Responses of wintering corvids to New Year's Eve fireworks in Berlin

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Abstract

Animals around the globe are strongly affected by anthropogenic disturbances, creating concerns for welfare and conservation. Fireworks during New Year's eve are a major, regularly recurring anthropogenic disturbance, causing light, noise as well as air pollution. In the present study, we investigated behavioural responses of mixed-species flocks of corvids (hooded crows, *Corvus cornix*, rooks, *Corvus frugilegus* and jackdaws, *Corvus monedula*) in Berlin. We observed direct responses of corvids to fireworks already during the day on 31st of December. Behavioural responses included gathering in large numbers in trees early during the day, not using the usual roosting trees, frequent changes in flight direction as direct response to fireworks, and erratic flight patterns during the main fireworks at midnight. Our anecdotal report shows a significant and prolonged behavioural response of corvids to fireworks, likely to be reflective of a major effect on individual welfare. This adds to a growing body of evidence of impacts of fireworks on wild animals.

Key words: animal welfare, anthropogenic disturbance, corvids, fireworks, urban wildlife.

Introduction

Anthropogenic disturbances, such as noise or light pollution, are a concern for the welfare and conservation of wildlife (Halfwerk & Jerem, 2021). Disturbances due to artificial noise and light can result in changes in the behaviour and physiology of individuals (Wright et al., 2007), which ultimately can affect individual fitness (Read, Jones, & Radford, 2014) and community dynamics (Kok et al., 2023).

A major regularly re-occurring world-wide anthropogenic disturbance are New Year's Eve firework celebrations, causing significant chemical, noise, and light pollution (Saporito et al., 2024) and growing evidence suggests significant negative effects on humans, domestic animals, wildlife and the environment (Bateman, Gilson, & Bradshaw, 2023). In domestic animals, a growing body of literature contributes to our understanding of individual responses to fireworks and potential ways to mitigate impact (dogs, *Canis familiaris*: Levine & Mills, 2008; Dale et al., 2010; Gates et al., 2019; Gähwiler et al., 2020; Riemer, 2020; Handegård et al., 2023; horses, *Equus caballus*: Gronqvist, Rogers, & Gee, 2016). Outside of domestic animals, the number of studies investigating the effects of fireworks on animals are limited. A study on several species of captive zoo animals showed no changes in behaviour in response to fireworks in most species (Rodewald, Gansloßer, & Kölpin, 2014). In the wild, during New Year's eve, geese have been shown to fly 5–16 km further and 40–150 m higher, and more often shifted to new roost sites than on previous nights (Kölzsch et al., 2023). A pronounced increase in heart rate and body temperature was shown in geese in the first hours of the new year, indicative of a significant increase in energy expenditure (Wascher, Arnold, & Kotrschal, 2022). Hole nesting songbirds (great tits, *Parus major*; blue tits, *Cyanistes caeruleus* and wrens, *Troglodytes troglodytes*) increase

activity during the night, losing 7% night sleep (Bosch & Lurz, 2019). Weather radar data indicates that birds actually flee en masse, with approximately 1000 times as many birds in flight on New Year's Eve compared to other nights (Shamoun-Baranes et al., 2011; Hoekstra et al., 2024). Communities of large-bodied species, such as geese and ducks, displayed a stronger response than communities of small-bodied species, like finches or tits (Hoekstra et al. 2024) and flight activities lasted at least 45 minutes and peak densities measured at 500 meters altitude (Shamoun-Baranes et al. 2011). Stickroth (2015) provides an overview of reports on responses from 272 species to 133 fireworks, showing wide ranging impacts of fireworks on wildlife, for example physiological responses or signs of fear and anxiety.

In the present study, we recorded behavioural responses of mixed-species corvid flocks during New Year's Eve celebrations in the city of Berlin. In Berlin, fireworks are a prominent part of New Year's Eve celebrations but can generally only be used on New Year's Eve (December 31st) and New Year's Day (January 1st; https://gesetze.berlin.de/bsbe/document/jlr-ImSchGBE2023pP5). A large public fireworks display is conducted at the Brandenburg Gate, but the majority of celebrations involve individuals and families setting off their own fireworks in streets and neighbourhoods (https://www.theguardian.com/world/2018/dec/27/we-dont-want-to-spoil-the-fun-new-year-firework-displays-divide-germans). Stable populations of wintering rooks (*Corvus frugilegus*), Western jackdaws (*Coloeus monedula*), Eurasian magpies (*Pica pica*), hooded crows (*Corvus cornix*) and Eurasian jays (*Garrulus glandarius*) can be observed in the city (Witt, 1994). Corvids are highly adapted to urban living, for example many corvid species are generalist foragers who can exploit anthropogenic food sources in urban areas and their high degree of behavioural plasticity allows them to adapt to changing environments

(Benmazouz et al., 2021). While living in urban spaces allows corvids to exploit anthropogenic resources (Greggor et al., 2016), they are also subjected to disturbances, such as anthropogenic noise (Broad et al., 2024). Corvids in urban areas are used to roosting communally and maintain their circadian rhythm, independent of anthropogenic noise, i.e. traffic noise (Everding & Jones, 2006).

In order to investigate responses of corvids to fireworks, we opportunistically video-recorded the behaviour of corvids in Berlin and described direct responses to fireworks. Videos were collected between December 2023 and January 2024 in areas with high occurrence of corvids. We describe changes of behaviour in corvids in direct response to fireworks from midday on the 31st of December 2023, to early hours of 1st of January 2024.

Methods

The present study was conducted in Berlin. Data was collected on four locations (Marx-Engels-Forum [52.518524 latitude,13.404623 longitude], Neptunbrunnen / Weihnachtsmarkt [52.519595 latitude,13.406846 longitude], ESMT [52.515244 latitude,13.401887 longitude], Leise-Park / Georgen-Parochial Gemeinde Friedhof I / Sankt Nicolai und Sankt Marien Friedhof II [52.529811 latitude,13.421241 longitude]), which are regularly populated with flocks of wild wintering corvids. Eurasian jays, *Garrulus glandarius, and* common ravens, *Corvus corax,* have also been observed in Berlin, however not specifically in this study.

Marx-Engels-Forum and Neptunbrunnen / Weihnachtsmarkt are located next to each other, across a busy road, on the southwest side of Alexanderplatz. This area is

characterised by high levels of human activity, including lots of vehicle and foot traffic, dog walking, eating and drinking. The Weihnachtsmarkt draws a crowd of humans most nights in December, and on New Years Eve the area becomes an intense firework zone. Mixed flocks of wintering corvids also make extensive use of the area. While the exact clusters of trees and buildings they use for roosting change from year to year (and even sometimes week to week), WHP has observed them nearby since at least 2019. In December of 2023 WHP observed these areas on 13 different evenings, generally between 4-10pm, and on all but three of those evenings' corvids were present. Visits in January of 2024 were less regular, but WHP observed corvids present on at least two evenings.

ESMT is a quiet business school with a mostly flat semi-sheltered roof on a street with large mature trees and which encompasses a private fenced off green area with additional trees. This roost site is south-west of Alexanderplatz and characterized by relatively lower human activity, although there is vehicle and foot traffic. WHP visited this site five times in December, and corvids were present each time.

Leise-Park, Georgen-Parochial Gemeinde Friedhof I, and Sankt Nicolai und Sankt Marien Friedhof II together form a large green space north-east of Alexanderplatz. Here WHP has rooftop-level access and can see corvids dispersing and converging each day. These sites are divided up into territories by families of hooded crows, who sometimes roost there, but they are not normally used for roosting by large mixed-corvid flocks. In past years WHP had observed birds flying around in apparent distress during NYE fireworks, and documenting this was a primary goal of the present study.

Opportunistic behavioural observations of corvids in different contexts, such as on the ground, in trees or flying were conducted between 5th December 2023 and 31st January 2024, by WHP. The main focus of the data collection started around midday on the 31st of December. Video recordings were made with the aim to comprehensively document behaviours and capture as much of the behavioural repertoire as possible. All recordings were made with a pair of mirrorless cameras capable of recording 4k at 24fps (a Sony a7IV + a6400). Depending on the type of observations, e.g. whether corvids were filmed on the ground, in trees, or flying, a range of wide and/or telephoto lenses were employed including a Sigma 18-50 f/2.8 DC DN (wide angle, low light capable), a Sony FE 70-200 f/2.8 GMII (telephoto, low light capable), a Sony FE 200-600 f/5.6-6.3 G (super telephoto used for daylight shots), and an adapted AI Nikkor 400mm f/3.5 IF-ED (super telephoto, low light capable). Some observations were made from as close as two meters from the birds, however, the majority were conducted from a considerable distance, i.e. several hundreds of meters when filming corvids in flight. Corvids in Berlin are generally well-habituated to human presence and care was taken not to disturb the birds, e.g. no quick movements, however it cannot be excluded that presence of the observer had an effect on the behaviour of crows.

Results

Behavioural changes during the day

Already during the day on 31st of December, clear behavioural changes can be observed compared to days without firework activity. This includes corvids gathering in numbers earlier than usual, around midday, between 1-2pm (Figure 1 a and b), which is before the time they normally can be observed to gather pre-roost, around 3pm. During pre-roosting, corvids often take flight in response to loud firework noises (supplementary video 1). On their way to the roosting site, groups of flying crows can be observed to often change direction of flight (supplementary video 2).

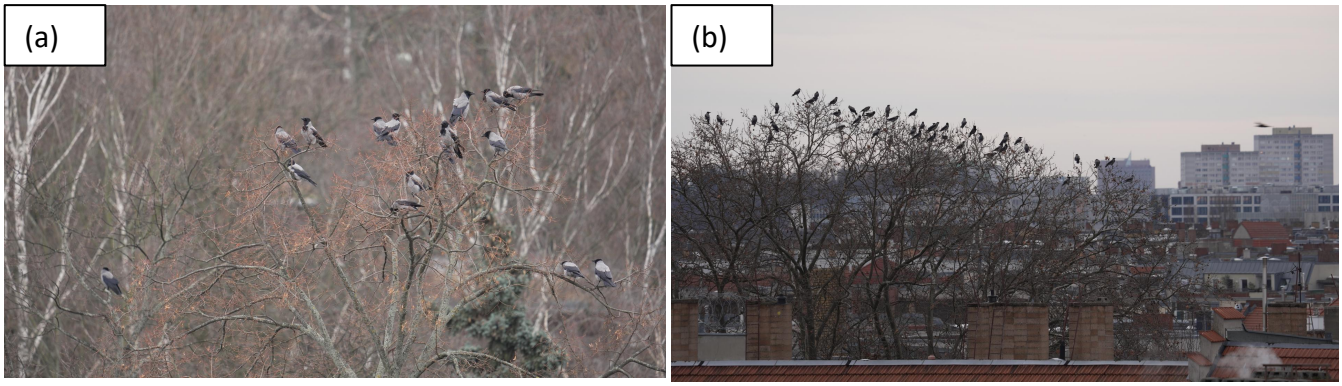
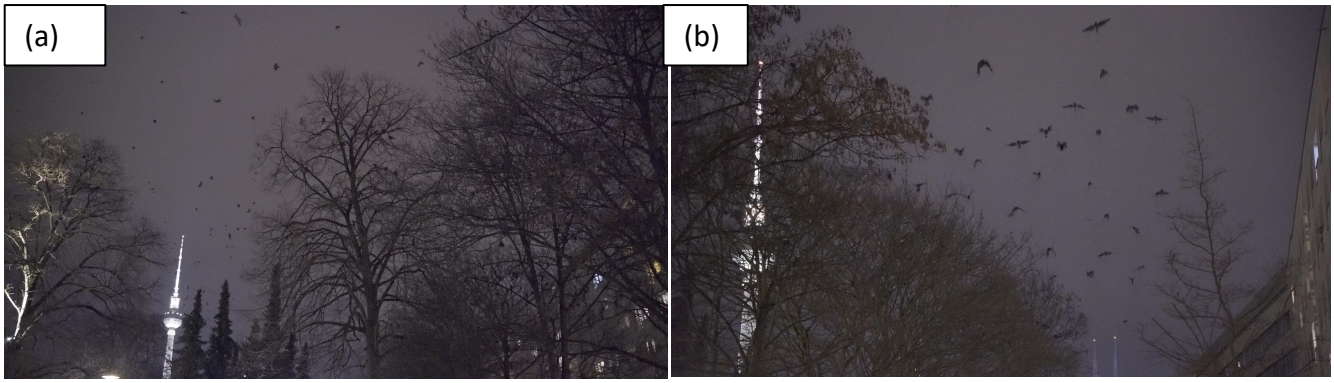


Figure 1 a and b: Corvids gathering on trees in and near Leise-Park in large numbers between 1-3pm on the 31st of December.

Evening

After sunset, corvids are observed flying around (Figure 2 a-b) and not using usual roosting trees (Figure 3 a-d; supplementary video 3). Corvids in trees were frequently disturbed by nearby fireworks (supplementary video 4).



161 Figure 2 a-b: Corvids flying between 5-6:30pm on the 31st of December.
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163


164 Figure 3: (a) from 15th of December between 5:30-8pm and (b) from the 5th of December
165 between 6-9pm show trees at Marx-Engels-Forum used by corvids for roosting. Trees in the
166 same square are empty on the evening of 31st December between 7-8pm, in (c) and (d).In
167 (e) crows are using the trees again on January 10th between 3-4pm.
168

169

170 *Midnight (00-130)*

171 During the intense fireworks shortly after midnight, crows can be observed in the air, flying
172 around and regularly changing direction, which can be interpreted as a sign of distress
173 (Figure 4 a-d; supplementary video 5).

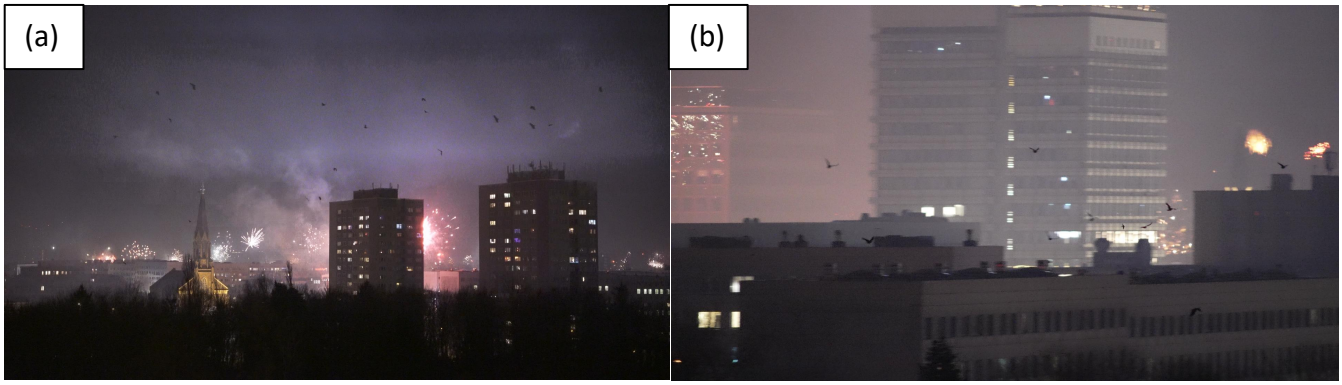

Figure 4 a-b: Crows flying above Leise-Park / Georgen-Parochial Gemeinde Friedhof I / Sankt Nicolai und Sankt Marien Friedhof II, not typical communal roosting locations, during intense firework activities between midnight and 1:30am.

193 **Discussion**

194 In the present study we describe corvid behaviour in response to New Year's Eve
195 firework celebrations. Already during the day on the 31st of December we recorded
196 behavioural responses to fireworks, such as sudden take offs from resting places. Around
197 midnight, when high levels of firework activity happen, a high number of birds can be
198 observed to take flight, which has been previously described in wild birds using weather
199 radar (Shamoun-Baranes et al., 2011; Hoekstra et al., 2024).
200
201 Corvids are generally diurnal animals (Ward & Raim, 2011; Tahajjul Taufique, Jha, &
202 Kumar, 2016), with the sensory system such as vision, not adapted for low levels of light
203 (Browne et al., 2007). Flying in the dark can cause disorientation (Atchoi et al., 2024),
204 increases the risk of collisions and thereby injury and death (Winger et al., 2019).
205 Additionally, the noise caused by fireworks likely interferes with corvids' acoustic signalling,
206 potentially impairing species-specific vocal communication, which is important to
207 coordinate action. Corvids belong to the order of songbirds and vocal communication plays
208 an important role in their social behaviour (Wascher and Reynolds 2025). Anthropogenic
209 noise has been shown to disturb calling and collective movements in Eurasian jackdaws,
210 *Coloeus monedula* (Broad et al. 2024). Flight patterns during firework activity also
211 resembled what is described as 'erratic flight' in the literature, characterised by rapid
212 acceleration, frequent twisting and turning, and occasional sudden vertical downward
213 plunges (Moynihan, 1956). Erratic flight usually can be observed during predation events
214 (Humphries & Driver, 1967) or significant anthropogenic disturbance, such as gas flaring
215 (Day et al., 2015). Increased flight activity in response to fireworks does not only cause
216 increased risks of injury but also increased energy expenditure (Wascher et al. 2022) and

disruption of night rest period (Raap et al. 2017, Aulsebrook et al. 2020, Grunst et al. 2021), which can have significant effect on reproduction and survival (Halsey et al. 2019, Pontzer and McGrosky 2022).

We not only describe behavioural changes during the night and peak firework activity, but pronounced behavioural changes already during the day, with frequent, albeit more isolated, firework activity. For example, birds have been observed gathering in large numbers at unusual times and regularly have been startled by loud noises. Generally, birds are known to gather in large numbers in order to maximise alertness to danger and minimizing risk to individual birds (Eiserer, 1984).

It is to be expected that results from the present study and responses of individuals to fireworks are quite generalizable to different bird species, which has been confirmed in previous studies (Shamoun-Baranes et al., 2011; Hoekstra et al., 2024) and mammals (Rodewald et al. 2014, Gronqvist et al. 2016, Pedreros et al. 2016, Gähwiler et al. 2020). Research in other taxa, such fish, reptiles, amphibians and invertebrates to our knowledge does not exist. Generally, it is difficult to study responses of animals to fireworks, as most firework activity takes place during the night and wild animals might hide and generally keep their distance from humans as they can potentially present danger (Ditchkoff, Saalfeld, & Gibson, 2006). New technology, such as weather radar (Hoekstra et al., 2024), transmitter technology (Wascher, Arnold, & Kotrschal, 2022; Kölzsch et al., 2023) and infrared thermography (Mazzamuto et al. 2023) can help to overcome this barrier. Further, from our present study we cannot tell whether corvids were disturbed most by light pollution, noise or chemical pollution or a combination of different stimuli. Corvids in many areas of the

241 world are hunted (Baxter and Robinson 2007) and given the similarity of fireworks with
242 shooting, it is expected for this to have an effect, however further experiments investigating
243 in more detail what causes the disturbance would be desirable.
244
245 Overall, our results clearly indicate corvids in Berlin to be highly disturbed by
246 fireworks and we suggest behavioural changes to be reflective of a state of fear (Stankowich
247 & Blumstein, 2005). The freedom of fear is a key concept in achieving good animal welfare
248 (Mellor, 2016) and as such, responses of corvids to fireworks should be considered a wild
249 animal welfare concern.

Declarations

Ethical Approval

This study was approved by the School of Life Sciences ethics panel at Anglia Ruskin University (ETH2324-7324).

Competing interests

The authors declare that they have no competing interests.

Funding

The work has not been externally funded.

Author Contributions

Conceptualization of study, writing of original draft, reviewing and editing: CAFW and WHP data collection and curation: WHP. All authors read and approved the final manuscript.

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