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Flight Initiation Distance in an Urban Bird: Influence of the Number of People, Gaze Orientation, and Bird Behavior

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Simple Summary: In this study, we assessed whether the flight initiation distance (FID) of Saffron finches (*Sicalis flaveola*, Aves), commonly observed in urban centers in Brazil, was influenced by the direction of gaze, the number of people, behavior, and habituation to humans. To achieve this, the researcher walked at a constant speed towards groups of birds, alone or in a group, either looking directly at the birds or not, and in locations with heavy or low pedestrian traffic. The results showed that Saffron finches exhibited longer FIDs when more people approached them while staring directly at them. If the birds were alert, the FIDs were longer. Pedestrian traffic did not influence FID responses, meaning that the birds were not habituated to humans.

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Abstract: The flight initiation distance (FID) measures the distance a bird flees from an approaching predator. Factors such as the frequency of predator approaches, the direction of predator gaze, variations in predator presence across different areas, and the specific behaviors displayed by predators can all affect the FID. For birds, people can assume the role of predators. This study aimed to evaluate whether the FID of the species *Sicalis flaveola* (Saffron finch, Aves, Passeriformes) is influenced by the number of people and their gaze direction, comparing areas with the greater and lesser flow of people and relating to the types of behavior exhibited by the birds. The results showed that the number of people walking towards the bird influenced the escape behavior, with more people generating longer FIDs than fewer people. If the approach was with the eyes fixed on the birds, the FIDs were longer. When birds were alert, FIDs were longer. Overall, the findings imply that birds exhibit nuanced reactions to human presence, even in areas with frequent human encounters, highlighting their advanced capacity for assessing and responding to perceived risks.

Keywords: FID; habituation; predation risk; Saffron finch; *Sicalis flaveola*; urbanization

1. Introduction

The escape behavior of a bird is considered the response reaction to flee from a possible predator when it indicates some risk of predation [1]. This response reaction allows the bird to protect itself against predation since it gives them time and distance to escape [2]. Birds should flee when the cost of staying is greater than the cost of escaping and when the probability of being caught by the predator is greater than the probability of survival if they stay [3]. Thus, birds estimate the threat level the potential predator offers to avoid an unnecessary escape without compromising their safety.

To better understand the factors that influence the decision of a prey bird to flee or continue feeding in an area with predation risk, the flight initial distance (FID), measured by the distance between the approaching predator and the moment when the prey decides to flee [3], is a good measure since it is sensitive to risk and readily measurable. The FID ensures the cost-benefit regulation of staying at a foraging site in a potentially predatory context. The higher the FID, the lower the chance of the bird being captured by the predator and the higher its survival rate [4]. The FID may vary according to the specific characteristics of the predator (size, position of the eyes, etc.), the environment (urban or rural), and the bird's degree of habituation to human presence [5].

FID studies allow for understanding how birds perceive predation risk in their environment, including in urban areas [6–10]. FID studies have already been developed in urban areas with humans playing the role of predators, and the results allow inferences about the role of humans in the biology and danger perception of birds [7,11–14]. The interaction between birds and humans in urban environments may vary depending on the bird species and the characteristics of the environment and humans. For example, a study conducted in Colombia assessed how urban birds perceived human presence in different environments, including public parks and gardens, residential areas, and commercial areas. The results showed that in large flocks, some species were more tolerant to human presence in residential areas than in commercial areas [10]. In another study in China, the scaly-sided merganser (*Mergus squamatus*) showed greater reactivity to human presence in all studied areas [15]. Another study conducted in urban areas of tropical countries investigated how urban birds respond to human disturbances, and the results showed that the responses varied among species, with some showing a higher tolerance to human presence while others showed a low tolerance to human presence [16]. In Brazil, a study conducted with three bird species showed that their responses to the human approach differed, with the golden-cheeked woodpecker (*Melanerpes chrysogenys*) tolerating the approach of humans more than the other two species (a dove and an oriole) due to its strategy to use tree trunks as hiding places [17]. In a study conducted in Thailand, the color of human clothing influenced the FIDs of the white-rumped shama (*Copsychus malabaricus*), with camouflaged clothing enabling individuals to approach birds more closely (shorter FIDs) compared to orange and black clothes [18]. Other examples can be found in the scientific literature [19]. In urban areas, human presence can pose risks to birds, as humans can act as predators for them [20], in addition to secondary factors arising from human presence, such as noise production, genetic factors [21,22], and filtering, since individuals could be selected based on their life history and personality [22–24], which can hinder predation risk assessment [25]. Thus, in areas with intense human disturbance, birds may be less able to perceive predation risk due to direct and indirect anthropic interference.

In urban areas, the FID can be influenced by factors such as habituation to the human presence, quantity, and the orientation of people's gaze [20,26]. Habituation and experience with humans significantly influence the escape responses of animals during bird–human interactions [27]. Generally, animals can habituate to human presence, depending on human behavior directed toward them [26]. In areas where human presence is frequent and non-threatening, birds may stop responding to the level of threat offered by humans, responding with shorter FIDs [13,28]. On the other hand, in areas where human presence is associated with threatening or discouraging behaviors, such as hunting, animals respond with longer FIDs [29]. In the study conducted in southern California (USA) in Los Cerritos, Anaheim Bay, and Bolsa Chica, for example, the species *Passerculus sandwichensis* (Savannah sparrow) was shown to have longer FIDs in Anaheim Bay, where it rarely encountered humans, than in Los Cerritos and Bolsa Chica, where the human visitation rate was relatively higher [30]. Thus, this result may be a consequence of the habituation effect because, in environments with a more significant presence of people, the repeated low-risk exposure of prey to a potential predator may facilitate the change in risk assessment towards the specific predator, affecting its escape behavior [31]. However, as mentioned above, habituation to human presence can also be linked to selectable factors and the filters imposed by urbanization (genetics, personality, etc.) [21–24]. The response of birds to human presence may differ depending on the number of people approaching them. The longer the FID, the larger the group of people [2]. Thus, birds may tolerate the approach of only one person but avoid the approach of large groups of people [25]. In the study conducted in Booderee National Park, located south of Sydney, *Platycercus elegans* (Rosella pennant) had a significantly longer FID when the group of people was larger than two [25]. In another study carried out in Australia with different species of waterfowl, the number of people approaching did not influence the FID of the individuals [32]. It is therefore important to evaluate the specific responses of birds and the local factors that can stimulate such different FID responses of species. Some studies regarding this theme have been published, showing that the FID responses of birds are variable and difficult to generalize [26,33–36], corroborating the necessity of more studies with different bird species.

In addition to the number of people, studies have shown that the orientation of the eyes of potential predators is also essential in the decision of birds to take off to escape. This is because birds can detect the direction of a potential predator's gaze and use this information to assess the threat level [37]. For example, a potential predator looking directly at a bird can be interpreted as a warning sign and imminent danger. In contrast, if the predator is looking in another direction, this may indicate that the predator is not paying attention to the bird and that it may be able to escape undetected [38]. Thus, birds tend to flee faster, i.e., exhibit longer FIDs, when predators' eyes are directed towards them [2,39]. It was observed in a study that the species *Bostrychia hagedash* (Hadada ibis) showed the longest FID when people approached with their eyes directed at them and the smallest FID when people were not with eyes directed at them [40]. This result is also in line with the idea of 'sub-lethal hunting', promoted by bird photographers in the wild, where the disturbance caused by the proximity of the photographer to the bird, their behavior during the approach (walking slowly and camouflaged, crouched down, and not making too many noises), and their equipment (which can resemble a gun, as the lenses are usually large) make them look like predators, stimulating escape responses in the birds [41].

The present study aimed to evaluate whether the FID presented by the Saffron finch (*Sicalis flaveola*), a bird commonly observed in Brazilian urban areas, is influenced by the number of people and their gaze direction, comparing areas with a greater and lesser flow of people and relating to the types of behavior exhibited by birds. Assuming habituation (reduced responsiveness to humans), we predicted that individuals in areas with higher people flow would have shorter FIDs than those in locations with lower people flow. In addition, we tested whether the number of people walking (NPW) towards the bird influences the FID, predicting that the higher the NPW, the higher the FID of the birds. We further analyzed whether the direction of people's gaze is related to the flight initiation response, predicting that when the gaze direction was fixed on the birds, the FID would be longer compared to the non-fixed gaze direction due to birds perceiving a higher predation risk. We also recorded the types of behaviors exhibited by the birds. We predicted that when the individual exhibited alert behavior, the FID would be longer than when it was not alert, and the bird would more readily perceive the presence of a predator or the increased risk of predation [42]. Finally, we assessed whether the FID varied depending on the number of birds in the group (number of conspecifics). We predicted that more individuals would detect approaching people faster than smaller numbers, presenting longer FIDs due to the many-eyes effect [43]. The Saffron finch is one of Brazil's most trafficked bird species [44–46]; thus, it is essential to understand the factors that influence the escape capacity of the species since such factors may increase or decrease capture by humans.

2. Materials and Methods

2.1. Ethics Statement

This study was submitted to the ethics committee of the Federal University of Ouro Preto, Minas Gerais, Brazil, and was approved under protocol no. 5495281119.

2.2. Study Area and Animals

This study was carried out at the Federal University of Ouro Preto (UFOP), Morro do Cruzeiro campus, located in the municipality of Ouro Preto (20°17′15″ S, 43°30′29″ W), state of Minas Gerais, southeastern Brazil. Four areas were defined on the campus: two with a higher flow of people and two with a lower flow of people. The areas selected as having the highest flow were the entrance of the Institute of Exact and Biological Sciences (ICEB) and the Department of Geological Engineering (DEGEO), the two most attended buildings of the UFOP (this was determined by previous personal observations and information provided by university staff). The areas with the lowest flow of people were the areas of native vegetation behind the Animal Science Centre of the UFOP and DEGEO buildings, where people's presence was rare.

The Saffron finch, *Sicalis flaveola* (Thraupidae, Passeriformes), is a typical urban bird species in Brazil, and it can be found in more significant numbers at the UFOP campus. This species forages mainly on the ground, and its diet consists of seeds; it is usually observed in flocks, especially when immature [47,48]. Its alert behavior can be observed through a tense posture, with heads raised and eyes wide open, searching for possible threats nearby [49]. When the finch perceives a nearby threat, it emits a high-pitched, repetitive call that serves as an alert to other members of its species and to scare off the intruder [50].

2.3. Experimental Protocol

Data collection started in September 2021 and ended in June 2022 (April to September: hot and wet season; October to March: cold and dry season). A mixture of seeds was offered ad libitum to the birds in all studied areas, always placed on the ground. The start distance (SD) of 12 m from the food areas was standardized and based on preliminary tests. When the Saffron finches arrived to explore the food items, the researcher started walking towards them at a constant speed of 1 m/s, recording the number of birds in the group, their behaviors, FID, and latency to respond to the approaching humans. Samples were collected with one, two, and three humans walking side-by-side toward the birds, with or without a fixed gaze. The fixed gaze occurred when the humans went towards the bird looking directly at them (staring at the bird), and the unfixed gaze transpired when the humans went towards the bird looking around and not directly at the bird (not staring at the bird). The researchers always wore more discreetly colored clothing (black, green, dark blue, and camouflage), but the influence of clothing color on the finches' response was not assessed. All four areas were visited at least six times, and in each area, 60 samples were collected (240 samples in total). The intervals between field campaigns were random, varying from 1 to 20 days.

We used a manual tape measure to measure the FID (in meters). When more than one bird was present, the FID of the first bird to fly was recorded. As the Saffron finches were not marked, it was possible that repeated recordings of the same individuals may have occurred, although intervals of one hour between data collections and larger intervals between field surveys were used to avoid or minimize this. However, moderate pseudo-replication does not alter the main results of most analyses in FID studies [51]. The behaviors exhibited by the Saffron finches and recorded during the tests were as follows: eating (EAT): individuals were feeding with their heads down and not paying attention to the surroundings; eating and moving (EAT/MOV): individuals were feeding with their heads down and moved through the food area; eating and alert (EAT/AL): individuals were feeding, but always alert to the surroundings; and eating, alert, and moving (EAT/AL/MOV): individuals were feeding and moved through the food area, but always alert to their surroundings.

2.4. Data Analysis

We used R 4.2 software [52] and the lme4 package [53] to construct multiple generalized linear mixed models (GLMMs) with a Gamma distribution to test whether the FID (response variable) was influenced by the number of humans walking towards the birds (1, 2, or 3), gaze direction (staring or not staring), people flow (high or low), group size (number of Saffron finches on the group), climatic season (cold and dry or hot and wet), and bird behavior (EAT, EAT/MOV, EAT/AL, and EAT/AL/MOV) (explanatory variables). Post-hoc tests were conducted using the emmeans package [54]. The best models were selected using stepAIC, with the best model identified as having the lowest AIC.

Spearman's rank correlations were used to test the correlations between the explanatory variables before generating the GLMM models. Since no variables showed a correlation ($p > 0.05$ and r equal or very close to 0), all variables were included in the GLMM analysis.

3. Results

Saffron finches fled at distances ranging from 1.3 to 12 m (mean ± SD: 4.5 ± 1.9 m; n = 240). The bird group sizes (i.e., number of conspecifics) ranged from 1 to 12 individuals (mean ± SD: 3 ± 2.3 individuals; n = 240).

The number of people walking (NPW) towards the birds influenced the FID: the greater the number of people walking towards the birds, the greater the FID (Table 1 and Figure 1). When people walked towards the birds with a fixed gaze (staring at the birds), the FIDs were longer (Table 1). When the birds were eating/alert (EAT/AL) and eating/alert/moving (EAT/AL/MOV), the FIDs were longer compared to the birds that were eating/moving (EAT-MOV), especially in the hot/wet season (Table 1 and Figure 2). The other variables evaluated did not influence the FIDs of birds (Table 1).

Table 1. The results of the generalized linear mixed models (GLMMs) for the flight initiation distance (FID) of Saffron finches (*Sicalis flaveola*) concerning the behaviors exhibited, the number of people walking towards the birds (NPW), the number of birds in the group, the gaze direction of people (staring at the birds and not staring at the birds), the climatic season (hot/wet or cold/dry), and the flow of the site (high and low). Explanatory variables that lacked significance were excluded from the best models and, therefore, did not appear in the table.

Explanatory Variable	Beta	95% CI	*p*-Value
Eating/alert	−0.05	−0.08, −0.03	<0.001 *
Eating/moving	0.02	−0.02, −0.07	0.30
Eating/alert/moving	−0.08	−0.14, −0.02	0.005 *
NPW	−0.04	−0.06, −0.02	<0.001 *
Staring at the birds	−0.03	−0.05, −0.01	0.003 *
Season: hot and wet	−0.04	−0.06, −0.01	0.008 *

* = statistically significant differences; CI = confidence interval.

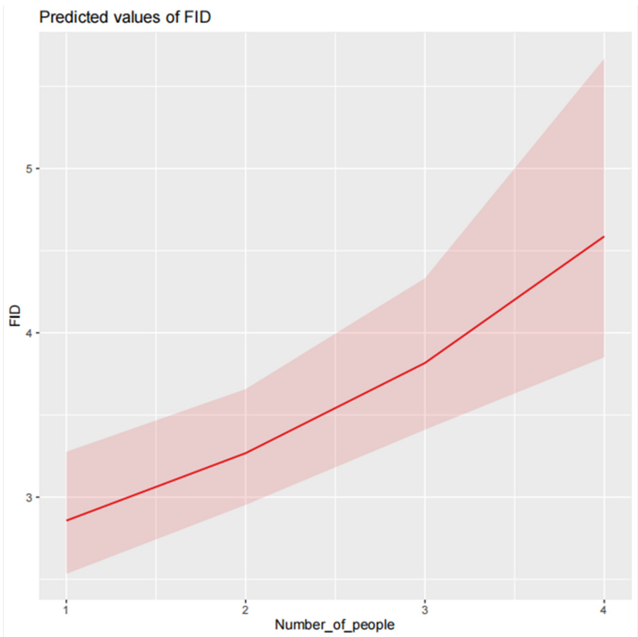

Figure 1. The flight initiation distance (FID (in meters)) of Saffron finches (*Sicalis flaveola*) in relation to the number of approaching individuals.

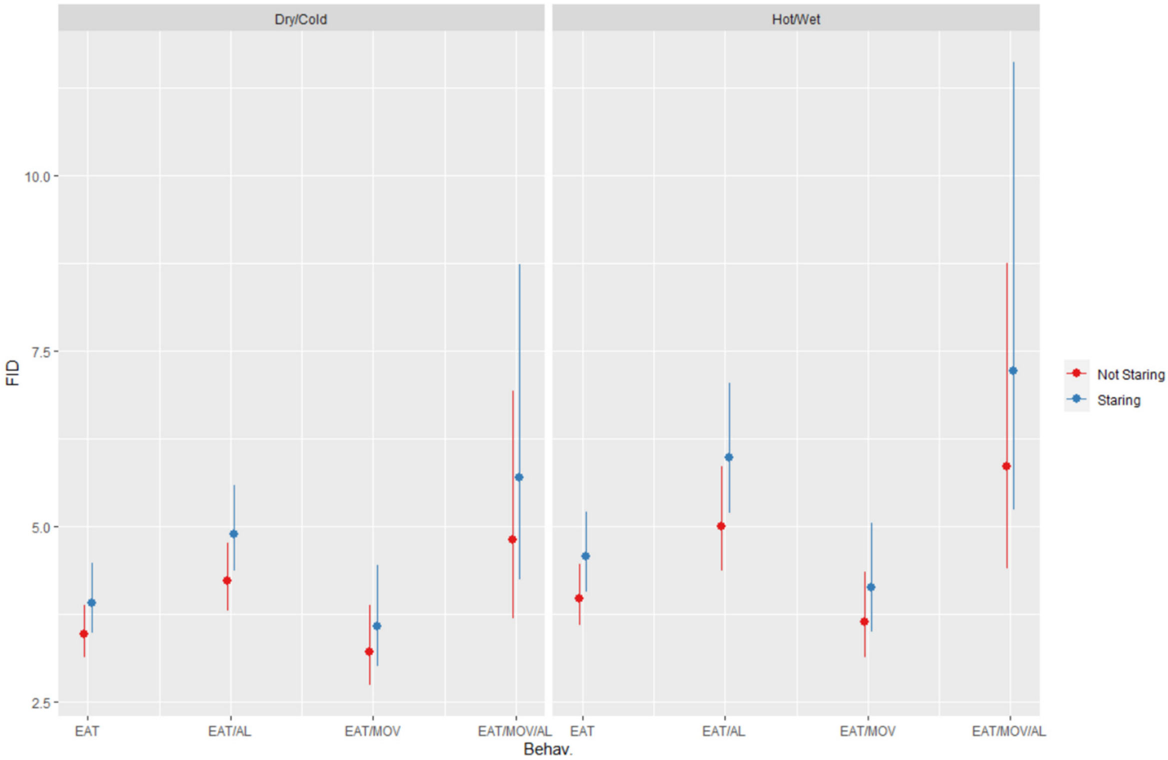

Figure 2. The flight initiation distance (FID (in meters)) of Saffron finches (*Sicalis flaveola*) concerning the climatic seasons and the behaviors exhibited by the birds. Circles represent the mean number of the registers, and the bars represent the standard deviations. Statistical differences were only observed in association with the alert behavior (EAT/AL and EAT/MOV/AL).

4. Discussion

Saffron finches modified their FID depending on the number of people walking towards them and the direction of people's gazes. However, they did not vary this response regarding the flow of people or the number of birds in the group. When alert, birds respond faster to approaching people, indicating the benefit of vigilance and the cost of not being vigilant. These results partially corroborated our predictions.

Saffron finches showed longer FIDs when the approaching people gazed at them. These results indicated that the birds used gaze direction as a clue for an increase in the threat level. Thus, the birds are more likely to be alert and react defensively when humans directly observe them because the risk of predation is understood to be higher [39]. Previous studies similarly suggested that when humans are looking directly at birds, they can disturb the animals at greater distances than when they are not looking directly at them [2,37,55,56]. Staring at prey is a characteristic behavior exhibited by predators, with solid learning power by the prey, as it is permanently exhibited under conditions of pursuit and capture during predation events [57–59]. The response of the Saffron finches to people's gaze may indicate that the birds have already associated this cue with increased predation risk [56,57].

The number of people walking (NPW) toward the finches also influenced their FID. The higher the NPW, the longer the FID. This result follows the study where the common blackbird *Turdus merula* showed a longer FID when being chased by more significant numbers of people [60]. According to the risk allocation hypothesis [61], there is a negative relationship between the FID and the number of predators since animals should decrease their allocation of anti-predator efforts in increasingly frequent high-risk situations. That is, in high-risk predation situations, such as those involving more predators present, prey decrease their effort to exhibit many anti-predator behaviors by quickly fleeing the scene [26]. This behavioral response can be extrapolated to humans because human disturbances can cause anti-predator responses like those elicited by natural predators [62]. This negative relationship was observed in the present study. In this study, the birds' initial approach distance was 12 m. At this distance, it may be that the birds perceived a group of 3–4 people approaching as a strong stimulus, encouraging them to make a quick escape. It may also be that the height of the researchers may have influenced this perception of a strong stimulus, or not, since they could have been mistaken for a superpredator as they approached them side-by-side. These hypotheses should be tested in the future. In a study conducted with black swans (*Cygnus atratus*) in Europe, however, this influence of the researchers' height was not significant for the birds' FID [63].

The alert behavior influenced the FID of the Saffron finches, showing that when individuals were alert, the FIDs were longer. The FID increases with alert behaviors because the animals can perceive the predator's approach at greater distances and assess the degree of threat and thus adjust their anti-predatory responses [42,64,65]. However, vigilance behaviors are costly since they reduce the time required to perform other vital activities, such as breeding or feeding [66,67]. Many species prefer to live in groups to decrease such vigilance costs since there are more eyes to detect predators, allowing more time for foraging and reproductive behaviors (the many-eyes effect) [43]. Thus, birds that exhibit fewer vigilance behaviors are less likely to show a faster escape response to predators. In the present study, however, the number of birds in the group did not influence the FID's response to approaching humans. This result follows the results shown in a recent meta-analysis, where the FID of passerine birds was not influenced by the number of individuals in the flock [36].

Concerning the climatic season, the FID was found to be longer in the hot–rainy season, coinciding with the main reproductive period of Saffron finches [48]. During the reproductive season, birds with offspring face a trade-off between the costs and benefits of caring for their young and fleeing from predators, which is reflected in the FID [31]. Consequently, Saffron finches increase their vigilance and anti-predatory activity during the reproductive period compared to other times of the year, suggesting that offspring protection and reproduction are important priorities [68]. They respond with longer FIDs, avoiding predation risk and ensuring the species' reproductive success. The birds adjusted their anti-predation behaviors during the reproductive period, such as reducing activities outside the nest and changing foraging patterns to avoid high-risk predation areas [61,69,70]. In a European study, the authors found a decrease in the FID of various bird species under warm and humid conditions, which was related to lower foraging success under these conditions [71].

Finally, Saffron finches did not show different FIDs depending on the flow of people. Some studies have shown shorter FIDs for birds living in urban areas than for their counterparts living in rural areas [8,16]. Urban noise sometimes decreases urban birds' FIDs because noise disrupts their attention to their surroundings [72]. Thus, in the present study, the Saffron finches may be habituated to humans in both areas (high and low flow of people), or some factors not investigated here could have influenced their capacities to be alert to surrounding threats. However, assessing the impact of human presence on birds' FIDs across urbanization gradients may be complex, sometimes yielding results divergent from prior assumptions [73]. This underscores the necessity for further research across various urbanization contexts and diverse bird species.

5. Conclusions

We conclude that Saffron finches adjust their FIDs depending on human presence and behavior. Overall, the findings imply that these birds exhibit nuanced reactions to human presence, even in areas with frequent human encounters, highlighting their advanced capacity for assessing and responding to perceived risks. These results corroborate the idea that humans can provoke disturbance and fear in Saffron finches in urban environments, influencing their behavior and probably their fitness.

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Data Availability Statement: The original data presented in this study are openly available in the Mendeley Data Repository under the doi: 10.17632/zs7p7dwpkb.1.

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