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RESEARCH ARTICLE

An experimental test of the impact of avian diversity on attentional benefits and enjoyment of people experiencing urban green-space

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Abstract

1. Biodiversity may play a key role in generating the well-being benefits of visiting green-spaces.
2. The ability of people to accurately perceive variation in biodiversity is, however, unclear and evidence supporting links between biodiversity exposure and well-being outcomes remains equivocal. In part, this is due to the paucity of controlled experimental studies that deal adequately with confounding factors that covary with biodiversity.
3. Attention restoration theory (ART) proposes that natural environments contain many softly fascinating stimuli that provide visitors with a sense of separation from their normal settings and routines, switching off direct attention and allowing recovery from attention fatigue. Increased biodiversity could increase these stimuli, and ART therefore potentially provides a mediating effect linking biodiversity to well-being.
4. Here, we conduct a controlled experiment in which participants virtually experience urban green-space containing high and low levels of avian biodiversity (altered by manipulating bird song).
5. Respondents accurately identified the contrast in biodiversity and reported greater enjoyment of the high biodiversity treatment than the low diversity control. Higher biodiversity did not, however, elicit greater self-reported stimulation or restoration, and did not increase perceived restorativeness scores or attentional capacity (quantified using the Digit Span Backwards attention test).
6. Respondents that were more connected to nature, however, had greater attentional capacity following exposure to green-space.
7. Our study provides rare experimental evidence that people can accurately detect variation in biodiversity, that high avian diversity boosts visitor perceptions of urban green-space quality, and that people with increased nature connectedness show enhanced attentional capacity following an exposure to green-space.

KEYWORDS
birds, nature, parks, soundscapes, species richness, urbanisation

1 | INTRODUCTION

Urban residents have reduced access to green-spaces, such as parks and woodland, compared to people living in rural settings (Kareiva, 2008). The ongoing global trend towards urbanisation of the human population (UN Department of Economic and Social Affairs, 2019) and recent declines in urban green-space (Richards & Belcher, 2020) are amplifying this disparity. This is a major public health concern in light of the growing consensus that visiting green-spaces has multiple positive effects on mental health and well-being (Bratman et al., 2019; Hartig & Kahn, 2016; Shanahan et al., 2015). Mental health disorders represent a growing proportion of the global disease burden (Steel et al., 2014; WHO, 2008) with, for example, one in four UK adults suffering mental health problems in a given year (Mental Health Foundation, 2015). Accordingly, policy initiatives are beginning to recognise the importance of urban green areas, for example Sustainable Development Goal 11.7 calls for adequate green-space provision in towns and cities (UN, 2015), while the UK government permitted exercise in local green-spaces throughout the Covid-19 crisis (Ministry of Housing, Communities, and Local Government, 2020).

Despite growing acceptance of the positive effect of green-space access on mental health outcomes, there remains uncertainty about the causal pathways that drive this relationship (Markevych et al., 2017). Increased understanding of the underlying drivers is important if interventions, including changing the management of green-space, are to optimise mental health outcomes (Hartig et al., 2014; Marselle et al., 2020). Proposed frameworks describing the links between health and green-space (Markevych et al., 2017), nature (Hartig et al., 2014) and biodiversity (Marselle et al., 2021), have explored multiple possible mechanisms, including that: access to local green-spaces promotes exercise (Maas et al., 2008) and facilitates social interaction and community cohesion (Jennings & Bamkole, 2019), natural settings create a strong sense of place and identity for residents (Hernandez et al., 2007; Poe et al., 2016) and that green-spaces provide passive stimulation which restores the capacity for attention (Hartig et al., 2003). The last of these, known as attention restoration theory (ART), suggests that exposure to green-spaces can be psychologically beneficial by alleviating attention fatigue (Kaplan & Kaplan, 1989; Kaplan, 1995). Attention fatigue is the overexertion and depletion of an individual's cognitive ability to focus on a single task or stimulus, that is, 'directed attention', with negative consequences for mood (Kaplan & Kaplan, 2003). Natural environments, according to ART, provide visitors with a sense of separation from their normal settings and routines and a setting with many softly fascinating stimuli (i.e. features that are engaging without demanding directed attention), which together promote recovery from attention fatigue (Basu et al., 2019; Hartig et al., 1997; Kaplan & Berman, 2010). Multiple studies measuring actual restoration, using psychological tests of attention (Rogerson et al., 2016; Taylor & Kuo, 2009), and perceived restorativeness, using self-reported perceptions of the attention restoration value of a setting or experience (Hartig et al., 1997; Wang et al., 2016), conclude that green-spaces are more restorative of attentional capacity than built-up or indoor settings. There is thus strong support for the central claim of ART that visitors to green settings show greater attention restoration effects than visitors to other environments.

Evidence supporting other causal pathways suggests that a combination of the proposed mechanisms drive the positive relationship between access to green-space and mental health (Hartig et al., 2014). Understanding the relative importance of these mechanisms is complicated by the heterogeneity of urban green-spaces and, in particular, how different features and qualities of green-spaces moderate mental health benefits (Akpinar, 2016; Wyles et al., 2019). With regard to ART, it is unclear which types of stimuli produce the soft fascination required for attention restoration (Joye & Dewitte, 2018). Biodiversity is one potential stimulus as high species richness could provide a more varied sensory environment with greater potential for soft fascination (Marselle et al., 2021). In a study that surveyed visitors to 12 parks in Bradford, UK, Wood et al. (2018) concluded that greater species richness of plants, birds, bees and butterflies recorded at the site significantly predicted higher perceived restorativeness. Other studies have found positive associations between various aspects of biodiversity—including habitat type and plant diversity (Carrus et al., 2015), vegetation structure (Hoyle et al., 2017), avian species diversity (Ferraro et al., 2020) and perceived biodiversity of coastal settings (White et al., 2017)—and perceived restorativeness. There is, however, a paucity of studies, especially experimental ones, that assess associations between variation in the magnitude of biodiversity and empirical measures of attentional capacity (Chiang et al., 2017; Marselle et al., 2019).

Here we provide one such study, using an experimental approach to assess how the level of biodiversity experienced during an exposure to a green-space affects attention outcomes. Crucially, the experiment used a paired design in which each respondent is exposed to two different magnitudes of biodiversity, while all other environmental features are kept constant. We used virtual exposures to green-space as these facilitate experimental manipulation of biodiversity exposure, and numerous other studies have demonstrated that virtual green-space exposure can generate benefits, including attention restoration (Chow & Lau, 2015; Craig et al., 2015; Lee et al., 2015).

This study focuses on one element of biodiversity in green-spaces—audible avian species diversity. Previous studies have elucidated a link between birdsong and perceived attention restoration—for example, birdsong was the natural sound most commonly associated with attention restoration by a group of interviewees (Ratcliffe et al., 2013), although this potential varies between bird species, in part because respondents perceive species to vary in their association with natural settings, and some species are more familiar to respondents than others (Ratcliffe et al., 2016). Each respondent in our study experienced video footage mimicking a short walk through one of three urban parks, with an audio track of birdsong from a low and high diversity avian community, while keeping the number of singing individual birds constant.

By playing song from individual birds at intervals throughout the duration of the video, we sought to simulate the experience of passing one singing bird after another while navigating through a green-space. This design has consequences for the acoustic diversity of the audible component of the exposures. Specifically, we expect the virtual green-space with higher avian species richness to have improved evenness of sounds across frequency bands (Bradfer-Lawrence et al., 2019).

Our overall objective is to test the hypothesis that exposure to the high diversity treatment delivers greater benefits to attention, measured through the perceived restorativeness and actual changes in attentional capacity, than exposure to the low diversity treatment. We also assess if exposure to higher diversity elicits greater self-reported enjoyment of the simulated green-space visit and test the ability of respondents to perceive the increased diversity. By measuring the ability of participants to perceive differences in avian diversity, we are able to examine whether or not any perceived or actual attentional benefits of increased biodiversity might arise without conscious awareness of the ecological quality of the setting.

2 | METHODS

Data were collected between May and July 2020. The study was approved by the University of Sheffield's ethical review board and all participants indicated their informed consent by checking a box after reading a brief description of the experiment (Appendix A), including information on data protection policy and compensation through a prize draw (for one of three Amazon vouchers worth £50, £100 and £150).

2.1 | Participants

All respondents were required to confirm that they were over 18 years old and a UK resident. We used a chain sampling approach to participant recruitment (Tenzek, 2017). The initial respondents were recruited from informal acquaintances (all adult UK residents that were unaware of the study's design and objectives) of the research team that, following Morgan (2008), were selected across a range of employment situations, socio-demographic groups, ethnicities and ages, with an approximately even gender balance in order to minimise accrual of bias in the type of respondents. Each of the initial contacts were encouraged to ask their own acquaintances to participate in the study to generate a chain sampling approach. To participate, these secondary participants were required to contact the research team to indicate their interest—only then were they provided access to the survey and associated materials. We believe this recruitment process was successful as the respondents had a wide range of socio-economic and demographic characteristics that were broadly representative of the UK population (Table S1) and exhibited a wide range of nature relatedness scores (measured using the NR-6 scale (Nisbet & Zelenski, 2013); Table S2), thus validating our use of a chain sampling approach. This approach was required due to the difficulty of conducting alternative recruitment techniques (such as on-site recruitment of visitors to urban green-spaces) which would have necessitated face-to-face social interactions which were legally restricted at the time due to Covid restrictions. Following the initial contact, a first reminder email was sent to each individual that failed to complete the study within a month, and a second reminder was sent 1 week later. The overall response rate from those who expressed an interest in participating was 75.9% (88 of 116); one of these was from outside the United Kingdom giving a final sample size of 87 questionnaires. Of these 87 respondents 49.4% were drawn from the initial pool of contacts with the remainder being recruited through the chain sampling approach.

2.2 | Exposure to urban green-space and biodiversity manipulation

Each participant watched two 3-minute videos of a walk along footpaths in one of three urban parks in Sheffield, UK (Figure 1). The duration of this exposure to green-space is similar to that used by previous studies that found attention restoration effects of virtual exposures to green-spaces (6 min, Chow and Lau (2015); 4 min, Craig et al. (2015); 40 s, Lee et al. (2015)). Sites were selected so that, in combination, they captured the range of typical urban parks in the United Kingdom. All sites had a mixed vegetation profile, with open lawns, shrub and areas with trees. One site (Figure 1a) is close to the city centre and primarily surrounded by service facilities including educational establishments, a hospital, museum and coffee shops. It is well-maintained and contains formal flowerbeds. The other two sites are in suburban areas. One is bordered by woodland and a main road, is well-maintained and contains formal flowerbeds (Figure 1b); the other is adjacent to a golf course and industrial areas, lacks formal planting and is managed less intensely (Figure 1c). All footage was recorded on the same day in late March 2020, ensuring that weather and seasonal conditions were consistent across the videos.

2.2.1 | Manipulation of experienced biodiversity using birdsong

Each participant watched two versions of the same video from a single site, with differences in the audio used to manipulate the avian

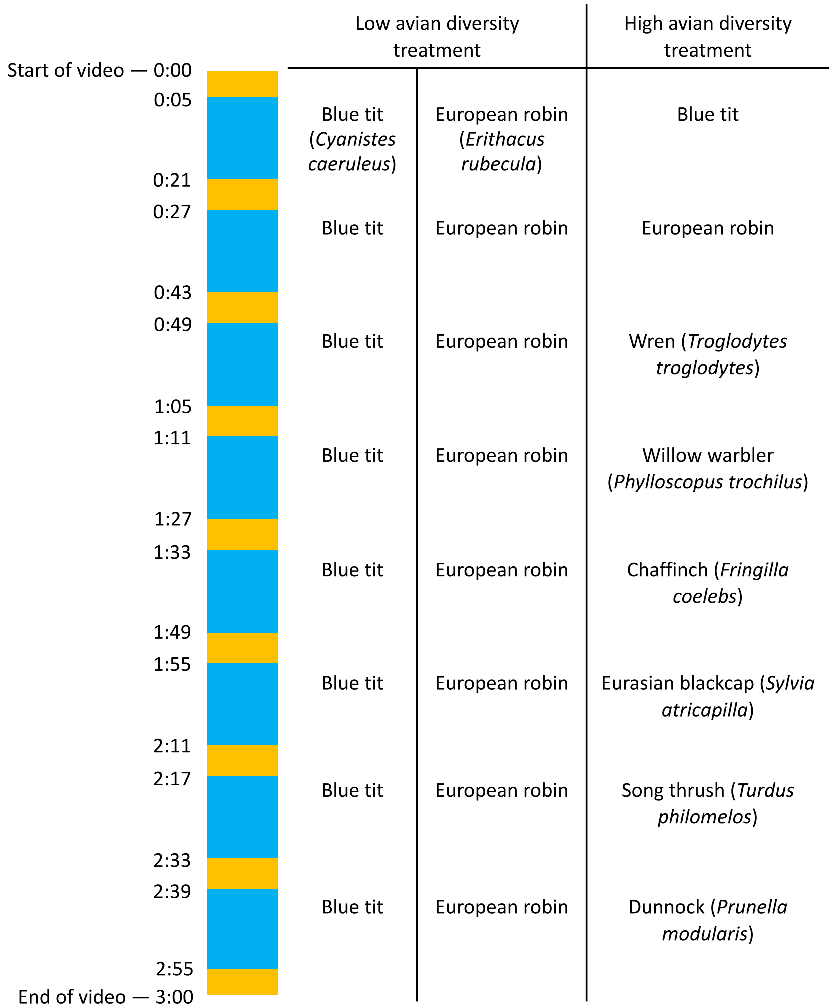
FIGURE 1 Images of (a) the city centre formally managed green-space, (b) the sub-urban formally managed green-space and (c) the sub-urban informally managed urban green-space. Aerial images (Google Earth Pro, Version 7.3.4.8248) show the surrounding landscape (left-hand image) and the area surrounding the route used to record the video, in yellow (central image). The lengths of these routes are (a) 160 m, (b) 155 m and (c) 165 m. The right-hand images show a still from the start of each video

diversity experienced by the viewer. We focused on manipulating avian diversity due to the practical viability of this approach, and because prior studies have established that people recognise the restorative potential of birdsong (Ratcliffe et al., 2013, 2016). During the recording and editing process care was taken to minimise the presence of birds in each recorded walk—video from the city centre site recorded three species, video from the formally managed sub-urban site contained one species and the video from the other site did not contain any species. None of these species were those used in the audio tracks and they all only occupied a small part of the view and for a short duration.

Each respondent experienced, in a randomised order, a high diversity treatment and low diversity treatment video. The high diversity video contained birdsong from eight species: blue tit *Cyanistes caeruleus*, European robin *Erithacus rubecula*, wren *Troglodytes troglodytes*, willow warbler *Phylloscopus trochilus*, chaffinch *Fringilla coelebs*, Eurasian blackcap *Sylvia atricapilla*, song thrush *Turdus philomelos* and dunnock *Prunella modularis*. All of these species are native to the United Kingdom and occur in urban parks, although they vary from abundant to rare in these settings. The high diversity treatment thus represents a situation that could realistically be encountered in an urban park with high habitat quality. A 16-s clip of song from each species was played with a 6-s gap between each species (Figure 2). Song volume was faded upwards and then downwards to mimic a respondent approaching and then passing a singing bird as they walked along the route.

One of two low diversity videos was randomly allocated to each participant; these either consisted of robin (n = 43) or blue tit

FIGURE 2 Structure of audio playback throughout each 3-min virtual green-space exposure. Birdsong plays on eight occasions for 16-s intervals (blue), divided by 6-s intervals of silence (orange) and 5-s intervals at the start and end of the exposure



($n = 44$) song. These are both abundant species in urban settings but differ in the complexity and variability of their songs—simple and limited variation in blue tit, more complex and varied in robin. Use of two low diversity treatments thus increases the ability to infer that any detected treatment effects were due to variation in species richness and were not just due to limited benefits of exposure to the song characteristics of the species selected for the low diversity treatment. In each low diversity video a 16-s clip of song was played eight times with a 6-s gap between recordings, with the volume changing to mimic a respondent approaching and then moving away from a singing bird. The low diversity and high diversity videos were therefore identical in the apparent number of individual birds and only differed in avian diversity.

The video exposures did not include any other audio, to avoid any impacts of bird song that was naturally present while recording the videos, and to allow participants to clearly hear the birdsong itself. This increases the sensitivity of the experimental setup to any effect of avian diversity. Participants were instructed to set the volume on their computer to 50% and to adjust to a comfortable volume once the first video began, to ensure that participants with varying hearing sensitivity could hear the birdsong tracks.

2.2.2 | Acoustic diversity of virtual green-space exposures

Structuring the soundscapes in the virtual green-space exposures with eight individual birds singing in sequence simulates the experience of walking through a park and encountering one bird after another. This has consequences for the acoustic diversity of the two low avian species richness and the high species richness soundscapes relative to a soundscape of birds singing in chorus. Specifically, we expected all three soundscapes to have similar patterns in amplitude—given that they follow the same structure of birdsong separated by periods of silence—but expected the high avian diversity treatment to have a greater evenness of sounds across frequency bands. Recordings of natural soundscapes demonstrates that higher avian species richness correlates positively with acoustic evenness across frequency bands in the United Kingdom (Eldridge et al., 2018).

We calculated two acoustic indices to check that these expectations were correct. Using the Seewave package (Sueur et al., 2008) in R (version 3.6.1) we calculated the temporal entropy—a measure of the modularity of amplitudes across a sound sample—of the low avian diversity treatments (blue tit = 0.881, robin = 0.894) and the high avian diversity treatment (0.899). The similarity of outputs for all three treatments reflects our expectation for equivalent patterns in amplitude. We also used the SOUNDECOLOGY package (Villanueva-Rivera & Pijanowski, 2018) in R (version 3.6.1) to calculate the Acoustic Evenness (AEve), a measure of the evenness of sounds across different frequency bands (Villanueva-Rivera et al., 2011). The high avian diversity treatment produced a lower AEve score (Left channel: 0.570, Right channel: 0.577; note that this index is constructed so that lower scores indicate greater acoustic diversity) than either of the low avian diversity treatments (blue tit—Left channel: 0.624, Right channel: 0.624; robin—Left channel: 0.606, Right channel: 0.606). Consequently, sounds in the high avian diversity treatment were spread more evenly across frequency bands thus generating greater acoustic diversity.

2.3 | Outcome variables

After exposure to both of the treatment videos, participants answered five questions asking them to compare their experience of the two videos, with answers given on a 7-point Likert scale. Two questions assessed if respondents accurately detected differences in biodiversity as there is conflicting evidence regarding people's ability to do this (Dallimer et al., 2012; Fuller et al., 2007; Southon et al., 2018). These two questions were: 'Do you think that you heard more or fewer individual birds in the second video compared to the first video?' and 'Do you think that you heard more or fewer species of bird in the second video compared to the first video?' (Potential responses: 1 'Much fewer', 2 'Moderately fewer', 3 'Slightly fewer', 4 'The same', 5 'Slightly more', 6 'Moderately more' and 7 'Much more'). Other studies (e.g. Dallimer et al., 2012; Fuller et al., 2007) have asked participants to quantify how many bird species were present in urban parks using categorical scales, but we do not follow this approach here as using a comparative question is more accessible for participants with low levels of wildlife knowledge, and takes advantage of the paired experimental design (i.e. each respondent experiences the low and high diversity treatments).

The other three questions captured self-reported relative benefits (enjoyment, restoration and stimulation): 'Which recorded walk did you enjoy more?' (1—'I much preferred the walk in video 1', 2—'I moderately preferred the walk in video 1', 3—'I slightly preferred the walk in video 1', 4—'I enjoyed both walks equally', 5—'I slightly preferred the walk in Video 2', 6—'I moderately preferred the walk in Video 2' and 7—'I much preferred the walk in video 2'), 'Which recorded walk did you find more restorative?' (1—'The walk in video 1 was much more restorative?' etc.), and 'Which walk did you find more stimulating?' (1—'I found the walk in video 1 much more stimulating' etc.). The question on restoration was designed to identify any perceived benefit of increased biodiversity to restoration in a broad sense, incorporating attention restoration, as well as other aspects of psychological restoration, such as stress restoration. The question on fascination was included to inform our discussion of the soft fascination element of ART. The high biodiversity treatment was predicted to enhance self-reported enjoyment, restoration and stimulation relative to the effects of the low diversity treatment.

Actual effects on attentional capacity were measured using the Digit Span Backwards (DSB) attention test, which is a more sensitive test for measuring the effects of green-space exposure on attention than alternative tests such as the Stroop and Necker Cube tests (Berman et al., 2008; Ohly et al., 2016; Rogerson et al., 2016). The DSB is also more demanding of directed attention and thus more sensitive to changes in attentional fatigue than other attention tests, including the Digit Span Forwards test which only makes use of short-term memory (Hale et al., 2002; Ohly et al., 2016). We follow Grassini et al. (2019) in administering the DSB test visually, by showing each series of numbers on a screen, rather than the standard method of a researcher reading the series to participants. Our version differs by virtue of being delivered online, with participants being instructed in the use of a publicly accessible tool and initiating new sequences themselves (see Appendix A). We tested the viability of this method during piloting, to confirm that participants were able to follow the provided instructions. Pre- and post-exposure DSB scores were obtained to ensure that the post-exposure scores could be balanced against a baseline. Participants were presented with a list of single digits, provided one at a time, and asked to repeat the series in reverse order. Correct answers led to a new series, one digit longer than the last. The test continued until the participant failed a given length of series twice, and their score was the length of this failed series. Low DSB scores indicate increased distractibility, depleted executive function and poor working memory, all of which correspond to a reduced capacity for directed attention (Hale et al., 2002).

Following each exposure, we recorded each participant's score on the perceived restorativeness scale (PRS). The PRS measures the perceived restorative quality of a site by asking respondents to indicate their level of agreement on a 7-point Likert scale with 16 statements relating to their experience of that site (Hartig et al., 1991, 1997). It can be divided into four subscales, one for each of the components of ART proposed by Kaplan and Kaplan (1989)—fascination, coherence, compatibility and being away. Several studies have, however, concluded that these subscales cannot be considered independent (Hartig et al., 1997; Hauru et al., 2012) and we thus only analyse the complete scale here. The PRS is the most sensitive measure of the perceived restorativeness of a site (Han, 2018). In this study, the items of the scale were preceded by this instruction: 'Thinking about the video you have just watched, indicate your level of agreement with the following statements about the depicted location'. Prior to statistical analysis, the scores of all negatively framed questions were reversed.

2.4 | Socio-demographic variables and nature relatedness

Additional data were collected to enable potentially confounding socio-demographic and other factors to be taken into account in our analysis. Respondents were asked to provide their age, gender and ethnicity. In addition, financial status was recorded using the scale of Goff et al. (2017) which is the mean of four responses on a 7-point Likert scale (1 'Strongly disagree', 2 'Disagree', 3 'Slightly disagree', 4 'Neither agree nor disagree', 5 'Slightly agree', 6 'Agree', 7 'Strongly agree') to the following statements: 'I usually have enough money to go abroad on holiday', 'I often worry about being able to pay my monthly utility bills, such as heat, water, or electricity', 'I am often able to purchase luxury items, such as jewellery or designer clothing' and 'Being able to pay my rent or mortgage payments is a constant concern'.

We also asked respondents to provide their full postcode, from which we obtained the multiple deprivation index (MDI) deciles for their Lower-Layer Super Output Area—an area with approximately 1,500 residents in England and Wales (Ministry of Housing, Community, and Local Governance, 2019; Statistics for Wales, 2019) or 800 residents in Scotland (National Statistics, 2020). The MDIs of the constituent countries of the United Kingdom are calculated from measures of employment, income, health and other aspects of socio-economic status. Although the methods for calculating these indices contain slight variations between the UK's constituent countries, they are sufficiently similar for use of decile data; low numbers indicate high deprivation (Office for National Statistics, 2014).

Respondents' connectedness to nature can influence their perception of biodiversity and responses to green-space (Martin et al., 2020; Southon et al., 2018), and was thus measured using the NR-6 scale, a shortened version of the original 30-item nature relatedness scale (Nisbet & Zelenski, 2013).

2.5 | Procedure

The survey was conducted between May and July 2020 and took approximately 30 min for each participant to complete, including watching both virtual green-space exposures. The order that each participant watched the high diversity and low diversity videos was randomised, as was the focal site. Participants received an online survey link and an information sheet by email explaining that they would watch two videos of walks through a park with some small environmental differences between them, answer some questions about the walks and themselves, and complete some memory tests. Instructions on completing the DSB test and a link to the test were then provided, and a pre-exposure DSB test completed before watching the first video. After watching the first video, participants completed a post-exposure DSB test, followed by a post-exposure PRS questionnaire (Figure 3). Note that participants did not have their attentional capacity artificially depleted prior to the treatment, so the outcomes of the DSB tests only reflect the improvements in attentional capacity experienced by participants against their level of attentional depletion going into the experiment. Next, participants answered the socio-demographic and NR-6 questions. The respondents then completed a new pre-exposure DSB test before watching the second video, and then post-exposure DSB and PRS scores were obtained. Finally, participants answered the set of questions comparing their experience of the two green-space exposures.

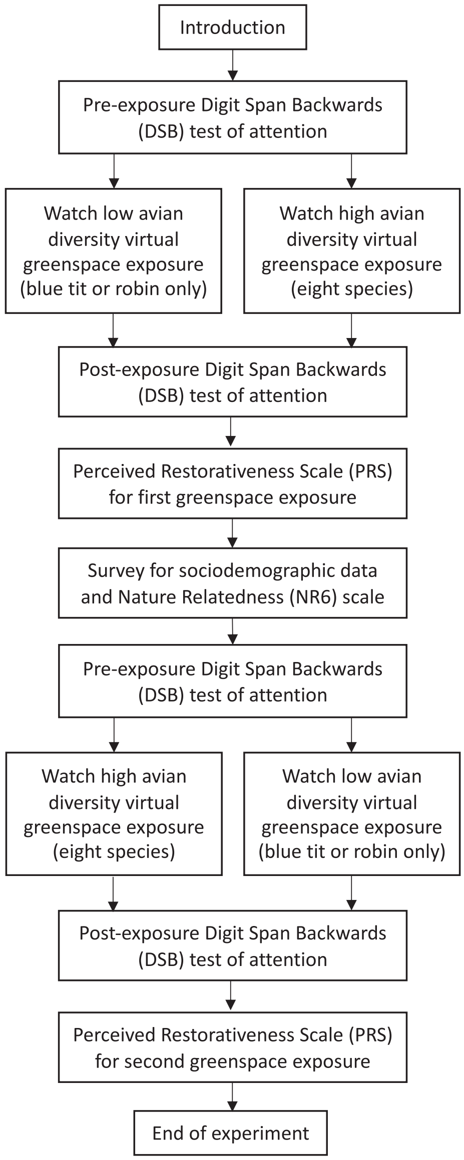


FIGURE 3 Diagram showing the sequence of the experimental procedure for a given participant. Participants experienced both the low diversity treatment and the high diversity treatment, but the order of the treatments in the study is randomised

2.6 | Statistical analysis

All analyses were completed using R, version 3.6.1 (R Core Team, 2020). Following Whittingham et al. (2006), full models that took socio-demographic variables and NR-6 scores into account were used to assess the a priori hypotheses that exposure to the high biodiversity treatment, relative to the low biodiversity treatment, resulted in participants (a) perceiving higher avian diversity (but not more individual birds), (b) greater self-reported benefits (enjoyment, restoration and stimulation), (c) greater improvements to attentional capacity (DSB test) and (d) greater perceived restorativeness (PRS test). As a robustness check we also constructed much simpler models that increased statistical power, relative to the full models, but excluded socio-demographic information and NR-6 scores.

Prior to testing these hypotheses, we carried out a preliminary check to assess whether the two versions of the low avian diversity treatment differed in their impact on attention and perceived restorativeness (DSB and PRS scores). To do this we modelled post-exposure DSB scores as a function of species (blue tit or robin), pre-exposure DSB score, age, gender, ethnicity, financial status, MDI decile, nature relatedness and site (as a fixed factor) using a general linear model. This method of constructing models using pre-exposure DSB scores as a predictor follows the recommendation of Vickers and Altman (2001). We then modelled post-exposure PRS scores using the same approach (excluding a pre-exposure score, as PRS focuses on a participant's experience of a site and can thus only be recorded after exposure to green-space). These models demonstrated that post-exposure DSB and PRS scores did not vary with the species used in the low diversity treatment (DSB: $p = 0.121$, $df = 76$, parameter estimate = 0.362 ± 0.231 (1 *SE*), PRS: $p = 0.372$, $df = 77$, parameter estimate = 0.131 ± 0.146 (*SE*); blue tit used as the reference). We thus pooled data to form a single low diversity treatment dataset that was used in all subsequent analyses.

The randomised order of the low biodiversity and high biodiversity treatments prevents any potential learning effects from biasing our assessment of biodiversity effects on the DSB scores. However, as a final validation check we ran a paired *t* test to look for learning effects, that is, an improvement in DSB scores after their first green-space exposure and before the second exposure. As these two scores are not separated by an exposure to green-space, any significant increase would indicate a learning effect. The test did not reveal any significant increase in DSB scores ($t = -0.63$, $df = 170.31$, *p*-value = 0.53) suggesting that learning effects are negligible.

2.6.1 | Self-reported perceptions of diversity and benefits of exposure to high biodiversity

Likert scale responses for the five questions asking respondents to compare their experience of the two exposures (perceived avian abundance, perceived avian species richness, enjoyment, restoration and stimulation) were reverse coded for participants that were first exposed to the high diversity treatment. Consequently, scores greater than four consistently reflected situations in which respondents perceived greater avian abundance, species richness, enjoyment, restoration and stimulation when experiencing the high diversity treatment. A one-tailed Wilcoxon signed rank test was then used to assess whether each median score was significantly greater than four. Finally, we modelled scores for each of the five questions against age, gender, ethnicity, financial status, MDI decile, nature relatedness and site (fixed factor), using cumulative link models (ORDINAL package), to assess if and how responses to the high diversity treatment varied with respondents' socio-demographics and nature relatedness.

2.6.2 | Effect of avian diversity on DSB and PRS scores

We modelled each respondent's post-exposure DSB score as a function of treatment type (low or high avian diversity), pre-exposure DSB score, age, gender, ethnicity, financial status, MDI decile, nature relatedness, site (fixed factor) and participant (random factor) using a general linear mixed effects model with the LME4 package (Bates et al., 2015). The random effect of participant was included to account for pseudoreplication arising from each respondent contributing DSB scores for two different exposures. This full model again follows the structure recommended by Vickers and Altman (2001) for experimental datasets with pre- and post-exposure measurements. We also produced a second model of post-exposure DSB scores including all of the same terms as the first, with the addition of the nature relatedness × treatment type interaction to test if participants that were more strongly connected to nature received greater benefits of exposure to high biodiversity. We also produced a third model of post-exposure DSB scores including the same terms as the first, plus scores from the comparative question on the perceived avian species richness of the two treatment exposures as an additional predictor variable. This model allowed us to identify any potential effects of perceived biodiversity on changes in attentional capacity. Finally, we constructed a much simpler model of each respondent's post-exposure DSB score as a function of pre-exposure DSB score, treatment type (low vs. high biodiversity) and participant (as a random effect)—we did this a such models have greater statistical power to detect treatment effects. This simpler model did not alter our inference regarding effects of treatment and are thus reported in the Supporting Information (Table S3).

To assess the effect of biodiversity on perceived restoration, we modelled PRS as a function of treatment type (low or high avian diversity), age, gender, ethnicity, financial status, MDI decile, nature relatedness, site (fixed factor) and participant (random factor) using a general linear mixed effects model (LME4 package; Bates et al., 2015). We again ran two additional models that were identical to the first but included, (a) the nature relatedness × treatment type interaction and (b) scores from the perceived species richness comparative question. Again, as a robustness check we ran a much simpler model that had greater statistical power to detect treatment effects, but only included treatment type (low or high diversity) and participant (random effect) in the model—and report the results of this model in Table S4, as it does not change our inference regarding the effect of treatment.

3 | RESULTS

3.1 | Self-reported perceptions of diversity and benefits of exposure to high biodiversity

Likert scale responses to the question regarding perceived species richness were significantly greater than four (one-tailed Wilcoxon signed rank test; $p < 0.001$, $V = 1,595$; Figure 4) indicating that participants perceived greater avian diversity in the high diversity treatment. Similarly, participants perceived a greater abundance of individual birds in the high diversity treatment video ($p < 0.001$, $V = 1,996.5$; Figure 4). Cumulative link models of respondents' Likert scores indicated that participants' nature relatedness, age, gender, ethnicity, financial status and MDI decile did not significantly influence perceptions of relative avian diversity in the high diversity and low diversity exposures (Table 1). There were, however, marginally significant trends for respondents with greater nature connectedness, lower financial status and men (compared to women) to perceive greater avian abundance in response to the high diversity treatment (Table 1).

Participants enjoyed the higher diversity treatment more than the low diversity treatment ($p = 0.007$, $V = 1,057$), but did not

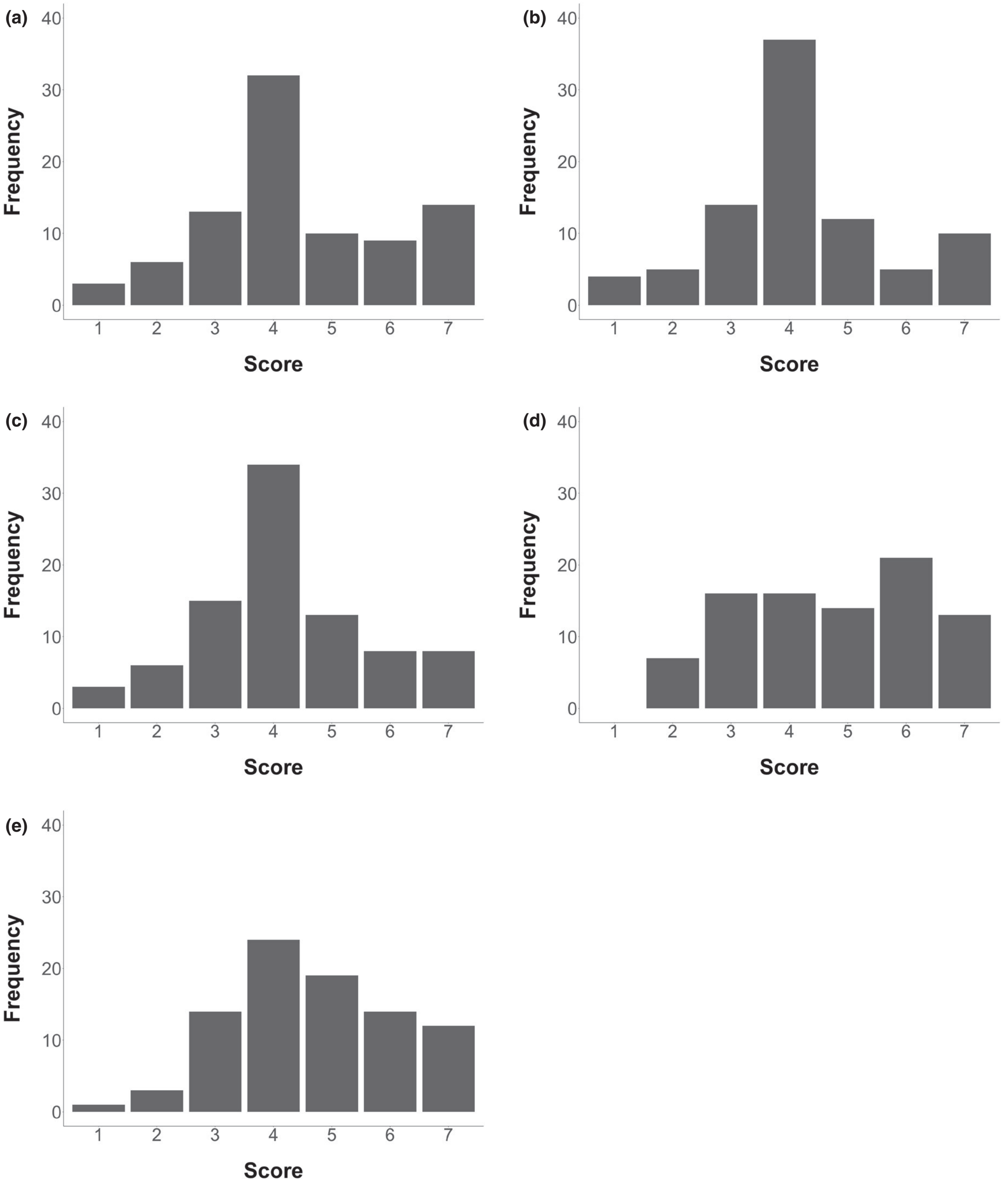


FIGURE 4 Distribution of Likert scores for questions comparing the high avian diversity treatment and low avian diversity treatment on the following criteria: (a) enjoyment, (b) restoration, (c) stimulation, (d) perceived avian abundance and (e) perceived avian diversity. Scores above four indicate that respondents stated that the high diversity treatment performed better on the focal criteria than the low diversity treatment. Scores of four indicate a neutral response to the question

report it to be more restorative ($p = 0.125$, $V = 754.5$) or stimulating ($p = 0.102$, $V = 856.5$; Figure 4). Respondents with lower financial status and non-white (compared to white) respondents were more likely to report greater restorative benefits from the high diversity treatment compared to the low diversity treatment (Table 1). Older respondents were more likely than younger respondents to perceive the high diversity treatment as more stimulating (Table 1).

3.2 | Effect of avian diversity on attentional capacity effects and perceived restoration

When modelling post-exposure DSB scores there was no evidence for a significant relationship with the interaction between the high diversity treatment and nature relatedness ($p = 0.732$, parameter estimate = −0.076, 95% confidence interval = −0.508 to 0.355). We thus infer results from a full model that only contains the main effects, which provided no evidence that high diversity treatments increased post-exposure DSB scores compared to the low diversity treatment (Table 2; Figure 5). Post-exposure scores were, however, higher in respondents with greater nature relatedness, and declined with age; no other predictors were significant (Table 2). Treatment also had no significant effect on DSB scores in the simpler model, which had greater statistical power to detect effects due to the exclusion of nature relatedness and socio-demographic predictors (Table S3).

Modelling PRS scores revealed a marginally significant relationship with the interaction between the high diversity treatment and nature relatedness. In this model there was no evidence that the high diversity treatment elevated PRS scores, and the effects of other predictors were consistent in this model and a model that only contained main effects (Table 3). We thus base our inference on the main effects only model, which confirmed that the high diversity treatment did not increase PRS scores compared to the low diversity treatment (Table 3; Figure 5). PRS scores declined with age and men had lower PRS scores than women (Table 3). Treatment also had no significant effect on PRS scores in the simpler model that had greater statistical power to detect effects due to the exclusion of nature relatedness and socio-demographic predictors (Table S4).

Additional modelling of both post-exposure DSB and PRS, which incorporated scores from the comparative question on the relative avian diversity of the two treatment exposures indicated that there was no effect of perceived avian species richness on either actual changes in attentional capacity (Table S5) or perceived attention restoration (Table S6).

4 | DISCUSSION

Our experiment quantifies how self-reported enjoyment and experience of a virtual green-space, metrics of attentional capacity, and perceived restorativeness are influenced by avian biodiversity. Previous experiments have used virtual exposures to green-space, of similar duration to those that we use here, to demonstrate the

TABLE 1 Results of cumulative link models for each of the survey questions asking respondents to compare their two green-space exposures (low diversity vs. high diversity), including parameter estimates, 95% confidence interval and p values. Parameter estimates are set at zero for the reference levels, which for site is High Hazels Park, for gender is female, and for ethnicity is non-white. Significant results ($p < 0.05$) are in bold and marginally significant results ($p < 0.1$) are in italics

Response	Site (Millhouses Park)	Site (Weston Park)	Age	Nature relatedness NR-6	Financial status	Multiple deprivation index (MDI)	Gender (Male)	Ethnicity (White)
Perceived avian abundance	−0.749 (−1.704 to 0.198) $p = 0.121$	−1.027 (−2.005 to −0.071) **$p = 0.037$**	0.004 (−0.019 to 0.027) $p = 0.748$	0.558 (−0.083 to 1.221) *$p = 0.092$*	−0.480 (−0.995 to 0.018) *$p = 0.062$*	0.012 (−0.143 to 0.167) $p = 0.874$	0.691 (−0.083 to 1.477) *$p = 0.082$*	−0.157 (−1.394 to 1.081) $p = 0.802$
Perceived avian species richness	−0.255 (−1.222 to 0.714) $p = 0.605$	−0.645 (−1.588 to 0.284) $p = 0.176$	0.012 (−0.010 to 0.035) $p = 0.273$	0.249 (−0.394 to 0.901) $p = 0.449$	−0.326 (−0.819 to 0.156) $p = 0.187$	−0.019 (−0.176 to 0.137) $p = 0.814$	0.646 (−0.123 to 1.428) $p = 0.101$	−0.321 (−1.494 to 0.856) $p = 0.588$
Preference	0.254 (−0.705 to 1.222) $p = 0.604$	0.455 (−0.529 to 1.444) $p = 0.364$	0.003 (−0.020 to 0.025) $p = 0.818$	0.399 (−0.242 to 1.050) $p = 0.224$	−0.227 (−0.740 to 0.297) $p = 0.388$	−0.095 (−0.255 to 0.061) $p = 0.234$	−0.391 (−1.187 to 0.397) $p = 0.331$	−0.803 (−2.186 to 0.558) $p = 0.246$
Restoration	−0.061 (−1.039 to 0.915) $p = 0.902$	0.386 (−0.576 to 1.354) $p = 0.432$	0.003 (−0.020 to 0.026) $p = 0.816$	0.234 (−0.420 to 0.890) $p = 0.481$	−0.588 (−1.112 to −0.063) **$p = 0.027$**	−0.058 (−0.220 to 0.103) $p = 0.484$	−0.521 (−1.323 to 0.270) $p = 0.198$	−1.399 (−2.767 to −0.051) **$p = 0.041$**
Stimulation	0.302 (−0.707 to 1.322) $p = 0.558$	−0.317 (−1.286 to 0.642) $p = 0.517$	0.032 (0.009 to 0.055) **$p = 0.007$**	0.183 (−0.468 to 0.833) $p = 0.580$	−0.182 (−0.691 to 0.336) $p = 0.485$	−0.106 (−0.271 to 0.057) $p = 0.202$	−0.004 (−0.799 to 0.790) $p = 0.991$	−0.448 (−1.766 to 0.884) $p = 0.504$

TABLE 2 Results of a general linear mixed effects model (main effects only) of post-exposure Digit Span Backwards (DSB) scores as a function of pre-exposure scores, treatment (high avian diversity or low avian diversity), site, nature relatedness, financial status, multiple deprivation index (deciles), gender and ethnicity. We report parameter estimates, (95% confidence intervals) and *p* values. The reference level for treatment type is the low diversity treatment, for site is High Hazels Park, for gender is female and for ethnicity is non-white. Significant results ($p < 0.05$) are in bold and marginally significant results ($p < 0.1$) are in italics

Pre-exposure DSB score	Treatment type	Site	Age	Nature relatedness NR-6	Financial status	Multiple deprivation index (MDI) decile	Gender (Male)	Ethnicity (White)
0.613 (0.489 to 0.737) **$p < 0.001$**	−0.007 (−0.299 to 0.287) $p = 0.987$	Millhouses Park: 0.211 (−0.243 to 0.665) Weston Park: 0.061 (−0.396 to 0.518) $p = 0.595$	−0.015 (−0.026 to −0.004) **$p = 0.009$**	0.394 (0.083 to 0.705) **$p = 0.010$**	−0.070 (−0.303 to 0.162) $p = 0.512$	0.027 (−0.049 to 0.102) $p = 0.458$	0.120 (−0.262 to 0.481) $p = 0.553$	−0.447 (−1.013 to 0.118) *$p = 0.097$*

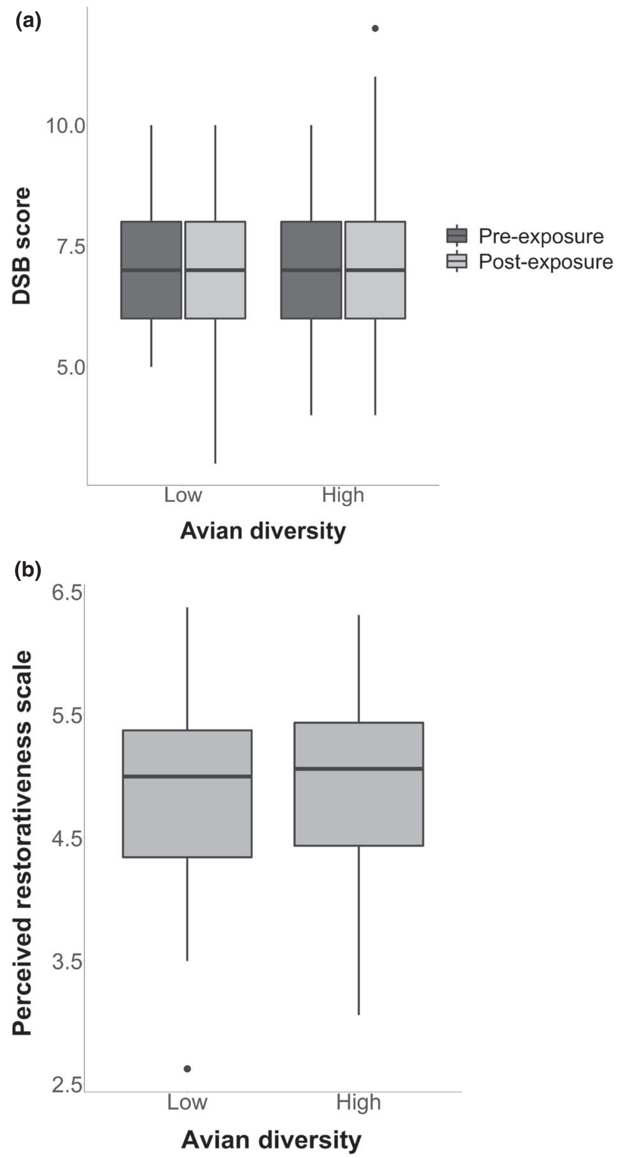


FIGURE 5 Boxplots comparing respondents (a) digit span backwards (DSB) attention test scores and (b) perceived restorativeness scale (PRS) scores in response to the high avian diversity treatment and low diversity treatment. There is no pre-exposure score for the PRS, as this records the impact of experiencing a location and thus cannot be obtained before the experience has taken place

attention restoration benefits of experiencing an urban green-space compared to urban areas without vegetation (Chow & Lau, 2015; Craig et al., 2015; Lee et al., 2015). Here, we used a virtual experiment that facilitated manipulation of biodiversity and ensured that all other conditions, other than biodiversity exposure (operationalised here as species richness), were kept constant and in which the only auditory stimulus was birdsong. This is likely to increase the sensitivity of participants to differences in biodiversity and thus our ability to test the hypothesis that higher avian biodiversity enhances the experience of greens-space and attention capacity compared to experiencing less biodiverse green-space.

TABLE 3 Results of general linear mixed effects models for overall perceived restorativeness scale (PRS), including parameter estimates, 95% confidence interval and *p* values. The reference level for treatment type is the low diversity treatment, for site is High Hazels Park, for gender is female and for ethnicity is non-white. Significant results ($p < 0.05$) are in bold and marginally significant results are in italics

Model	Treatment type	Site	Age	Nature relatedness NR-6	Financial status	Multiple deprivation index (MDI) decile	Gender (Male)	Ethnicity (White)	Treatment type × Nature relatedness (NR-6)
Main effects only	0.014 (−0.079 to 0.106) *p* = 0.772	Millhouses Park: 0.030 (−0.304 to 0.364) Weston Park: −0.187 (−0.520 to 0.147) *p* = 0.345	−0.010 (−0.018 to −0.003) ***p* = 0.007**	0.094 (−0.131 to 0.318) *p* = 0.389	−0.075 (−0.246 to 0.095) *p* = 0.362	0.010 (−0.046 to 0.065) *p* = 0.714	−0.3802 (−0.653 to −0.108) ***p* = 0.005**	−0.264 (−0.679 to 0.151) *p* = 0.191	n/a
Main effects and interaction between avian species richness and nature relatedness	−0.408 (−0.912 to 0.096) *p* = 0.111	Millhouses Park: 0.030 (−0.304 to 0.364) Weston Park: −0.187 (−0.520 to 0.147) *p* = 0.345	−0.0103 (−0.018 to −0.003) ***p* = 0.007**	0.036 (−0.198 to 0.270) *p* = 1	−0.075 (−0.246 to 0.095) *p* = 0.362	0.010 (−0.046 to 0.065) *p* = 0.714	−0.3802 (−0.653 to −0.108) ***p* = 0.005**	−0.264 (−0.679 to 0.151) *p* = 0.191	0.115 (−0.020 to 0.250) *p* = 0.094

4.1 | Respondents' perceptions of biodiversity

When exposed to two recorded walks through an urban green-space, one with a single audible bird species and the other with eight audible bird species, participants reported significantly enhanced enjoyment of the high diversity treatment. A few experimental studies have demonstrated that visitors to urban green-spaces prefer locations with greater plant diversity (Lindemann-Matthies et al., 2010; Southon et al., 2017), and our research extends the results of these studies to focus on a specific factor, enjoyment, that can determine preference, and from the visual to the auditory sensory pathway.

Previous studies provide mixed and inconclusive evidence that members of the public can accurately perceive differences in biodiversity. Fuller et al. (2007) finds a positive association between perceived and actual plant richness and a marginally significant positive relationship between perceived and actual avian richness, while another study using similar methods found no significant associations between perceived and actual species richness (Dallimer et al., 2012). In observational studies such as these other cues could be used by respondents when estimating species richness, such as forest cover (Dallimer et al., 2012), site facilities (Wood et al., 2018) habitat diversity (Fuller et al., 2007) or vegetation structure and colour (Southon et al., 2018). These cues may not, however, always be accurate indicators of species richness. Our experimental design removes the potential influence of such misleading cues, as visual stimuli are constant, and our findings (which concur with Southon et al., 2018)) confirm that people are able to perceive differences in species richness. Notably, we provide evidence that people have the capacity to detect differences in biodiversity that arise purely from auditory stimuli. Respondents' capacity to do this may have been enhanced by the nature of our experimental design, which removed other sounds that in real life situations may reduce participants' attention or masked bird song. Ferraro et al. (2020), however, also report that people can detect enhanced avian diversity via aural pathways in natural settings.

While the high diversity and low diversity videos both presented the birdsong as belonging to eight individual birds, participants perceived a higher number of individual birds during the high biodiversity treatment than during the low diversity treatment. This suggests that participants may be unable to distinguish environments that support high numbers of species from those that support a high abundance. The lower perceived avian abundance of the low diversity walk may arise if participants perceived that some of the eight discrete audio clips were generated by the same individual bird changing locations during the walk. Such a perception is less likely to arise during the high diversity treatment when each audio clip is more aurally distinct and enables respondents to recognise that each individual bird represents a different species. Consequently, future studies assessing the relationship between perceived biodiversity and psychological benefits should be careful to assess whether impacts arise from perceived biodiversity per se or perceived increases in the abundance of wildlife.

4.2 | Impacts of biodiversity on attention

Although participants' enjoyment was greater when exposed to higher diversity and they were able to perceive the difference in species richness, respondents did not identify the high avian diversity treatment as being more restorative or stimulating. We expected the high diversity walks to be more softly fascinating, that is, contain more features that are engaging without demanding directed attention (in part due to the greater evenness of sounds across frequencies) and therefore more restorative of directed attention. In contrast, our results do not indicate any impacts of avian diversity on actual attentional capacity (DSB metrics) or perceived restorativeness (PRS scores), including impacts arising through effects of increased perceived diversity. This does not support our hypothesis that the number of avian species that are audible during a green-space visit has an effect on attentional outcomes.

One reason why we fail to detect effects of enhanced biodiversity on attentional capacity and perceived restorativeness could be that the visual aspects of the green-space exposures were sufficiently restorative that variation in aurally detected biodiversity had negligible additional effects. There is precedent for this as a virtual greenspace exposure with either birdsong, traffic noise or combined birdsong and traffic noise had similarly restorative effects on stress indicators (Hedblom et al., 2019). It is notable though that respondents in our study did detect aural differences in the avian communities, with higher diversity increasing enjoyment, thus suggesting that auditory stimuli are impacting the outcomes of exposure to green-space and are not swamped out by visual stimuli. While attentional theory is less developed with regards to auditory than visual stimuli (Shinn-Cunnigham, 2008), van Hedger et al. (2019) find that auditory stimuli from natural soundscapes are more restorative of attention than urban soundscapes, thus contrasting with Hedblom et al. (2019). Exposure to birdsong has also been associated with increased psychological well-being with regard to positive affect and perceived stress recovery (Cameron et al., 2020; Ratcliffe et al., 2013). While aural exposure to avian biodiversity does not appear to influence attention outcomes in our study, it may produce other types of benefits to mental well-being (Cameron et al., 2020) and influence other causal pathways connecting green-space access and improved mental health outcomes (Marselle et al., 2021). In particular, the diversity of birdsong audible at a site may help develop place attachment (Schebella et al., 2017) and encourage the use of local green-spaces, boosting the mental health benefits of exercise (Mikkelsen et al., 2017), social interaction and community cohesion (Kawachi & Berkman, 2001).

Our results contrast with Ferraro et al. (2020) who concluded that experimental manipulations of aural avian diversity along two hiking trails generated small improvements in perceived restoration of hikers. On one trail increasing perceived restoration was directly driven by increased diversity, and along another trail increases arose indirectly from increased perceived biodiversity. There are a number of potential reasons for these contrasting results, and additional studies are clearly needed, but two potential explanations deserve particular exploration. First, while our experiment held avian abundance constant, participants in the Ferraro et al. (2020) study experienced an increase in abundance as well as diversity, suggesting that biodiversity may enhance attention restoration by increasing the amount of 'softly fascinating stimuli' (as defined in ART theory) rather than their diversity. As highlighted in Section 4.1, determining how diversity and abundance of wildlife, which are distinct aspects of ecological quality, influence visitor perceptions and mental health outcomes will be a productive area for future research. Second, differences between the two studies may be generated by variation in the type of respondents. Our survey focused on participants that are broadly representative of the general public, while the Ferraro et al. (2020) study focused on hikers that have stronger connections to nature—which may enhance the capacity of biodiversity to deliver benefits to attentional capacity. Indeed, we find evidence that people with stronger nature connections show greater attentional capacity overall (see Section 4.3 below), which may influence their attentional outcomes under different biodiversity conditions.

4.3 | Nature relatedness and attentional capacity

Although there was no evidence that improvements in attentional capacity, as indicated by pre- and post-exposure DSB scores, were related to biodiversity levels, our models do show that respondents with higher nature relatedness produced higher DSB scores overall. The NR-6 scale specifically targets the identity and contact aspects of nature relatedness (Nisbet & Zelenski, 2013), so this result indicates that people who spend more time in natural environments and identify more closely with nature have improved attentional capacity. This trend is consistent with ART, as greater exposure to natural settings serves to combat attentional fatigue. Previous studies have linked higher nature relatedness to improvements in other aspects of mental health and well-being, including reduced anxiety (Martyn & Brymer, 2016), greater positive affect (Nisbet et al., 2011; Zelenski & Nisbet, 2014) and self-reported overall health (Dean et al., 2018). Our study appears, however, to be the first to establish a positive association between nature relatedness and an objective measure of attentional capacity.

4.4 | Limitations

The experimental design of this study, which was carried out remotely using virtual green-space exposures, was well suited to the questions it sought to answer particularly given the context of collecting data under the restrictions on face-to-face interaction imposed during the Covid-19 pandemic. It is, however, useful to explore potential limitations of this approach.

Our experimental design lacked a control exposure in which participants experienced green-space without birdsong. This was necessary to limit the duration of the experiment and prevent 'questionnaire fatigue' (Rolstad et al., 2011). While our design prevents us assessing the impacts of the presence/absence of birdsong on attentional outcomes there is already evidence that birdsong is associated with attention restoration (Ratcliffe et al., 2013, 2016; Uebel et al., 2021). Moreover, our design reflects the reality that most urban parks and green-spaces contain birds, and our core objective of testing how changes in the magnitude of biodiversity influences attentional outcomes.

Participants will have experienced the virtual green-space exposures and completed the questionnaire under variable ambient conditions, including different levels of background noise and other distractions, while using different devices with variable sound quality and volume. While the instructions provided to participants were worded to ensure that their experiences of the experiment were as consistent as possible, the remote data collection approach will inevitably have reduced the consistency of participant experience compared to the same experiment carried out in a single neutral location. The bulk of this variation is, however, likely to have been between participants, with each individual respondent likely to have experienced similar conditions when experiencing the low and high diversity exposures. Our paired experimental design and incorporation of respondent as a random factor in our analyses will therefore have reduced the impact of variation in test conditions on our ability to detect treatment effects.

There is potential incongruity between the effects of virtual green-space exposures, as observed in this study, and the effects of an equivalent in-person visit to an urban green-space. While virtual exposures allow researchers to more easily manipulate the experience of a green-space, they also lack environmental elements that are present during an in-person visit, including other sources of ambient noise, distractions from other visitors and other sensations produced by the weather, among numerous other factors. This study introduces an additional potential discrepancy between virtual and actual green-space experiences, that is, the relatively high number of audible birds compared to the negligible number of birds that are visible. Such a situation does, however, match typical experiences when visiting green-space with most avian detections being aural rather than visual. It is also notable that the Ferraro et al. (2020) study which concluded that diversity increased perceived restoration also used an experimental design with a disconnect between visually and aurally detected avian diversity and we thus conclude that such a disconnect is unlikely to severely influence our conclusions.

5 | CONCLUSIONS AND FUTURE RESEARCH DIRECTIONS

When exposed to two recorded walks through an urban green-space, with low and high levels of audible avian biodiversity respectively, participants accurately perceived the increase in species richness and reported greater enjoyment of the high diversity walk. That people are both aware of differences in avian diversity and prefer green-space exposures with birdsong from a greater number of species suggests that biodiversity plays a role in promoting green-space usage and its associated mental health benefits. However, we found no evidence for any difference in effect on attentional capacity or perceived restorativeness between the low and high avian diversity conditions. This indicates that the diversity of species represented in birdsong may not contribute to the greater attention restoration potential of urban green-spaces compared to other urban environments. Participants with higher nature relatedness scores, as measured by the NR-6 scale (Nisbet & Zelenski, 2013) gave higher scores for the DSB test of directed attention after the green-space exposures. Given that a major component of this scale reflects the respondent's level of contact with natural environments, this finding supports the fundamental assertion of ART that spending time in green-spaces, serves to dissipate attentional fatigue. It also suggests that policies that encourage development of nature connections will deliver attentional benefits.

The use of experimental methods is essential if future studies are to identify the features of urban green-spaces that have the most influence over attentional outcomes. There is notable potential for further research into the role of biodiversity in links between visiting green-space and directed attention, particularly teasing apart the relative roles of the abundance and diversity of wildlife, visual rather than aural cues, and the role of acoustic diversity (rather than species focused diversity metrics) when assessing people's responses to bird song.

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CONFLICT OF INTEREST

The authors declare no conflict of interest to report.

AUTHORS' CONTRIBUTIONS

Both authors conceived the ideas and designed methodology; J.W.A.D. collected and analysed the data; both authors led the writing of the manuscript. All authors contributed critically to the drafts and gave final approval for publication.

DATA AVAILABILITY STATEMENT

We have archived a fully anonymised version of the dataset through Dryad Digital Repository at https://doi.org/10.5061/dryad.9ghx3ffj9 (Douglas & Evans, 2021). The dataset is anonymised but only includes data from the 71 of the 87 participants in the original study that gave consent for their data to be made publicly available for viewing or use by other researchers.

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