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Original Research Article

Face masks matter: Eurasian tree sparrows show reduced fear responses to people wearing face masks during the COVID-19 pandemic

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A B S T R A C T

Continuous exposure to human activity has led to considerable behavioural changes in some wildlife populations. Animals are more likely to survive in a changing environment by adjusting their behaviour to repeatedly occurring but harmless stimulations. During the COVID-19 pandemic, starting in late 2019, face masks were recommended to the public to prevent the spread of pathogens. In this context, we compared the flight initiation distance (FID) of the Eurasian tree sparrow (*Passer montanus*), a commonly seen bird across China, in Yibin and Dazhou, Sichuan, in response to people with or without face masks. After continuous exposure to people wearing face masks for nearly six months, sparrows evidently became adapted to people wearing face masks, and correspondingly showed shorter FIDs in response to people wearing masks. To our knowledge, this is the first study showing that birds show reduced fear responses to people wearing face masks during the COVID-19 pandemic. Our results suggest a novel aspect of short-term adaptation of wildlife to human behaviour, and that the learning ability of sparrows allows them to adjust their behaviours to adapt to such subtle changes in the environment.

1. Introduction

Animals modify their behaviour in response to disturbances in their environment (Frid and Dill, 2002; Caro, 2005). In the past decades, conflicts between humans and wildlife have become more common due to human encroachment (Dickman, 2010). Numerous wildlife populations cannot escape human proximity, and behavioural flexibility is one option for coping with increasing human disturbance (McLennan et al., 2017; Barrett et al., 2018). For example, predators which are diurnal in their natural habitats are frequently nocturnal in urban areas so as to avoid humans (Ditchkoff et al., 2006), and great tits (*Parus major*) change the frequency of their calls in noisy environments in order to ensure successful mate attraction and reproduction (Slabbekoorn and Peet, 2003). In most cases of urban human–wildlife encounters, humans do not harm wild animals (Barbara and Marzluff, 2012), thus animals which frequently encounter humans will show reduced fear responses (Metcalf et al., 2000; McCleery, 2009; Chapman et al., 2012). Wild animals in urban habitats such as birds, lizards, and

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mammals showed more tolerance towards humans following repeated encounters (Samia et al., 2015). Such alterations of behavioural responses to repeated neutral stimuli are a form of behavioural plasticity (Vincze, 2016). In other words, by establishing a connection between information and appropriate behaviour, animals can change their behaviour to adapt to complex and unstable environments (Mery and Burns, 2010).

The predominant elicitor of behavioural responses of animals to humans is fear of predation (Frid and Dill, 2002; Blumstein et al., 2005; Kleindorfer et al., 2005), and studying how animals escape potential predators and quantifying anti-predator behaviours helps understand and predict how animals respond to human activity (Blumstein, 2006; Geffroy et al., 2015). Flight initiation distance (FID) is the distance at which an individual flees from a threat stimulus, and it is commonly used as a quantitative measure of anti-predator behaviour and habituation to human disturbance (Ydenberg and Dill, 1986; Cooper and Blumstein, 2015). An animal's FID can reflect a trade-off between survival benefits and the risk of being preyed upon (Cooper and Blumstein, 2015), which can thus also be used to evaluate habituation of birds to humans. Previous studies showed that many factors may affect FID in birds, including body size (Laursen et al., 2005; Blumstein, 2006; Møller, 2008b), physical health (Beale and Monaghan, 2004), flock size (Laursen et al., 2005; Møller and Garamszegi, 2012), clutch size (Møller and Liang, 2013), and urbanisation level (Møller, 2008a; Díaz et al., 2013; Blumstein, 2014).

In order to effectively prevent the spread of COVID-19, China and many other countries as well as the World Health Organization recommended that people wear face masks in public areas (Greenhalgh et al., 2020). By the end of June 2020, nearly 90% of the world's population lived in areas where masks are commonly used or required by law (World Health Organisation, 2020). Daily living and traveling habits of the general public have also experienced considerable changes due to the pandemic. Based on our own observations, before the outbreak of the pandemic, face masks were highly uncommon, whereas people were mostly wearing face masks during the lockdown period and continued wearing masks after it was lifted. Thus, urban birds have been exposed to people wearing face masks for nearly six months. During this period, birds were forced to undergo the stimulation of people wearing masks. Face masks could be a continuous stimulus, and birds may adapt to people with face masks quickly. Therefore, we would like to compare the flight initiation distance (FID) of birds in Yibin and Dazhou, in response to people with or without face masks. According to previous studies on local bird behavioural plasticity (e.g. Feng and Liang, 2020; Shen et al., 2020), we speculated that people wearing face masks may be able to approach birds at a reduced FID, compared with people without face masks.

2. Materials and methods

2.1. Study area and study species

The study was conducted in the Yibin (27°50′–29°16′ N, 103°36′–105°20′ E) and Dazhou (30°18′–32°21′ N, 106°41′–108°28′ E) areas of Sichuan, China, from April to May 2020. These two areas (for more details, see Jiang et al., 2020) were rated as 'low COVID-19 risk' areas during this experiment, therefore face masks were not mandatory in outdoor areas where sufficient social distancing was possible.

The Eurasian tree sparrow (*Passer montanus*) used in this study predominantly inhabits urban environments and occurs in close proximity to people. These birds are widely distributed in towns and villages across China (Zheng, 2017). Therefore, Eurasian tree sparrows relatively frequently encounter people and may thus alter their behaviour in response.

2.2. Data collection

Previous studies showed that the colour of human clothing affects the FID of birds (Gutzwiller and Marcum, 1997). Therefore, two investigators (XJ in Yibin and CZ in Dazhou) of the current study wore neutral-coloured clothes and behaved like regular pedestrians. The experiments were performed in a random order with investigators either not wearing face masks (Fig. 1a) or wearing common blue surgical masks (Fig. 1b). As the vertical positioning of the bird and intraspecific behavioural effects (Møller, 2010b) may affect FIDs, we only recorded FIDs of individual birds or groups which initially were at ground level. The FID was recorded as described by Blumstein (2003). Before data collection, each investigator was allowed at least two months' time to familiarise themselves with the standardised FID measurement. All investigators walked towards the focus birds at normal walking speed in a straight line. The straight-line distance between the focus bird and the investigator at flight initiation was recorded as FID. The horizontal distance at which the individual took flight was recorded as the FID, whereas the starting distance was the distance from where the observer started walking up to the bird. In most cases, this was chosen as a fixed distance of 30 m to avoid a correlation between FID and starting distance (Møller et al., 2019). In this study, the distance was measured in steps and was converted to meters. In order to avoid pseudo-replication, the investigators walked continuously in one direction without turning around; however, one site could be used a second time with the respective other face mask condition.

2.3. Data analyses

IBM SPSS 20.0 for Windows (IBM Inc., USA) was used for statistical analyses. A generalised linear mixed model with a binomial error distribution was fitted to compare FIDs. To compare FID between the two study areas, FID was used as the response variable, and flock size, face mask presence, and study area were used as predictors. To test the FID of sparrows in

Fig. 1. An example of investigators with (a) and without (b) face masks.

each study area, FID was used as the response variable, and flock size and face mask presence were used as predictors. To test the FID of an individual sparrow, independent sample t-tests (when data did not significantly deviate from normal distribution) or Mann–Whitney U tests (when data significantly deviated from normal distribution) were used to compare the means. All the tests were two-tailed, and statistical significance is reported at $P < 0.05$. Data are shown as means ± standard deviation.

3. Results

FIDs of birds in the two study areas were compared and analysed with respect to site, face mask presence, and flock size. The results showed that FIDs differed significantly between study areas (Dazhou FID: 3.25 ± 0.45 m; Yibin FID: 9.90 ± 0.41 m; $P < 0.001$; Fig. 2a); FIDs differed significantly between face mask presence and absence (FID with face masks: 6.09 ± 0.43 m; FID without masks: 7.06 ± 0.42 m; $P < 0.001$; Fig. 2b); and FID was a function of flock size, with large groups having shorter FIDs ($P < 0.001$).

The results of data collected in Dazhou (FID with face masks: 2.57 ± 0.36 m; n = 102; FID without masks: 3.09 ± 0.37 m; n = 109; Fig. 3a) showed no significant difference in FID between flock sizes ($P = 0.397$), whereas FID with face mask presence was significantly lower than FID with face mask absence ($P = 0.018$). The results of data collected in Yibin (FID with face masks: 9.25 ± 0.44 m; n = 104; FID without masks: 10.66 ± 0.38 m; n = 93) showed that FID depended on flock size ($P < 0.001$), and FID with face mask presence was also significantly lower than with face mask absence ($P = 0.001$; Fig. 3b).

As flock size affected FID, we compared FIDs of individual birds. A significant difference in FID between face mask presence and absence was observed in sparrows in Yibin (FID with face masks: 8.45 ± 2.82 m; n = 85; FID without masks: 10.41 ± 2.61 m; n = 72; Mann Whitney U, $P < 0.001$), and a significant difference in FID between face mask presence and absence was found in Dazhou sparrows (FID with face masks: 2.60 ± 1.57 m; n = 94; FID without masks: 3.10 ± 1.60 m; n = 105; Student's t-test, $P = 0.015$).

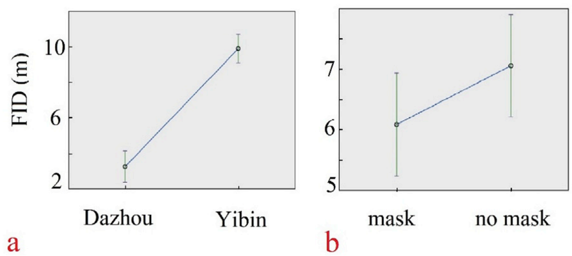

Fig. 2. Main fixed effects on flight initiation distances of sparrows (a refers to site, b refers to mask type, with error bars showing standard error).

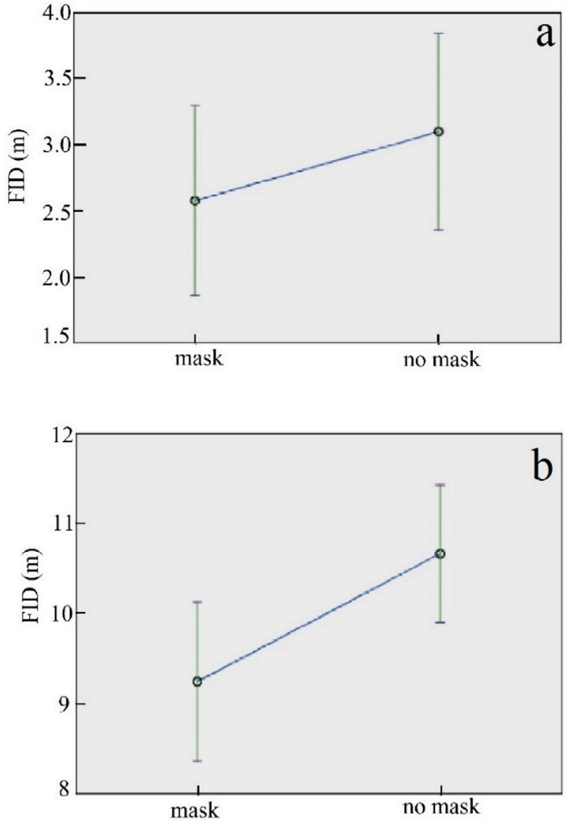

Fig. 3. Mask effects on flight initiation distances of sparrows in two study areas (a refers to Dazhou and b refers to Yibin, with error bars showing standard error).

4. Discussion

We investigated whether wearing face masks would influence the Eurasian tree sparrows' FID, and we found a significant effect of face mask presence on FIDs of sparrows. In addition, study site and flock size also affected FIDs.

FIDs of Dazhou sparrows were significantly shorter than those of Yibin sparrows. In previous studies, differences between urban and rural areas were found to result in different FIDs of birds. The differences may be due to local adaptation, level of urbanization and habitat selection (Samia et al., 2015; Vincze et al., 2016; Møller et al., 2015), and urbanized birds are more tolerant to humans than suburban or rural birds. Therefore, FIDs of birds in urban areas are generally shorter than those of birds in rural areas (Møller, 2010a; Samia et al., 2015; Vincze et al., 2016). In the present study, all data collection locations were in rural areas, thus no effect of habitat type was expected; however, in Yibin, data were mainly collected in agricultural areas whereas data from Dazhou originated mainly from township roads and surrounding residential areas. Compared with the Yibin data collection area, human population density of Dazhou was greater which led to shorter FIDs, thus there may also be differences in the degree to which birds are disturbed by humans in the two sites, which may lead to different levels of tolerance towards humans (Levey et al., 2009; McGiffin et al., 2013; Blumstein, 2016).

FID of sparrows in Yibin was also affected by flock size, with shorter FIDs in larger flocks, which is in line with the results of Samia et al. (2015) and Ye et al. (2017). The 'collective vigilance hypothesis' predicts that shared information in a group of animals increases the ability of individuals to assess risks (Roberts, 1996; Beauchamp, 2015), and the 'dilution effect hypothesis' predicts that the probability of a single individual being preyed upon decreases with increasing flock size (Roberts, 1996; Sridhar et al., 2009). Taken together, the risk of an individual being preyed upon decreases with increasing flock size, thus sparrows in larger flocks should show shorter FIDs. However, some studies showed that the FID will increase with an increase in flock size. A larger number of individuals increases the probability of detecting threats, leading to a positive correlation between FID and flock size (Elgar, 1984; Stankowich and Blumstein, 2005; Laursen et al., 2005; Mayer et al., 2019). However, individuals showing larger FIDs in a flock may cause conspecifics to do the same after flight, causing individuals which by themselves would show shorter FIDs to copy their behaviour and react sooner to threats (Stankowich and Blumstein, 2005; Hingee and Magrath, 2009; Weston et al., 2012; Morelli et al., 2019), which may also lead to a larger flock FID.

Regardless of flock size, sparrows in Dazhou and Yibin showed significant differences in FID when responding to people with or without face masks. During the COVID-19 pandemic, many countries adopted lockdown policies to prevent viral transmission, and factors such as reduced human encounters, reduced traffic, and reduced noise levels led to an increase in activities of some wildlife during the lockdown (Rutz et al., 2020). After the disease outbreak was considered to be under control in China, a large proportion of the population continued wearing masks for safety reasons. Therefore, we assumed that for a certain period, sparrows may have experienced fewer encounters with humans, whereas after the lockdown period, human activity increased again, and most people encountered by sparrows were wearing face masks. Although there was only about 6 months for birds to adapt to people with face masks, the continuous exposure to people wearing face masks may have produced rapid adaptive behavioural changes. Such behavioral responses to humans were also observed in other studies. For example, Feng and Liang (2020) showed that waterfowl are exposed to fishermen who fish on the coast and pose little threat, thus their FID is shorter when exposed to people wearing fishermen's clothes than when encountering tourists, which indicates that wild birds respond to continuous contact with humans. Other studies showed that birds can also learn to distinguish humans from other threats within a relatively short period of time. For example, Shen et al. (2020) produced harmless disturbances in the nests of Oriental reed warblers (*Acrocephalus orientalis*) which led to a reduced alert behaviour towards humans. Birds have high perception and rapid learning abilities (Marzluff et al., 2010), while weaker stimuli may lead to faster adaptation (Blumstein, 2016). However, compared to a long history for birds adapting to people without face masks, six months for birds adapting to people with face masks should be short. Whether such relatively short time can also allow other bird species to cause adaptive behavioural changes needs to be confirmed.

Taken together, our results indicate that cognitive learning in sparrows helps them adapt their behaviour to human-induced changes in their environment. Due to this behavioural plasticity, we speculate that flight responses may change back to the pre-pandemic status once the birds are re-adapted to people without face masks, which, however, would require further investigation.

Authors' contributions

W.L. designed the study; X.J. and C.Z. carried out field experiments; J.L. performed statistical analyses; X.J. and J.L. wrote the draft manuscript; W.L. revised and improved the manuscript. All authors approved the final submission.

Ethical approval

The experiments reported here comply with the current laws of China. Fieldwork was carried out without specific permit.

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Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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