regions, such as grasslands and prairies, where they build nests in burrows dug by burrowing mammals such as badgers, ground squirrels and prairie dogs (Poulin et al. 2011). However, due to habitat

fragmentation and range contraction, their populations have been declining since the 1970's (Johnson et al. 2010). Due to the declining populations of these birds, they are listed as an Endangered Species in Canada, according to the Species at Risk Act. Breeding projects have been established throughout North America to aid in the conservation of this species.

At the BC Wildlife Park, just outside of Kamloops BC, roughly 40 Burrowing Owl chicks are hatched each year and released into the wild the following year. Breeding projects such as this are an effort to reestablish, or to fortify existing wild populations of Burrowing Owls throughout North America. Breeding projects such as these also allow for research to be conducted on species that are normally elusive and particularly difficult to observe in their declining populations.

Burrowing Owls have an asynchronous hatch where eggs in a clutch do not hatch simultaneously but rather over a period of several days. This hatching asynchrony is dependent on the initiation of incubation (Slagsvold T. 1986). Once an egg is laid by a female, it is immediately incubated. This leads to differences in development between individuals within a clutch as all eggs are not incubated simultaneously but rather, dependent on their laying. This laying-incubation pattern in Burrowing Owl clutches indicates that Burrowing Owl chicks hatch within two to four days of the other clutch mates (Brekke et al. 2016). This asynchronous hatch order is unlike other bird species who incubate their eggs after laying the clutch and therefore, their clutch hatches over a very short period of time. Female Burrowing Owls lay usually one egg per day for 8-12 days, with an average clutch having nine. The earlier incubated eggs will hatch earlier then the later incubated eggs. Thus, this asynchronous hatch order puts an age and thus size difference between the first and last hatched eggs within a clutch (Conway et al. 2012). This

age and size difference between individuals within a clutch, particularly between the first and last hatched individuals in a clutch, may influence the success and fitness of these later hatched individuals. Later hatched and thus smaller chicks, must compete against their older and presumably larger chicks for resources, putting the younger owls at a disadvantage. The older larger chicks may be able to use their size as an advantage to gather more food from their mother while the smaller individuals are unable to compete against their larger siblings. The inability of the smaller individuals to compete efficiently against their siblings would put them at a further disadvantage to their older clutch mates as lack of resources would slow their growth and thus accentuate the age and size differences between clutch mates. There is intra population variation in the degree of asynchrony. Hatching asynchrony tends to increase with increasing size of the clutch but tends to decrease with the increasing age of the mother (Wellicome T.I. 2005.). I propose that the last hatched chicks will be more aggressive and dominant than earlier hatched chicks to compensate for their age and size disadvantage compared to their clutch mates.

Burrowing Owls are monogamous meaning males mate with one female. This pair formation allows for the allocation of sex specific roles within a mating pair. The male spends much of its time outside of the burrow acting as a guard at the burrow entrance, as well as playing a hunting role to feed himself and his mate. Burrowing owls are opportunistic hunters feeding largely on insects and small mammals. Females on the other hand spend much of their time in the burrow where they incubate and feed their young (Brandes S. 2016). The difference in the sex based roles associated with a burrowing owl pair could lead to differences in behaviour. Males may tend to be more bold and aggressive due to their role as the primary guardian of the burrow while females tend to be more reserved. Due to the differences in the behaviour of the

males and females, it is possible that clutches with more males may tend to be more dominant and aggressive due to the innate nature to guard their burrows. Conversely, it is possible that clutches that have greater numbers of females may tend to be less dominant as they do not necessarily have the same innate behaviour to fight off intruders, as is the role for the males. I propose that males will tend to be more aggressive and dominant compared to females due to their innate behaviours to compete against other males for access to mates, burrows and resources along with the need to protect their burrows.

Methods

At the BC Wildlife Park, there were eight clutches of Burrowing Owl eggs that were being cared for by eight separate mating pairs. The mating pairs involved in the breeding project were captive bred. Each of the eggs were marked with dye to identify the individual eggs within each clutch. The time that each of the eggs within a clutch were laid was recorded. Cameras set up within the burrows of the owls allowed for the monitoring of the clutches as well as the ability to record the hatch order of all the eggs in all the clutches. Upon the hatching of the chicks, the legs of the chicks were marked with multiple colours of elastic bands to identify each of the individuals that hatched in each of the clutches. The order and combination of coloured elastic bands allowed for the identification of individuals. Mating pairs raised their young within isolated pens where they had no visual contact with neighbouring mating pairs but were not auditorally isolated. At six weeks of age, all the juveniles were banded with two plastic leg bands. One of the bands had a letter that represented the year in which it was born and the other band an accorded two-digit number. The writing on the bands was large enough that it could be easily read from a

distance using binoculars. At this time, the isolated pens were opened and the individuals had access to a communal flight pen with continual access to their burrow of origin. Individuals of different mating pairs and thus different clutches could then interact amongst each other within this common flight pen. As the birds were banded with the plastic leg bands, feather samples were also taken from each of the individuals. These samples were sent to a lab to genetically sex each of the individuals.

Observations began once the birds were released from their separated pens where they were they had access to a common flight pen. This pen allows for intraspecific interactions between the birds of difference clutches. The flight pen was 40 meters long, 25 meters wide and 3 meters tall as seen by Figure 1. Burrows and perches of various heights were distributed throughout the pen allowing ample space for the owls. Observations occurred at different times of the day, during different days of the week and alternating before and after feeding times. Intraspecific behaviours were observed and categorized to allow for the analysis of the behaviours. Observers would sit in corners of the flight pen while recording the data during the entire observation period. Binoculars were used to identify the individuals that were being observed. All interactions between the owls were recorded during the one to two hours observation periods, depending on the productivity of the observation period. The observer wore drab coloured clothes of natural tones such as greens, greys and browns to minimize the impact that their presence would have on the behaviour of the owls.

Figure 1. Experimental burrowing owl enclosure at the BC Wildlife Park

The observed behaviours of the owls were then categorized into two categories based on their perceived intent. The first category, giving the behaviour a behavioural rating of 1 out of a possible 2, were behaviours that did not appear to be confrontational, aggressive or dominant in intent; these behaviours were neutral or submissive in nature. For example, this was often perceived as individuals being able to feed or perch within proximity of another individual or a group of individuals. In the case that a group of owls were perched beside one another on a perch, they each received a behaviour rating of 1 due to their lack of conspecific interactions and their ability to perch within proximity of each other without aggressive interactions. The second category, giving the behaviour a behavioural rating of 2 out of a possible 2, were behaviours that appeared to be confrontational, aggressive or dominant in intent. For example, confrontational

approaches between individuals such as fighting would result in all the individuals involved receiving a behavioural rating of 2.

The frequency of each of the individual's intraspecific behaviours was recorded. The total frequencies of individual behaviours were then determined for each individual. A behaviour frequency of 1 would be used to explain a behaviour rating of 1 or 2, where one individual made a behavioural initiative towards another or a group of individuals. An individual could have as many observed behaviour frequencies as necessary throughout the observational period. The total number of behavioural interactions can be seen by Figure 2. in the appendix. In the case that an individual was appearing to behave submissive within a group of owls, such as if they were all perched on a perch cooperatively, then they would all receive a behaviour frequency of one due to their ability to act non-aggressively amongst their conspecifics. In the case that individuals acted aggressively towards another, only individuals directly involved would be acknowledged for their interactions, all acquiring a behavioural frequency of 1 representing their aggressive interaction with other individuals.

Results

There was no significant difference in the behaviours exhibited by all the individuals, the juvenile females or the juvenile males. There was also no significant difference in aggressive behaviours between juvenile male and female Burrowing Owls. This indicates that the asynchronous hatch order does not appear to affect the dominance of individual Burrowing Owls nor does sex appear to have significant influence on the dominance as juvenile males were not any more aggressive than juvenile females.

Table 1. Intraspecific behaviours amongst all individual *Athene cunicularia*

t-Test: Two-Sample Assuming Equal Variances

	Behaviour rating = 1	*Behaviour rating = 2*
Mean	5.52	2.14
Variance	31.15265306	7.020816327
Observations	50	50
Pooled Variance	19.08673469	
Hypothesized Mean Difference	0	
df	98	
t Stat	3.868306577	
P(T<=t) one-tail	9.86952E-05	
t Critical one-tail	1.660551217	
P(T<=t) two-tail	0.00019739	
t Critical two-tail	1.984467455	

Table 2. Intraspecific behaviours amongst all individual female *Athene cunicularia*

t-Test: Two-Sample Assuming Equal Variances

	Behaviour rating = 1	*Behaviour rating = 2*
Mean	5.208333333	1.583333333
Variance	30.43297101	3.644927536
Observations	24	24
Pooled Variance	17.03894928	
Hypothesized Mean Difference	0	
df	46	
t Stat	3.042126217	
P(T<=t) one-tail	0.001936456	
t Critical one-tail	1.678660414	
P(T<=t) two-tail	0.003872911	
t Critical two-tail	2.012895599	

Table 3. Intraspecific behaviours amongst all individual male *Athene cunicularia*

t-Test: Two-Sample Assuming Equal Variances

	Behaviour rating = 1	*Behaviour rating = 2*

Mean	8.166666667	4.416666667
Variance	28.15151515	11.90151515
Observations	12	12
Pooled Variance	20.02651515	
Hypothesized Mean Difference	0	
df	22	
t Stat	2.052599417	
P(T<=t) one-tail	0.026097472	
t Critical one-tail	1.717144374	
P(T<=t) two-tail	0.052194944	
t Critical two-tail	2.073873068	

Table 4. Dominance behavioural comparison between male and *Athene cunicularia*

t-Test: Two-Sample Assuming Equal Variances

	Female Behaviour rating = 2	*Male Behaviour rating = 2*
Mean	1.583333333	4.416666667
Variance	3.644927536	11.90151515
Observations	24	12
Pooled Variance	6.316176471	
Hypothesized Mean Difference	0	
df	34	
t Stat	-3.188713767	
P(T<=t) one-tail	0.001532231	
t Critical one-tail	1.690924255	
P(T<=t) two-tail	0.003064462	
t Critical two-tail	2.032244509	

I used a two tailed t-test assuming equal variances.

Discussion

At the BC Wildlife Park the eggs started to hatch in early May 2018 after having been incubated for three to four weeks. Each of eggs in the clutches were marked using non-toxic dye

to allow the recognition of each of the eggs. The hatch order of each clutch was observed and recorded by video cameras placed in the burrows. At six weeks of age, the juveniles were leg banded and feather samples were taken. The owls were leg banded with two plastic bands. One had a letter associated with their year of birth and the other was a number that allowed for the identification of the individual easily with a set of binoculars. The feathers that were taken, were for genetic tests to be conducted to determine the sex of the individuals.

Over the course of this project I examined the effects of an asynchronous hatch order, gender ratio and the sex of burrowing owls. Upon the approval of my ethics application through both Thompson Rivers University and the BC Wildlife Park, I could begin collecting data. I collected data during the summer and into the fall. My data was based on observations. I observed the intraspecific interactions between the individual burrowing owls at the BC Wildlife Park. At the BC Wildlife Park the owls are kept within a large flight cage that is 25 meters wide and 40 meters long. This allowed for interactions between individuals of the same clutch and different clutches. I identified individuals using binoculars and recorded behaviours and later quantified these behaviours to asses my collected data. I was particularly interested in the submissive and aggressive behaviours since I had proposed that individuals that hatch later in a clutch would be more dominant to compensate for the age and size difference while individuals that hatch earlier will be less aggressive as they recognize their age and size difference.

This project allowed me access to the world of research in a way that would not be possible through classes. I have new knowledge and ambition to finish my undergraduate degree at Thompson Rivers University and push on to apply myself to more research projects. In the short term, I am to use this experience to portray to others, in academic and non-academic

settings, the importance of not only burrowing owl conservation but also grassland conservation as a whole. There is no sense in conserving a species that relies on an arid grassland habitat if the grasslands that it depends on are disappearing.

Based on the results of this study, it appears as if there are no behavioural differences associated with the asynchronous hatch order as seen in Burrowing Owls. Individuals who hatched earlier in a clutch were no more dominant than those who hatched later in the clutch. The sex of an individual also did not appear to affect the dominance of behaviour of the individual as there were no significant difference in the dominance or aggression behaviour between the juvenile males and females. It can therefore be inferred that no individuals would be better suited to living in proximity to one another compared to any other bird. When placing captive bred birds into the wild it can be inferred that the selection of which owl pairs go to which burrow, does not need to be dependent on the hatch order of the individuals within proximity.

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Appendix

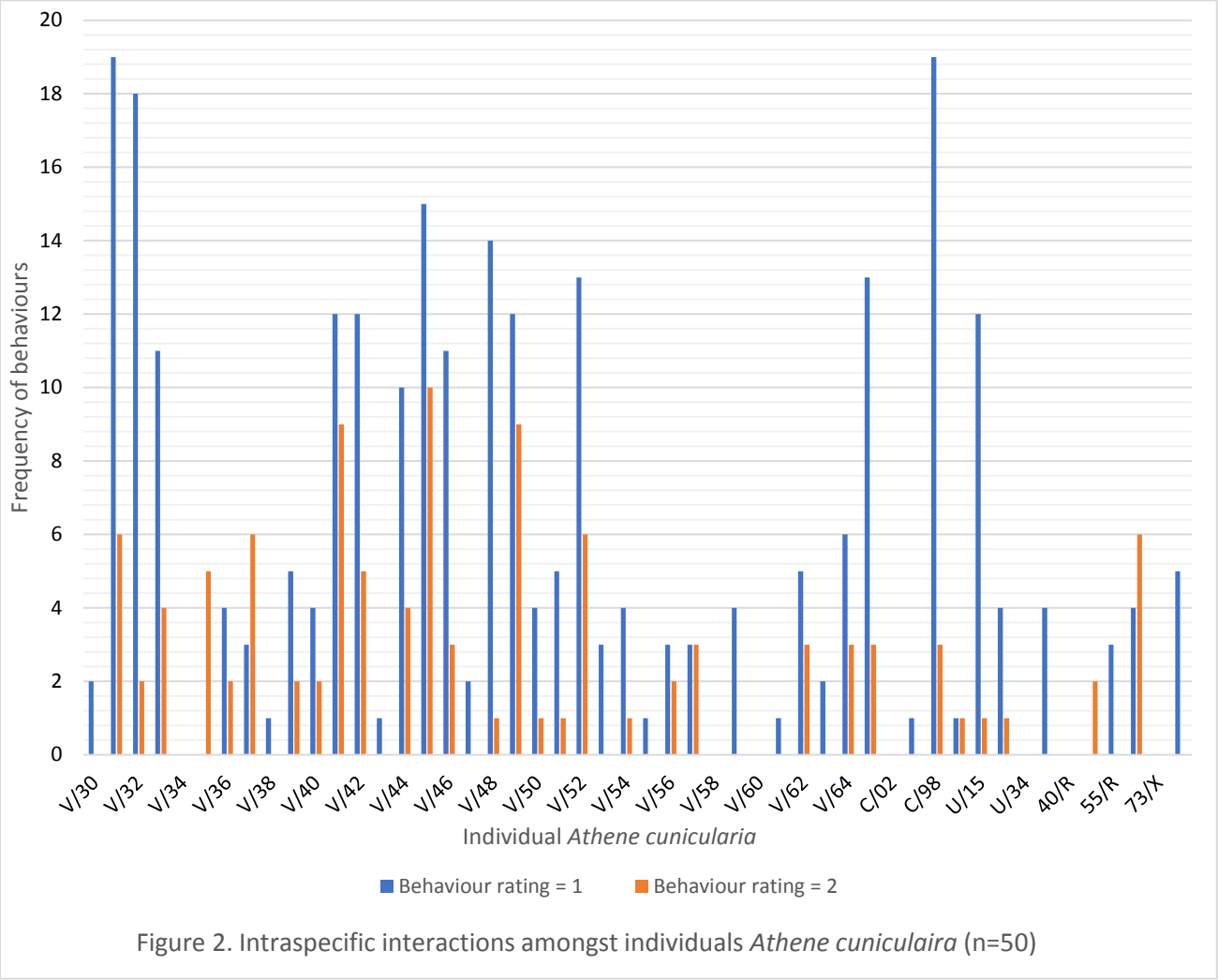

Figure 2. Intraspecific interactions amongst individuals *Athene cuniculaira* (n=50)

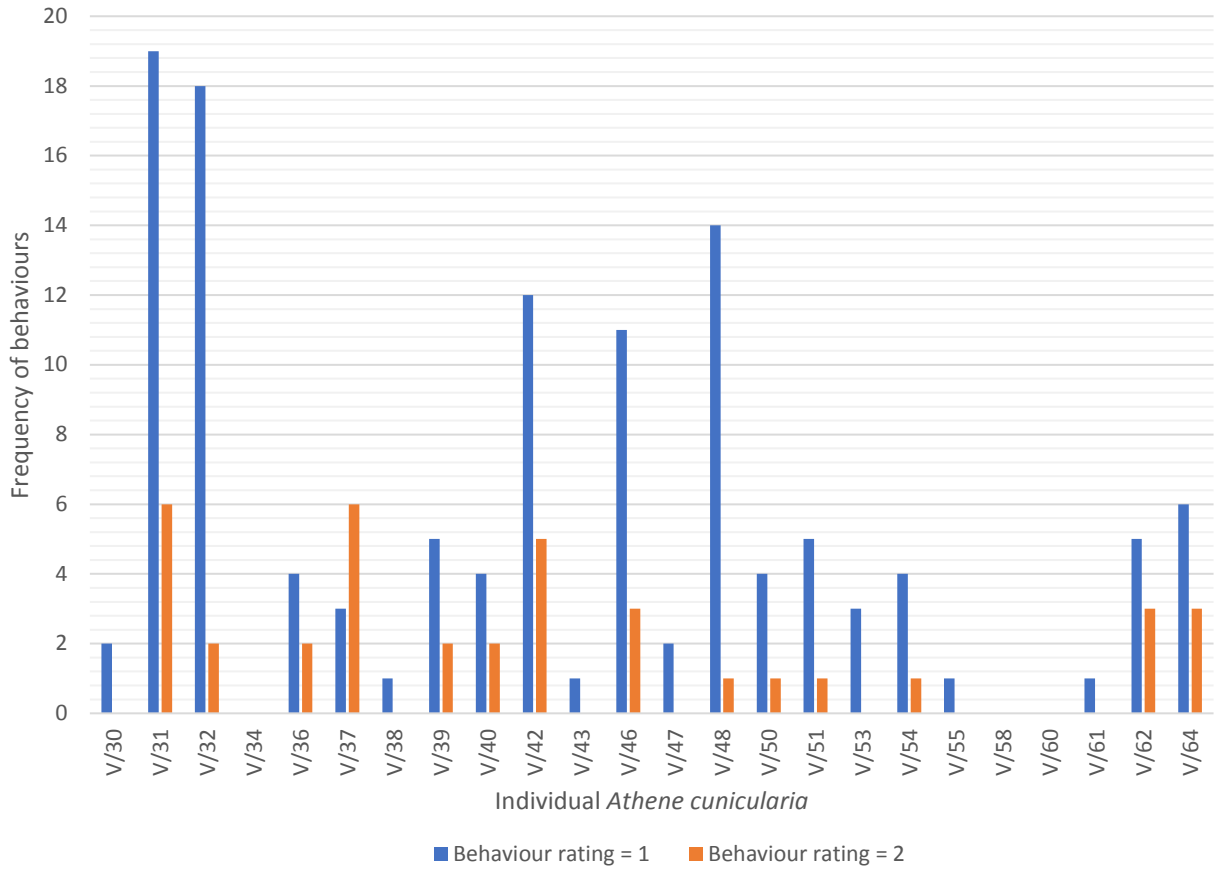

Figure 3. Intraspecific interactions amongst juvenile female *Athene cuniculaira* (n=24)

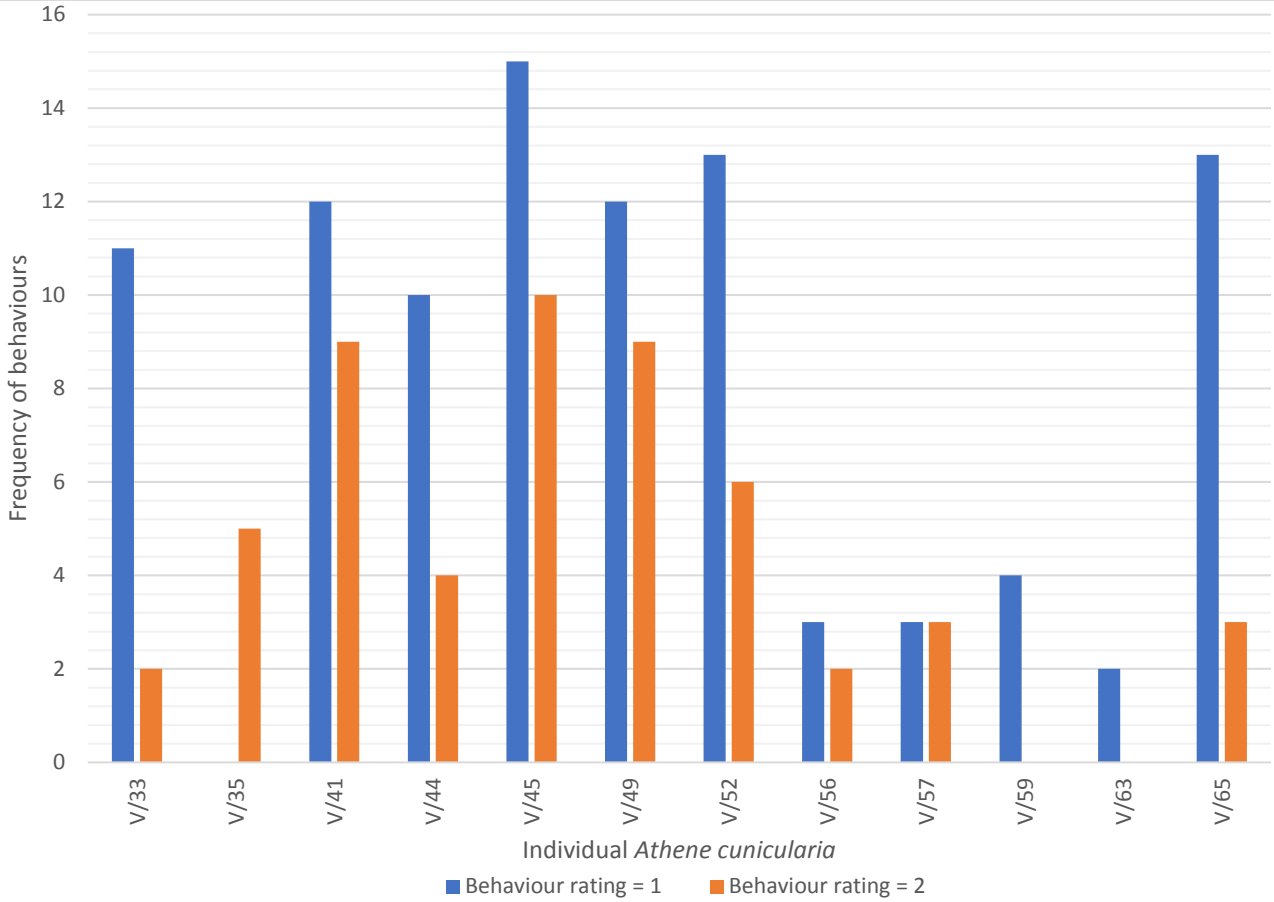

Figure 4. Intraspecific interactions amongst juvenile male *Athene cuniculaira* (n=12)