INTERACTIONAL RULES IN CAPTIVE SISKINS (*CARDUELIS SPINUS*)

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*Interactional rules in captive Siskins (*Carduelis spinus*).–* A first step in any study on social organization is the analysis of interactions. Here, three factors affecting agonistic interactions: rank; sex and age, have been investigated to throw light on the organization of interactional nets. Interactional rates and patterns of direction have been analysed in more than 4,000 interactions between captive Siskins (*Carduelis spinus*). Four groups of different composition were used as different replicates to the study. Reproductive period was excluded. Subordinate individuals threatened dominants less than expected, and the more dominant the opponents were, the fewer threats they showed. Dominants threatened subordinates more than expected. Young and adult males interacted more than expected, young females interacted very few times with the rest of the group, and adult females received more threats from adult and young males than expected. There were three kinds of clusters of interaction: individuals of future pairs, several males presumibly competing around one female, and high ranking individuals. Dynamics of reproduction and pairing relationships in cardueline finches are reviewed. Patterns of interaction found in this work seem to fit these dynamics. It is therefore proposed that interactions in wintering Siskins, not only organize hierarchy, but also have a pairing function.

Key words: *Carduelis spinus*, Siskin, Interactional rules, Hierarchy, Agonistic behaviour.

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INTRODUCTION

The study of interactions is one of the most useful tools to understand a social system (HINDE & STEVENSON-HINDE, 1976).

Factors affecting interactions between birds are, among others: season, time of day, sex, rank, degree of familiarity between birds (BALPH, 1977), and age (WATSON, 1970). Rank, degree of familiarity and sex are the three factors that have been most studied in finches (BALPH, 1977; BALPH et al., 1979; DILGER, 1960; TORDOFF, 1954; COUTLEE, 1967; KETTERSON, 1979). Sex, in particular, seems to be a very important regulator of interactions, influencing frequency and intensity of aggressive encounters according to the sex of implied birds (BALPH et al., 1979). Individual differences in the direction of interactions also seem to be of great importance (SABINE, 1959; BALPH, 1977), although little research has been done in this area.

In this paper, linearity of hierarchy and factors affecting dominance are studied in a flock of captive Siskins (*Carduelis spinus*). The rule of rank, sex and age in interactions is analysed. As birds were caged, the past, present and future history of the implied birds was known; thus, interpretations on the behaviour of each individual bird were facilitated.

MATERIAL AND METHODS

Subjects of study

This study was carried out with captive Siskins housed in an outdoor flight cage (125 x 60 x 125 cm). The group was first formed by two adult males (N and A) and two adult females (B and G). These birds were caged in November 1977. In 1979 and 1980, A paired with B; in 1980 they succeded in rearing three youngsters: two males (H and L) and a female (W). Male L paired posteriorly with B (springs 1981, 82, 83 and 84). In November 1982 another male (T) joined the group, pairing with the female G in 1983, and three males (J, S, and P) and two females (I and D) were reared. In spring 1984 two pairs were formed: S paired with D, and J with G. Throught the study, four individuals left the group (having died or escaped): A (July 28, 1982), W (May 12, 1982), T (November 2, 1983), and I (July 15, 1984).

Collection of data

This group of variable composition was studied over 4 different periods of time. Each one of these groups was numbered, and was used in the analysis of data as different replications. Group I was observed from November 12, 1977 to June 2, 1980, and was composed of individuals N,A,B and G. Group II from June 25, 1980 to May 24, 1983, and of individuals N,A,B,G,H,L and W. Group III from August 1, 1983 to November 2, 1983, and of individuals N,B,G,H,L,T,J,S,P,I and D. Group IV from November 3, 1983 to January 6, 1984, and of individuals N,B,G, H,L,J,S,P,I and D.

Main attention was devoted to agonistic interactions. The different agonistic displays used by Siskins have been described by SENAR (1982, and in prep.). In any interaction, the first bird displaying towards an opponent was considered the initiator or actor, and the bird receiving the display the reactor. For each dial interaction, the behaviour of the actor, of the replay of the reactor and the replay of the actor was recorded by casette. In total, more than 4000 of these interactions were recorded. Haphazard samples of interactions were taken whenever seen, although there was a concentration of observations between 1 pm and 4 pm, when birds were fed. Duration of each recording session was also variable. Data from reproductive period were excluded (from April to July).

Analysis of data

It was defined that a bird had lost an interaction when the opponent answered it with an attack or an aggressive display. If the opponent continued to behave as previously, it was considered as a lack of replay and was thus excluded from this analysis. If the opponent replayed with flight or submission, it was considered as a win. From these data, sociometric matrixs wsre built up (LEHNER, 1979), one for each Group. Significance of each dial relationship was tested using the Binomial test (SIEGEL, 1956).

Once assymmetric dominance relationships between each pair of individuals was proved (one individual won significantly over the other), the percentage of wins over that opponent was used as a measure of its dominance degree over that individual. This measure was called the "dial rank", and it was used in all the analysis of dependence or correlation between dominance degree and rank, sex and age factors.

It was said that an individual maintained a clear dominance relationship or that both birds were distant in rank, if the dial rank of the dominant bird was greater than the mean of all the dial ranks of the individuals of the Group (in this study 75%).

The criterium of APPLEBY (1983) was used in the tests on the linearity of the hierarchy.

The four Groups were used, whenever possible, as different replicates for each of the analysis. Effect of rank on the interactions was only tested in Group II. Group I was not used when testing the effects of sex and age, since it only consisted of adults.

Expected frequencies on rates of interactions between the different sex and age classes were calculated following the method of ALTMANN & ALTMANN (1977). These interactions were studied from a symmetric and assymmetric point of view. Significance of standarized residuals ($Q = (O - E)/\sqrt{E}$) was tested following the method of FAGEN & MANCHOVICH (1982). Direction of interactions was tested using standarized residuals and Factorial Analysis of Correspondences (AFC; FOUCART, 1982).

To study the development of interactional activities in young Siskins, Group III was divided in three phases, each one characterized by the development stage of its members.

Phase 1: Siskins that were born in that spring ad were still dependent of their parents: "fledglings".

Phase 2: Siskins that already feed by themselves, but that still had a striked plumage and so their sex could not be determined: "juveniles".

Phase 3: Siskins that had completely adquired their 1-2 year plumage, which would be retained until the next moult, and with a clear sexual dimorphism: "youngsters".

For the other parts of the study, only Phase 3 of Group III was used, since by definition it was the unique of this Group with youngsters.

The factor individual, and specially the directional patterns of interactions by each individual, were studied with the Factorial Analysis of Correspondences (AFC; FOUCART, 1982).

RESULTS

Linearity

The Appleby test of Linearity gave a k value of 1 for Group I, 0.607 for Group II, 0.309 for Group III, and 0.369 for Group IV. Neither of them was significant for assuming a near linear hierarchy.

Factors Affecting Dominance

The percentage of dial relationships in which one individual was significatively dominant over the other was of 100% for Group I, 86% for Group II, 49% for Group III, and 52% for Group IV.

Sex was an important factor for the stablishment of dominance, being the males dominants over females (G.II: $X^2 = 6.4$; $p < 0.02$; G.III: $X^2 = 9.0$; $p < 0.01$; G.IV: $X^2 = 4.45$; $p < 0.05$).

Age factor was not significant (G.II: $X^2 = 0.286$; $p > 0.50$; G.III: $X^2 = 0.286$; $p > 0.50$; G.IV: $X^2 = 3.6$; $p > 0.05$).

Size factor, taking wing-length as the best predictor, was not significant (G.II: $r_s = 0.12$; $p > 0.30$; G.IV: $r_s = 0.27$; $p > 0.40$).

Kin factor could not be tested due to the small sample size. Qualitative observation of the two families studied did not show any relationship. For instance, individual T in Group III was dominant over nearly all his offpring (J,S,P and D) and in turn, they were dominant over their mother (G). In group II, offpring (H,L and W) were dominant over both parents (A and B).

Interactional Patterns

a. Factors Associated with the Social Hierarchy.

Correlation between give and receive threats was not significant ($r_s = 0.357$; $p > 0.20$).

When testing the effect of proximity in rank, it was found that Siskins displayed more towards close individuals than to distant birds. ($X^2 = 46.926$; $p < 0.001$). However, when discriminating between dominants and subordinates (in a dial sense), it was found that dominants threatened indiscriminately to close and distant individuals ($X^2 = 0.182$; $p > 0.10$) while subordinates more frequently threatened individuals close in rank ($X^2 = 142.379$; $p < 0.001$).

In general, dominant birds threatened their subordinates more than expected, and subordinates threatened their dominants less ($X^2 = 478.735$; $p < 0.001$). However, the correlation between the dominance degree of the opponent and the number of threats towards that individual was only significant for the subordinate birds ($r_s = -0.883$; $p < 0.01$). Dominants, threatened their subordinates indiscriminately ($r_s = 0.292$; $p > 0.05$).

Table 1. Rates of inter and intrasexual interactions (expected frequencies in brackets). Q. Standardized residuals (O-E/$\sqrt{E}$); M. Male; F. Female; *** $p < .001$, * $p < .05$.

*Tasas de interacción inter e intrasexual (frecuencias esperadas entre paréntesis). Q. Residuos Estandarizados (O-E/$\sqrt{E}$); M. Macho; F. Hembra; *** $p < 0,001$, * $p < 0,05$.*

	M-M	F-F	M-F/F-M	TOTAL
Group II	733 (572)	207 (286)	1060 (1142)	2000
Q	6.78***	−4.69	−2.45	
Group III (Ph.3)	94 (83)	11 (24)	112 (110)	217
Q	1.41	−2.65*	0	
Group IV	223 (171)	34 (70)	258 (274)	515
Q	4	−4.36***	−1	

b. Factors Associated with Sex and Age.

Table 1 shows that males interacted among themselves very much, females interacted with each other very little, and intersexual interactions were slightly less than expected. This was consistent for all Groups. If direction of interaction was taken into account, females threatened males less than expected (table 2).

When considering sex and age simultaneously, it was found that interactional rates were different according to the sex and age of the implied individuals (table 3). However, some variations among the results from the different Groups were found. Only the small amount of threats of young and adult females, and the high rate of threats of young males were consistently significant throughout the Groups. Direction of these interactions is shown according to values of Q in figure 1, and using AFC in figure 2 and table 5. Results were not consistent in the different Groups. Quantitatively a high interactional rate between adult and young males, and the presence of interactions from adult and young males towards adult females can only be supposed.

Siskins showed their first threat when 18-22 days old (N = 8). When fledgings, the number of threats made was very small and less than expected (table 4, Phase 1) (X^2 = 49.87; p<0.001).

Table 2. Rates of assymmetric intersexual interactions (expected frequencies in brackets). Q. Standardized residuals; M. Males; F. Females; *** $p < .001$, ** $p < .01$.

*Tasas de interacciones intersexuales, asimétricas (frecuencias esperadas entre paréntesis). Q. Residuos estandarizados; M. Machos; F. Hembras; *** $p < 0,001$, ** $p < 0,01$.*

	M-F	F-M
Group II	699 (571)	361 (571)
Q	5.29	−8.77***
Group III (Ph.3)	93 (55)	19 (55)
Q	5.10***	−4.90**
Group IV	209 (137)	49 (137)
Q	6.16	−7.55***

When juveniles (table 4, Phase 2), interactional rates in females increased, not only giving (X^2 = 37.09; p<0.001) but also receiving (X^2 = 30.45; p<0.01). This pattern, although not explicitly recorded, was also observed in Group II in relation to juvenile female W. In this phase, adult females displayed less than expected and adult males received less interactions than expected.

However, once Siskins became youngsters, this pattern changed considerably (table 3, Phase 3), being the young males who made more threats. In this phase young females

Table 3. Rates of given and received interactions by adult males (AM), adult females (AF), young males (YM) and young females (YF), for Groups II, III (Ph.3) and IV (Expected frequencies in brackets). Q. standardized residuals; ** $p < .01$, *** $p < .001$.

*Tasas de interacciones dadas y recibidas por machos adultos (AM), hembras adultas (AF), machos jóvenes (YM) y hembras jóvenes (YF), para los grupos II. III (Ph.3) y IV. (Frecuencias esperadas entre paréntesis). Q. residuos entandarizados; ** p <0,01, *** p <0,001.*

	AM	AF	YM	YF	TOTAL	X^2
GROUP II						
Give	471 (571)	402 (571)	961 (571)	166 (236)	2000	384***
Q	−4.12	−7.07**	16.31***	−7.07**		
Receive	406 (571)	572 (571)	688 (571)	334 (286)	2000	80***
Q	−6.93***	0.00	4.90**	2.83		
GROUP III (Ph.3)						
Give	95 (76)	9 (42)	90 (64)	20 (32)	214	46***
Q	2.24	− 5.10***	3.32**	−2.24		
Receive	51 (76)	86 (42)	58 (64)	19 (32)	214	60***
Q	− 2.83**	6.78***	− 1.00	− 2.24		
GROUP IV						
Give	249 (154)	24 (103)	181 (154)	59 (103)	513	144***
Q	7.68***	−7.81***	2.24	−4.36		
Receive	140 (154)	189 (103)	132 (154)	52 (103)	513	101***
Q	− 1.00	8.49***	− 1.73	−5.00*		

Table 4. Rates of given and received interactions by adult males (AM), adult females (AF), fledging males (FM), fledging females (FF), immature males (IM) and immature females (IF) (Expected frequencies in brackets). Q. Standarized residuals; ** $p < .01$, *** $p < .001$.

*Tasas de interacciones dadas y recibidas por machos adultos (AM), hembras adultas (AF), machos volantones (FM), hembras volantones (FF), machos inmaduros (IM) y hembras inmaduras (IF). (Frecuencias esperadas entre paréntesis). Q. Residuos estandarizados; ** p <0,01, *** p <0,001.*

GROUP III (Ph.1)	AM	AF	IM	FM	FF	TOTAL	X^2
Give	66 (35)	17 (17)	3 (9)	5 (17)	4 (17)	95	50***
Q	5.20**	0.00	−2.00	− 3.00**	−3.16**		
Receive	25 (35)	15 (17)	29 (9)	12 (17)	14 (17)	95	50***
Q	− 1.73	0.00	6.63**	− 1.41	− 1		
GROUP III (Ph.2)	AM	AF	IM	IF			
Give	156 (145)	27 (73)	123 (109)	93 (73)		399	37***
Q	1.00	−5.39**	1.41	2.45*			
Receive	144 (145)	78 (73)	116 (109)	114 (73)		399	30***
Q	− 2.65*	0.00	1.00	4.80**			

displayed less than expected, adult females continued displaying less than expected, and adult males received less displays than expected.

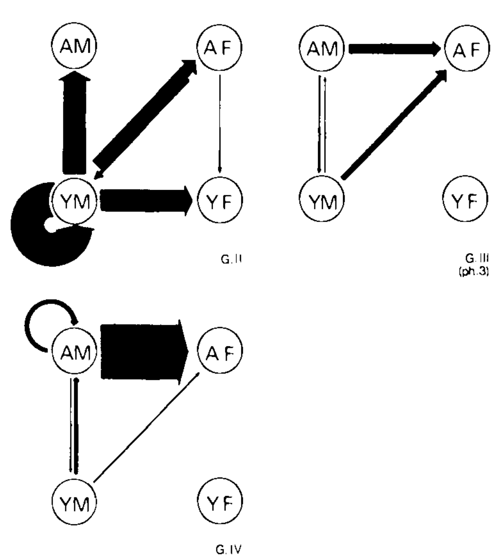

Fig. 1. Sociograms of the direction of interactions among the different age and sex classes for Groups II, III and IV (Arrows proportional to standardized residuals): AM. Adult males; AF. Adult females; YM. Young males; YF. Young females.

Sociogramas sobre la dirección de las interacciones entre las distintas clases de edad y sexo para los Grupos II, III y IV (Las flechas son proporcionales a los residuos estadarizados): AM. Machos adultos; AF. Hembras adultas; YM. Machos jóvenes; YF. Hembras jóvenes.

Table 5. Correlation matrix for Factorial Analysis of Correspondences (AFC) on interactional matrixes between adult males (AM), adult females (AF), young males (YM) and young females (YF), from Groups II, III and IV. * $p < .05$; ** $p < .01$; *** $p < .001$.

Matriz de correlaciones para el Análisis Factorial de Correspondencias (AFC) sobre la matriz de interacciones entre machos adultos (AM), hembras adultas (AF), machos jóvenes (YM) y hembras jóvenes (YF), para los Grupos II, III y IV. * $p < 0,05$; ** $p < 0,01$; *** $p < 0,001$.

	Group II		Group III (Ph.3)		Group IV	
Axis	I	2	1	2	1	2
Individuals						
Givers						
AM	.70	.18	.95*	.05	.41	–.58
AF	–.03	.96*	.00	–.99*	.96*	.04
YM	.40	–.59	–.82	–.17	–.99*	–.00
YF	–.96*	–.04	–.40	.59	–.09	.91
Receivers						
AM	.00	–.99*	–.45	.54	–.85	–.15
AF	–.89	.07	.09	–.91*	.95*	–.05
YM	–.51	.42	.59	.41	–.12	.88
YF	.96*	.04	–.99*	–.01	–.37	.61
Eigenvalues	.047	.028	.035	.022	.049	.015
% total variance	62%	37%	62%	38%	77%	23%
partial X^2	33.29***	19.83***	.98	.62	4.17	1.28
Total Inertia	.0758		.0572		.0640	
X^2	53.720***		1.601		5.450	

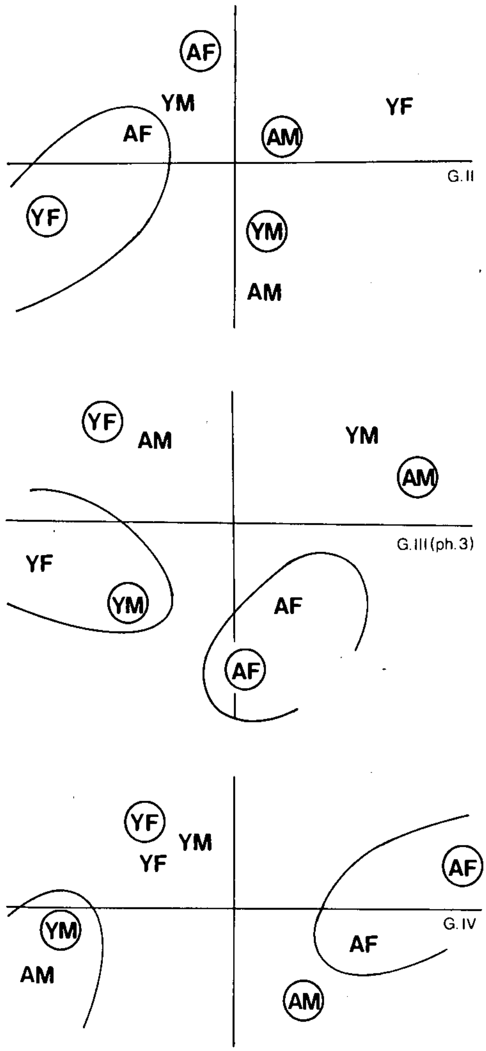

Fig. 2. Plot of the different sex/age classes along the first two axes of space generated by AFC. AFC are given for Groups II, III (ph. 3) and IV. Each sex/age class is represented as giver of interactions (when circled), and as receiver (when not circled). AM. Adult males; AF. Adult females; YM. Young males; YF. Young females.

Representación gráfica de las distintas clases de sexo y edad sobre los dos primeros ejes del espacio generado por el AFC. Se dan AFC para los Grupos II, III (fase 3) y IV cada clase sexo/edad se representa como dadora de interacciones (dentro de un círculo), y como receptora (sin círculo). AM. Machos adultos; AF. Hembras adultas; YM. Machos jóvenes; YF. Hembras jóvenes.

c. Individual differences in direction of interactions

Application of AFC to interactional matrix from Group I, grouped individuals in two clusters: one with the two females (B and G) which interacted in a reciprocal way, and another with the two males (N and A) (fig. 3, table 6).

In Group II, individuals N and H were grouped by a reciprocal interaction; they were the two males with a highest dominance rank. Individuals B and L were also grouped; they would pair during spring. The third and fourth interactional clusters were formed respectively by males L and A (male A had been paired with B in the previous spring), and by the three females B,G and W (fig. 3, table 7).

Table 6. Correlation matrix for Factorial Analysis of Correspondences (AFC) on interactional matrix between members of Group I. * $p < .05$; ** $p < .01$; *** $p < .001$.

*Matriz de Correlaciones para el Análisis Factorial de Correspondencias (AFC) sobre la matriz de interacciones entre los miembros del Grupo I. * $p < 0,05$; ** $p < 0,01$; *** $p < 0,001$.*

Axis	1	2	3
Givers			
N	.90*	.09	.01
A	−.14	−.84	.02
B	−.94*	.06	−.00
G	.77	−.08	−.15
Receivers			
N	−.82	−.07	−.11
A	.62	.37	−.01
B	.81	−.18	.00
G	−.97*	.06	.01
Eigenvalues	.416	.080	.011
% total variance	82%	16%	2%
partial X^2	258.38***	54.88***	7,39**
Total Inertia		.5080	
X^2		348.469***	

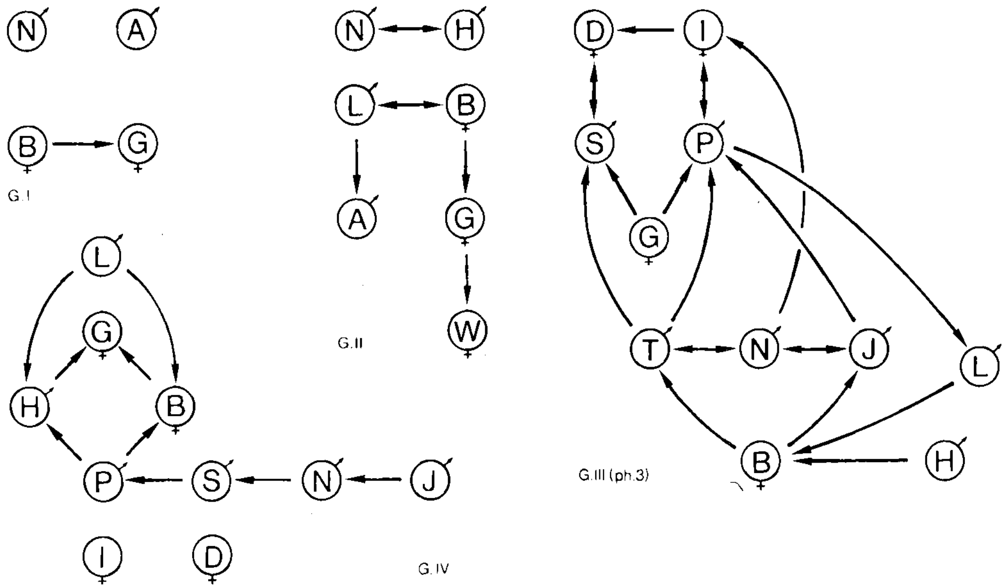

Fig. 3. Interactional nets, for each Group, builded up from analysis of AFC on interactional matrix. Arrows show direction of significant interactions. Sex of each individual is given.

Redes de interacción, para cada Grupo, construidas a partir del análisis del AFC sobre las matrices de interacción. Se detalla el sexo de cada individuo.

In Group III (Phase 3), several clusters of reciprocal interaction could be observed: male S with its future pair D, male P with female I, and the two males T and N which were quite close in rank. Another group of interactions was formed by the two males H and L and the female B (in the next spring male L paired with B); the fifth cluster of interaction grouped the different males of higher rank (except S) and the female of the highest rank (I) (fig. 3, table 8).

In Group IV the reciprocal interactional clusters between the male S and the female D, and between the male P and the female I disappeared. The interactional cluster among female B and males L and H (wich each year of the study competed by female B) remained. The other interactional cluster was formed by the high ranking males (fig. 3, table 9).

DISCUSSION

Although Siskins' hierarchies do not show a straight right pattern, true dial relationships of dominance were found between some members of the flock.

It has been suggested that rank can affect interactions between individuals by reducing aggressive interactions with greater social disparity in rank (BERNSTEIN & GORDON, 1974). This has been the rule in studies on Juncos (*Junco* sp.) (SABINE, 1949), Redpolls (*Acanthis flammea*) (DILGER, 1960), or the Siskins in this work. In other studies, the contrary has been the rule (*Loxia curvirostra*, TORDOFF, 1954; *Zonotrichia querula*, ROHWER, 1975). In this study, however, this kind of relationship has only been significant for subordinate individuals, since dominants indiscriminately threatened individuals both

Table 7. Correlation matrix for Factorial Analysis of Correspondences (AFC) on interactional matrix between members of Group II. * $p < .05$; ** $p < .01$; *** $p < .001$.

*Matriz de correlaciones para el Análisis Factorial de Correspondencias (AFC) sobre la matriz de interacciones entre los miembros del Grupo II. * p <.0,05; ** p <0,01; *** p <0,001.*

Axis	1	2	3	4	5
Individuals					
Givers					
N	.08	.65	.23	.02	–.02
A	.00	.02	–.15	–.81**	.00
B	.95**	.02	–.02	.01	–.00
G	.01	.00	.89**	–.02	.08
H	.01	–.98**	–.00	.01	.00
L	–.96**	.02	–.00	.00	–.02
W	–.19	.22	–.36	.13	.11
Receivers					
N	–.01	–.94**	–.01	–.03	.00
A	–.49	–.19	–.02	.27	–.03
B	–.77*	.01	–.13	–.06	.04
G	.64	.00	–.19	–.13	–.05
H	–.00	.97**	.00	.02	–.00
L	.92**	–.02	.01	.03	.02
W	–.11	–.01	.79*	–.09	–.01
Eigenvalues	.203	.095	.054	.036	.009
% total variance	51%	24%	14%	8%	2%
partial X^2	406***	190***	108***	72***	18**
Total Inertia	.3939				
X^2	787.750***				

close and distant in rank.

In the same way, the correlation between rank and number of threats towards individuals of contrary hierarchical classification (dominants in front of subordinates and viceversa) was only significant for subordinates ($r_s = -0.883$; $p<0.01$). This was also found by DEAG (1977) in Barbary macaques (*Macaca sylvanus*), in which subordinates paid closer attention to the opponent's rank, than dominants.

In relation to sex, males interacted aggressively with each other very often, while females interacted amongst themselves less than expected (table 1). The same pattern was found in American Goldfinches (*Carduelis tristis*, COUTLEE, 1967), House Finches (*Carpodacus mexicanus*, KALINOSKI, 1975), Cassins' Finches (*Carpodacus cassini*, SAMSON, 1977) and Juncos (KETTERSON, 1979). However, in Crossbills (TORDOFF, 1954) and Evening Grosbeaks (*Hesperiphona vespertina*, BALPH et al, 1979) it was found that females also interacted with each other more often than expected. In spite of this disparity among species, the general rule in all finches cited in these works is that intersexual aggression is low. According to KETTERSON (1979) this could be due to the fact that females eat in the peripheral positions of the flock, while males feed in the central area. Since the majority of aggressive

Table 8. Correlation matrix for Factorial Analysis of Correspondences (AFC) on interactional matrix between members of Group III (phase 3). * $p < .05$; ** $p < .01$; *** $p < .001$.

*Matriz de correlaciones para el Análisis Factorial de Correspondencias (AFC) sobre la matriz de interacciones entre los miembros del Grupo III (phase 3). * $p < 0,05$; ** $p < 0,01$; *** $p < 0,001$.*

Axis	1	2	3	4
Individuals				
Givers				
N	−.06	.92**	.00	−.00
B	−.07	.48*	−.11	−.00
G	.07	−.09	.57**	.02
H	−.03	−.06	.13	−.65**
L	−.05	−.19	.06	−.38*
T	.39*	−.01	.42*	.14
J	.79**	−.01	−.15	.00
S	−.05	−.11	−.36*	−.01
D	.00	.05	.77**	.03
I	.46*	.00	−.43*	−.05
P	−.67**	−.18	−.05	.08
Receivers				
N	.72**	−.01	−.02	.00
B	−.03	−.30	.28	−.34
G	−.54**	−.10	−.01	−.00
H	.20	−.01	−.16	.37*
L	−.58**	−.05	−.15	.14
T	−.03	.91**	−.00	−.04
J	−.01	.64**	.16	.14
S	.31	−.02	.40*	.24
D	−.24	−.05	−.44*	−.00
I	−.58**	−.02	−.07	.17
P	.64**	.01	−.16	−.07
Eigenvalues	.312	.243	.160	.104
% total variance	34%	27%	18%	11%
partial X^2	66.77***	52.00***	34.24**	22.26
Total Inertia	.9117			
X^2	197.841***			

interactions take place in these central positions where there are more individuals and greater competition (FRETWELL, 1969), this spacing in females could account for the low rate of intersexual aggressions. Another hypothesis, perhaps more plausible for this study in captivity and then with space restrictions, is contributed by BALPH et al. (1979) on an intersexual social status signalling system. It assumes that birds may be attentive to the plumage cues of sexual social status, and so they would be more tolerant with intersexual companions. However, intersexual tolerance in this study was assymmetric; reduction in intersexual aggression in Siskins can therefore be a consequence of males tending to be dominants, and females subordinates. Since subordinates threaten their dominants less than expected, females, as being subordinates, will threaten males

Table 9. Correlation matrix for Factorial Analysis of Correspondences (AFC) on interactional matrix between members of Group IV. * p < .05; ** p < .01; *** p < .001.

*Matriz de correlaciones para el Análisis Factorial de correspondencias (AFC) sobre la matriz de interacciones entre los miembros del Grupo IV. * p < 0,05; ** p < 0,01; *** p < 0,001.*

Axis	1	2	3	4	5
Individuals					
Givers					
N	−.97**	−.02	.01	.00	−.00
B	−.17	.48*	.00	−.17	−.06
G	−.01	−.01	.10	.28	−.05
H	.08	.87**	.01	.02	.01
L	.51*	−.11	.34	.02	−.00
J	.11	−.08	−.05	−.32	.42*
S	.32	−.00	−.53*	.03	−.09
D	.20	.20	.11	.21	.16
I	.10	−.15	−.27	.27	.09
P	.50*	−.00	.00	−.30	−.13
Receivers					
N	.27	−.00	−.14	−.09	.47*
B	.46*	.06	.32	.14	.00
G	.07	.79**	−.02	−.07	−.03
H	.54*	−.36	.01	−.04	−.01
L	.05	−.03	−.30	−.08	−.37*
J	−.12	−.00	−.20	.20	−.16
S	−.98**	−.00	.02	−.00	.00
D	−.10	−.30	.01	.02	−.07
I	−.07	.00	.00	−.77**	.05
P	.01	−.00	−.70**	.28	.01
Eigenvalues	.335	.129	.107	.071	.049
% total variance	46%	18%	15%	10%	7%
partial X^2	172.53***	66.44***	55.11***	36.72***	25.06**
Total Inertia	.7259				
X^2	465.298***				

less than expected, and so, intersexual aggressions is reduced.

Nevertheless, interactional net is also regulated by other motivations. Cardueline finches pair while in winter flocks (COUTLEE, 1968; SAMSON, 1976), or even in autumn (NAKAMURA, 1982). The reciprocal interactions between individuals of opposite sex found in this work could have this pairing function. Once pairs were formed, interactional rate would decrease (compare Groups III and IV). This could also explain that when studying a given group throughout winter, intersexual interactional rates were low.

Presence of pairing interactions in fall/winter flocks could explain antagonism found between young-adult males, and the high rate of interactions given by young males which has already been quoted by SAMSON (1977) in Cassins' Finches. In cardueline finches females are a high limiting source for reproduction (SAMSON, 1977), and generally, there are a surplus of young males that do not have access to reproduction (SAMSON, 1976; SMITH, 1978; GLÜCK, 1980). This competition for females would favor the high interactional rate between young and adult males found in this work. Interaction of these two groups of males towards adult females could also have this pairing function. They would prefer adult rather young females because of their greater reproductive success (MIDDLETON, 1979).

At the same time there are interactions whose social function could be to regulate the hierarchy and social organization of the flock, and they would involve males and high-ranked females.

The presence of these two kinds of interactions (social/aggressive and pairing/sexual) in wintering flocks, which has already been quoted by some authors (MARLER, 1956; BALPH, 1977) arouses the question of whether there are also differences in the displays used in these two kinds of interactions (qualitative or quantitative). BALPH et al. (1979) have detected that intersexual and intrasexual aggressions among wintering Evening Grosbeaks may be different in frequency and intensity. However, it is not yet possible to discern if a given Siskin display is sexual or aggressive, or even both, probably because of the close similarities between agonistic/sexual and agonistic/aggressive displays (HINDE, 1955/56). More information in this area is needed before we may satisfactorily explain interactional nets in cardueline finches.

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SUMMARY

A first step in any study on social organization is the analysis of interactions. In this work, three factors affecting agonistic interactions: rank, sex and age, have been investigated to throw light on the organization of interactional nets in Siskins (*Carduelis spinus*). Interactional rates and patterns of direction were analysed in more than 4,000 interactions between captive birds. Four groups of different composition were used as different replicates to the study (n = 4,7,11,10 individuals). As birds were caged, the history of each bird was known, and thus, interpretations on their behaviour were facilitated. Reproductive period was excluded.

Although Siskin's hierarchies did not show a straight right pattern, true dial relationships of dominance were found between some members of the flock. Males were dominant over females. Age, size (taking wing-length) and kin factor were not correlated with dominance. Subordinate individuals threatened dominants less than expected and the more dominant the opponents were, the fewer threats they showed. Dominants threatened subordinates more than expected, although in this case there was no correlation between the degree of opponents' subordination and number of threats. Young and adult males interacted more than expected, young females interacted very few times with the rest of the group, and adult females received more threats from adult and young males than expected. Analysis of interactional patterns for each individual showed that there were three kinds of clusters of interaction: individuals of future pairs, several males presumibly competing around one female, and high ranking individuals.

Patterns of interaction found, suggest that interactions in wintering Siskins not only organize hierarchy, but also have a pairing function. Reciprocal interactions between members of future pairs found here, could have this pairing function. In cardueline finches, females are a high limiting source for reproduction (SAMSON, 1977), and generally there are a surplus of young males that do not have access to reproduction (SAMSON, 1976; SMITH, 1978; GLÜCK, 1980). This competion for females would favour the high interactional rate between young and adult males. These two groups of males would prefer adult females rather than young females because of their greater reproductive success (MIDDLETON, 1979). However, it is not yet possible to discern if a given display is sexual or aggressive, or even both.

RESUMEN

Reglas de interacción en Lúganos cautivos (Carduelis spinus).– Un primer paso en cualquier estudio

sobre organización social es el análisis de las interacciones entre los distintos individuos del grupo. En este trabajo se estudia el efecto del rango, sexo y edad en las interacciones agonísticas entre Lúganos (*Carduelis spinus*). Tasas de interacción y patrones de dirección han sido analizados sobre más de 4.000 interacciones entre pájaros cautivos. Como distintas réplicas al estudio se han utilizado cuatro grupos de distinta composición (n = 4,7,11, 10 individuos). Debido a que los pájaros estaban cautivos, el historial de cada individuo era conocido, facilitando asi las posibles interpretaciones. El período reproductivo ha sido excluido.

Aunque las jerarquias de Lúgano no mostraban un patrón lineal, existían verdaderas relaciones de dominancia dial entre algunos miembros del grupo. Los machos eran dominantes sobre las hembras. Edad, grado de parentesco y tamaño (tomando longitud del ala) no estaban sin embargo, correlacionadas con el grado de dominancia. Los individuos subordinados amenazaron a los dominantes menos de lo esperado, y a mayor grado de dominancia del oponente, menor era el número de amenazas que le dirigían. Los dominantes amenazaban a los subordinados más de lo esperado, aunque en este caso no existía correlación entre el grado de subordinación del oponente y el número de amenazas realizadas. Machos adultos y jóvenes interaccionaron entre si más de lo esperado, las hembras jóvenes interaccionaron muy pocas veces con el resto del grupo, y las hembras adultas recibieron de los machos jóvenes y adultos más despliegues de lo esperado. El análisis de los patrones de interacción para cada individuo mostró que existían tres tipos de grupos de interacción: individuos de futuras parejas, varios machos presumiblemente compitiendo por una hembra, y individuos de alto rango.

La distribución de interacciones hallada sugiere que éstas podrían no solamente tener la misión de organizar al bando en un sistema jerárquico, sino también la de aparear a los individuos del grupo en período otoño-invernal. Las interacciones recíprocas entre miembros de futuras parejas halladas podrían tener esta función.

En los fringílidos carduelinos las hembras son un recurso altamente limitante para la reproducción (SAMSON, 1977), existiendo generalmente un exceso de machos jóvenes que no tienen acceso a la reproducción. (SAMSON, 1976; SMITH, 1978; GLÜCK, 1980). Esta competencia por las hembras sería la causa de la alta tasa de interacción entre machos jóvenes y adultos. Estos dos grupos de machos interaccionarían preferentemente con hembras adultas, frente a las jóvenes, por el mayor éxito reproductivo de las primeras (MIDDLETON, 1979). Todavía no podemos sin embargo, diferenciar dada una interacción agonística, si su motivación es agresiva o sexual, o incluso ambas.

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