



Dominance and Influence of Social Context on Foraging by Eurasian Siskin (*Carduelis spinus*)

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ABSTRACT

The tendency to consume greater amount of food in social context has traditionally been attributed as social facilitation, which is an important characteristic of social and flocking birds. In this study, we investigated Eurasian siskin (*Carduelis spinus*) dominant individuals for neophobia and influence of social context on foraging. In our experiments, a subject (observer) was presented with three novel and familiar food in each of three contexts: asocial, first social context (conspecifics without food) and second social context (conspecifics with food). The results showed that individuals preferred to consume novel food only in social context comparing to asocial. Furthermore, individuals consumed significantly greater amount of familiar food in social context than asocial. Our results showed that dominant male Eurasian siskins may reduce neophobia in social context and increase food intake. Present study showed that flocking in the Eurasian siskin and other gathering birds may influence individual fitness.

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Authors' Contribution

NB and HW conceived and designed the study, collected the data and wrote the article. MSA helped in writing of the manuscript. MS helped in data analysis.

Key words

Social facilitation, *Carduelis spinus*, Foraging behavior, Personality, Neophobia, Dominance.

INTRODUCTION

The tendency to consume greater amount of food in social context has traditionally been attributed as social facilitation (Pliner *et al.*, 2006). Social facilitation is an important characteristic of social and flocking birds, as the behavior of one individual can induce similar behavior in other group members (Palestis and Burger, 1998). Social facilitation can enhance the benefits of flock by contributing to foraging success, reproductive synchrony within flock and anti-predator defense (Clayton, 1978). Consumption of greater amount of food during social context than asocial correlates positively with the number of individuals that are present in social context (Herman *et al.*, 2003). Presence of conspecifics (independent of its behavior) can also produce motivational changes that can either increase or decrease individual performance, depending on whether the change in motivation produce a behavioral change compatible or incompatible with learned or to-be-learned behavior. Social facilitation comprises two main circumstances: effects of coaction and audience

effect (Zajonc, 1965). Presence of conspecifics or effects of coaction results in maximum utilization of food, but in contrast in case of audience effect individuals usually consume less amount of food (Herman, 2015). Greater consumption of food in the presence of conspecifics was found in several species *e.g.* blue jays (*Cyanocitta cristata*), ravens (*Corvus corax*), marmosets (*Callithrix jacchus*) (Coppinger, 1969; Heinrich, 1988; Voelkl *et al.*, 2006).

Though actual mechanism and structure underlying socially facilitated feeding is not clearly known and needs further investigation but, according to Fragaszy and Visalberghi (2004) one functional advantage of this phenomenon is might be the increased acceptance of novel food by naïve individuals. Novel food consumption might later result in animals' health risk, and might be the possible reason to explain why individuals of many species are originally reluctant to incorporate novel food in their diet, a tendency described as food neophobia. Food neophobia is known to reduce by presence or interaction of conspecifics (Voelkl *et al.*, 2006). However, if socially facilitated foraging functions to promote novel food acceptance, rather than inflating food utilization generally, animals should selectively eat those novel foods they have observed others eating (Visalberghi and Addessi, 2001).

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Animals showing an aversion to novelty are known as neophobia. Individuals of many species differ consistently in their neophobia (Bebus *et al.*, 2016) and their behavioral reactions toward novel and challenging situations, *e.g.* the great tit (*Parus major*) (Verbeek *et al.*, 1994), the poecilid (*Brachyraphis episcopi*) (Brown *et al.*, 2005), and the Sardinian warblers (*Sylvia melanocephala momus*) (Mettke-Hofmann and Greenberg, 2005; Mettke-Hofmann *et al.*, 2005a). These consistent individual behavioral differences have been termed as personalities (Wilson *et al.*, 1993; Drent *et al.*, 2003). Neophobia is often used as a trait of nonhuman personality, because it is considered as stable response to challenges or risk across novel situations and across time (Dall *et al.*, 2004). This behavioral trait is common to many species *e.g.* warblers (*Dendroica castanea* and *Dendroica pensylvanica*, Greenberg (1990)), and capuchin monkeys (*Cebus paella*) (Visalberghi and Fragaszy, 1995; Visalberghi *et al.*, 2003a). Neophobia can be affected by early experience, ecology, and social contexts (Adnessi *et al.*, 2007).

Previous studies have shown that social and flocking birds spend less time vigilant and more time foraging than alone (review in Krause and Ruxton, 2002; Yang *et al.*, 2015; Wan *et al.*, 2016). However, in four species of goose when flock size increased over considerable range foraging time also increased and vigilant decreased (Drent and Swierstrs, 1977; Inglis and Isaacson, 1978). In social and flocking species, individuals differ in their dominance rank, social bond and kinship with other flock members, all of which can have an important effect on foraging behavior and performance (East and Hofer, 2010; Marshall *et al.*, 2012; Goodale *et al.*, 2015). However, there is a general prediction that greater spatial clumping of resources should lead to a greater influence of social effects on foraging performance due to resources being more monopolized (Yang *et al.*, 2015). For example, Vahl *et al.* (2005) found that dominant ruddy turnstones (*Arenaria interpres*) utilized significantly greater amount of food where food resources were spatially clumped. Similarly, in a study of common cranes (*Grus grus*) dominant individuals only engaged in agonistic interaction in context where their intake fell below a certain threshold (Stillman *et al.*, 2002). Foraging behavior were also studied in two common scorpion species *i.e.* Hottentotta tumulus (Fabricius 1978) and Odontobuthus odonturus (Pocock 1897) (Ahsan and Tahir, 2016).

The Eurasian siskin (*Carduelis spinus*), a small monogamous granivorous cardueline finch, has a social system consisting of both transient and resident individuals in a particular habitat (Senar *et al.*, 1992). Transient individuals constitute 92% of total population making flight of 10-40 km in a single day and stay in one

habitat for short period; in contrast, resident individuals are present in specific area for prolonged period making short flights typically less than 3 km (Senar *et al.*, 1992; Pascual and Senar, 2014). This difference in movement patterns is not related to sexual or age differences. Due to low mortality rate, it is easy to keep them in captivity (Senar and Camerino, 1998; Senar and Domènech, 2011). Black bib in Eurasian siskin is used to categorize dominance and personality (Senar *et al.*, 1993; Senar and Camerino, 1998). Individuals with large black bib show more exploratory personality and are dominant over females (Mateos-González and Senar, 2012).

Eurasian siskin is also a socially foraging species, therefore in the present study we provided with an opportunity to exploit social information for their foraging behavior (Senar *et al.*, 1992). Our first aim was to examine whether social context can reduce neophobia and facilitate foraging behavior in the Eurasian siskin. Our second aim was to examine whether they may use social information to guide their foraging behavior.

MATERIALS AND METHODS

Catching and housing

Eurasian siskins were caught using mist nest from Changchun city and surrounding areas in Jilin Province, China, on January 11-2017. Birds were transported to laboratory within two hours. Upon arrival in research laboratory we kept individuals under 12 h:12 h daylight regime in cages of 25 cm × 30 cm × 30 cm with two small perches placed inside. Perilla seeds, pine seeds and commercial canary mixtures were provided as familiar food, and water *ad libitum* (Senar and Camerino, 1998).

Dominance status

We used the size of the black bib, which is highly correlated with dominance, as an indication of dominance (Senar *et al.*, 1993). We measured size of black bib (length and width) by tilting birds head back in line with body and the area was calculated following Senar and Camerino (1998). We used only transient male individuals because the usefulness of black bib as signal of dominance is especially relevant to transient (Senar *et al.*, 1992). Based on the area we categorized individuals as large bib and without bib. Four individuals without bib were excluded. Ten individuals with bib size (median bib size was 17 mm², and 95% confidence interval (CI) was 13-21 mm²) were included in this study. Among our caught birds none of individual had a larger bib size, *e.g.* bib size > 35 mm² as in the study of Senar and Camerino (1998).

Experiment setup

We used two cages adjacent to each other (0.9 m ×

0.4 m × 0.5 m) in each of three contexts. 1) In asocial context, cage adjacent to focal cage were empty however in other two social contexts a conspecifics were present (Verbeek *et al.*, 1996; Dally *et al.*, 2008). Each context comprises only one test. 2) During the first social context a conspecific were only present but without novel or familiar food. 3) The third context was that second social context where conspecifics were also provided with both familiar and novel food like the focal subject. Each individual was tested both as subject and conspecifics. Sequence to test individual in all three contexts were pseudo randomized to avoid testing the same bird in a single day. We provided 1 g of total novel and familiar food in each context (we selected this amount because we have first conducted a pilot experiment to know how much amount of food each individual can consume within a period of 3 min. However, data of the pilot experiments were not included in this study). We weighed amount of total novel and familiar food before and after trial. We recorded neophobia and latency to feed for 3 min (Senar and Camerino, 1998) and then the trial was terminated. Birds that didn't feed novel or familiar food during 3 min were assigned to the maximum latency of 180s. Each trial was started as soon as the subject (the observer) enters the tested cage where conspecifics were already present in front cage (Addressi and Visalberghi, 2006). A video camera was used to record experimental birds for 3 min. The video tapes were later analyzed for approach latencies (both novel and familiar food). Experimental birds were also observed behind the observation screen (Senar and Camerino, 1998).

Foraging and neophobia test

Asocial context

Trial was started in their home cages at 09:00 h to 13:00 h. Individuals were deprived of food 2 hours before commencement of the trial (Senar and Camerino, 1998; Dally *et al.*, 2008). As the trial started individuals were provided with familiar food (canary mixture) and novel food (chocolate cookies mesh) (Table I).

Table I.- Assignment of familiar and novel food in each context.

Context	Food (Familiar / Novel)	Sex
Asocial	Canary mixture / Chocolate cookies	Male
Social (Conspecifics without food)	Pine seed / Pop corn	Males
Social (Conspecifics with food)	Perilla seeds / Bread	Males

Social context

We used popcorn (novel food) and pine seeds (familiar food) during the first social context where conspecifics were only present in front cage but not provided with food. During the second social context we presented bread (novel food) and perilla seeds (familiar food) to the subject and conspecifics were provided with only familiar food (perilla seeds). We meshed novel food to the size of small grains like perilla seeds so individuals can eat (Addressi and Visalberghi, 2006).

Statistical analysis

As our data violated normality assumptions, we used non-parametric tests. We carried out Friedman analysis of variance (ANOVA) to compare latency to approach novel and familiar food and the total amount of novel and familiar food consumed across contexts, and Wilcoxon signed rank test between contexts. We set 0.05 as alpha and presented original p values (Addressi and Visalberghi, 2006; Dally *et al.*, 2008). Data were analyzed using SPSS (V. 22).

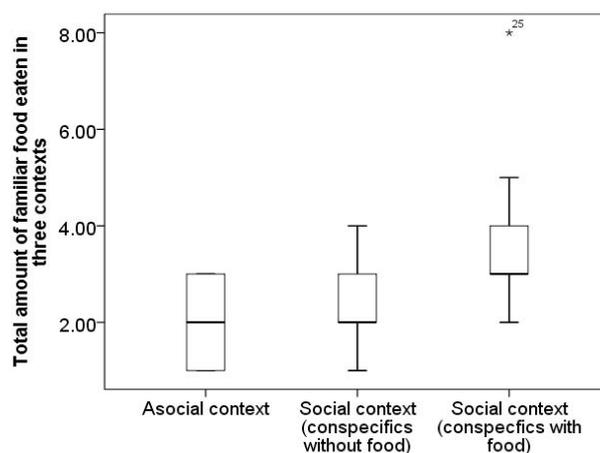


Fig. 1. A box and whisker plot of the median and inter quartile range (IQRs) of total amount of familiar food.

RESULTS

The Eurasian siskin preferred and consumed significantly greater amount of familiar food than novel food in all three contexts; asocial context (N =10, Z= -2.836, p <0.05), social context (conspecifics without novel or familiar food) (N =10, Z= -2.844, p <0.04) and social context (conspecifics with familiar food) (N =10, Z= -2.814, p <0.05, Figs. 1 and 2). Novel food was not eaten in asocial context (Fig. 2). Total amount of food eaten in asocial context was lower than social context (novel food, Freidman's ANOVA, $\chi^2 = 6.000$, N = 10, p

= 0.050, familiar food, Friedman’s ANOVA, $\chi^2 = 7.357$, $N = 10$, $p = 0.025$). Latency to approach familiar food was greater in asocial context than social context (Friedman’s ANOVA, $\chi^2 = 9.053$, $N = 10$, $p = 0.011$, Fig. 3). Individuals didn’t approach novel food in asocial context but they significantly approach novel food in social context (Friedman’s ANOVA, $\chi^2 = 7.946$, $N = 10$, $p = 0.019$, Fig. 4).

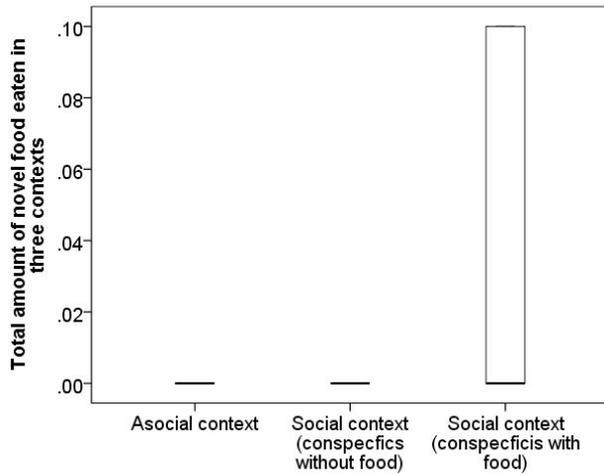


Fig. 2. A box and whisker plot of the median and inter quartile range (IQRs) of total amount of novel food eaten.

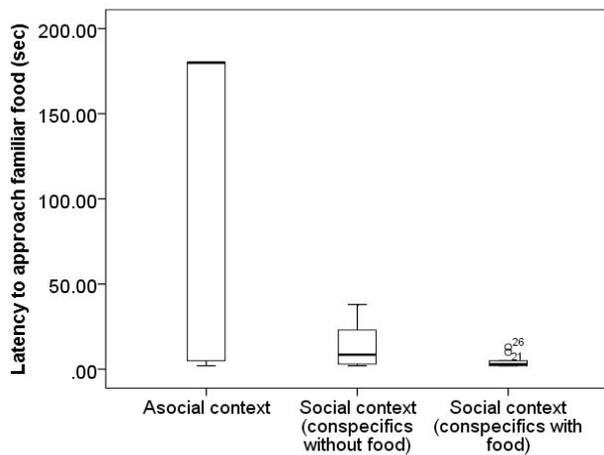


Fig. 3. A box and whisker plot of the median and inter quartile range (IQRs) of approach latency to familiar food.

DISCUSSION

In the present study, we showed that Eurasian siskin individuals ate significantly greater amount of familiar food than novel food in all contexts. This suggested a significant variation in food preference and utilization across contexts. One reason for increased food consumption in social

species might be reduced the need for each individual to engage in vigilant behavior like scanning for potential predators (Caraco *et al.*, 1980; Lima and Bednekoff, 1999). When animals are exposed to predation risk, they might benefit from exploiting socially available information as to food deliciousness rather than assessing that similar food resource (Laland, 2004). Another possible reason for greater consumption of food and reduction of neophobia is interspecific competition because birds living in groups experience possibly greater interspecific competition than alone. Therefore, group-living species may be less neophobic and/or more explorative (Greenberg and Mettke-Hofmann, 2001). Our study was also comparable to Pulliam and Caraco (1984) where they showed that in winter flocking birds, intake rate of group foragers is higher than that of solitary individual, *e.g.* one of the main advantage of aggregation in foraging birds is a reduction in predation risk (Giraldeau, 2008). But according to Sansom *et al.* (2008) an increase in group size may also result in an increase in interference competition among group members, which may reduce food intake rate (Beauchamp, 1998) and increase the time spent in vigilance (Knight and Knight, 1986).

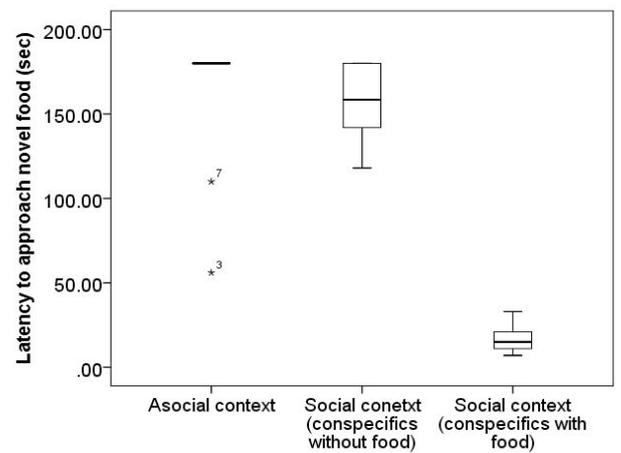


Fig. 4. A box and whisker plot of the median and inter quartile range (IQRs) of approach latency to novel food.

When animals show an aversion to unknown risk, they express a behavior, known as neophobia (Greenberg and Mettke-Hofmann, 2001). Neophobia may provide an advantage to animals by reducing their exposure to unknown danger but can also impose costs by preventing the exploration of potential resources (Greggor *et al.*, 2015). These costs and benefits of risk taking are likely to differ over contexts and time in a way that could alter the expression of neophobia. For instance, it could be advantageous to adjust neophobia levels when dangers or

environmental opportunities changed, such as predation pressure or food availability (Brown *et al.*, 2013). Food neophobia is influenced by factors like, the type of food (Visalberghi and Fragaszy, 1995; Visalberghi *et al.*, 2002), and the number of exposures to a novel food etc. (Visalberghi *et al.*, 1998). Previous investigations have shown that social influences increase the acceptance of novel food in different animals such as tufted capuchin monkeys (Visalberghi *et al.*, 1998), and marmosets (Yamamoto and Lopes, 2004; Schrauf *et al.*, 2004).

In our study individual's approaches to novel foods in social contexts indicated that they reduced neophobia. This reduction in neophobia in group might be because they utilized information from conspecifics and then approached novel food in the social context. But their preference to familiar food than novel food was might be due to unusual taste of novel food. Our results are also comparable to Mason and Reidinger (1981) where they showed that red-winged blackbirds (*Agelaius phoeniceus*) had tendency to utilize the same novel food as conspecifics after observing conspecifics eating that food. According to traditional definition of social facilitation, greater food consumption by focal subjects would only be defined as such if it was temporally synchronized with conspecifics' foraging behavior (Clayton, 1978). The tendency for Eurasian siskin to enhance consumption in the social context (non-feeding conspecifics) should, therefore, be attributed to an elevated motivation to feed rather than an effect of social facilitation. Indeed, rather than facilitating feeding per se, the existence of conspecifics might have decreased focal subjects stress level, increasing food consumption as a corollary. Regardless of actual process involved, our results supported the suggestion that presence of conspecifics exacerbated individual's tendency to reduce neophobia (Fragaszy *et al.*, 2004).

Our study showed that Eurasian siskin dominant males may reduce neophobia in the social context and increase food intake. This was comparable to Dally *et al.* (2008) showing social context influenced foraging behavior in rooks. However, unlike our results, Fragaszy *et al.* (2004) found no significant influence of the social context on social facilitation and consumption of novel food in the social context. Since we only used male dominant individuals in the present study, we suggested that sex differences and influence of the social context on personality of Eurasian siskins should need further investigation.

Ethical note

The experimental procedures were permitted by National Animal Research Authority in Northeast Normal University, China (approval number: NENU-20080416)

and the Forestry Bureau of Jilin Province of China (approval number: [2006]178).

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Statement of conflict of interest

Authors have declared no conflict of interest.

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