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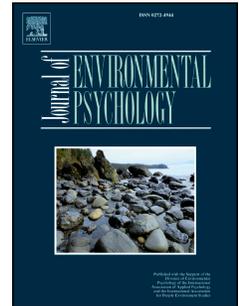
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Associations with bird sounds: How do they relate to perceived restorative potential?

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Associations with bird sounds: How do they relate to perceived restorative potential?**Abstract**

Bird sounds are related to perceptions of attention restoration and stress recovery, but the role of associations in such perceptions is understudied. 174 adult residents of the United Kingdom rated 50 bird sounds on perceived restorative potential (PRP) and provided qualitative data on associations with each sound. Bird sounds were associated with imagined environments, birds and other animals, time and season, and activities within the environment. Bird sounds rated as high in PRP were associated with green spaces, spring and summer, daytime, and active behaviours in the environment. Low-PRP bird sounds were associated with exotic and marine environments, non-avian animals, and showed a non-significant trend towards associations with negative bird behaviour. These findings highlight connections between semantic values and restorative perceptions of natural stimuli. Such connections can inform top-down approaches to study of restorative environments and may benefit conservationists seeking to improve bonds between people and wildlife.

1. Introduction

In recent years, study of restorative environments has broadened to include not just visual experience but also that of environmental sounds. Reflecting similar findings in the visual domain, natural sounds such as wind, water, and birds are perceived to be pleasant, relaxing, and potentially restorative (e.g. Björk et al., 2008; Grahn & Stigsdotter, 2010; Payne, 2013), and can lead to greater recovery from stress than sounds from the built environment (Alvarsson, Wiens, & Nilsson, 2010; Benfield, Taff, Newman, & Smyth, 2014; Medvedev, Shepherd, & Hautus, 2015). Across these findings, birds recur as a characteristic sound of nature; one that individuals bond with and draw inspiration and symbolism from (Mynott, 2009; N'gweno, 2010; Ratcliffe, Gatersleben, & Sowden, 2013).

1.1. Meaning and restorative perceptions

Despite the increased interest in restorative natural sounds, one topic that remains under-examined in both the visual and auditory domains is *why* certain environments and environmental stimuli can be perceived as restorative. In particular, the role of meanings, associations, and other semantic qualities of natural environments and stimuli cries out for further study, as noted by Pretty (2004) and Pretty et al. (2015). In his presentation of an affective, psycho-evolutionary framework of restorative environments, Ulrich (1983, p. 92) notes that, "Evaluation may be accompanied by memories and associations..." yet relationships between restorative perceptions or outcomes and these top-down appraisals remain speculative, due to lack of systematic study. Furthermore, Shaw, Coyle, Gatersleben and Ungar (2015) report on individuals' imagined restorative environments built up from non-visual perceptions. These aspects of the literature indicate that both past and imagined future experiences can influence perceptions of restorative potential and restoration.

Despite being but one part of the natural world, birds are regarded as one of the most important types of animals and sounds that individuals experience in nature (Curtin, 2009; Ratcliffe et al., 2013; Cox & Gaston, 2015), and they are particularly rich in semantic values and associations

(Mynott, 2009). Beyond merely conveying purely practical information, bird sounds can have symbolic value that may affect how they are cognitively and affectively appraised, and perhaps how restorative they are perceived to be. Throughout time birds have symbolised concepts, events, and aspects of human nature as told through stories and folklore, to the extent that they feature more than any other animal in Aboriginal Australian stories (Tidemann & Whiteside, 2010). N'gweno (2010) notes that bird sounds are often used to convey meaning and messages in folklore, such as the changing seasons, life events, and fortunes. She suggests that sound is particularly relevant in bird identification and knowledge because they are often heard before they are seen, thus making the bird's sound a symbol in itself for the bird and the concepts it represents. For this reason, bird sounds are an excellent vehicle through which to examine meanings associated with natural stimuli, and in particular how those meanings relate to perceptions of restoration in order to address the semantic gap in the field, described above.

1.2. Bird sounds as symbols of threat

While birdsong in a holistic sense is generally considered to be pleasant (Björk et al., 2008; Grahn & Stigsdotter, 2010), differences occur between bird species in terms of how pleasant or relaxing they are perceived to be (Björk, 1985; Ratcliffe et al., 2013; Cox & Gaston, 2015). Ratcliffe et al. (2013) showed that the associative values of different bird sounds are particularly important in establishing affective appraisals and restorative perceptions. For example, one participant in Ratcliffe et al. (2013, p. 224) described “screeches, owls hooting” as “archetypal spooky sounds ... Because they're frightening”, suggesting that certain bird sounds can act as symbols for negative valence or fear in an abstract sense, and in turn these sounds are not considered restorative. This view is supported by Cox and Graston (2015), who suggest that songbirds are preferred over calling, non-songbirds because they are less likely to be associated with aggressive or otherwise threatening behaviour.

The presence of threat in nature has been shown to reduce restorative potential and outcomes in

these environments; for example, Andrews and Gatersleben (2010) and Gatersleben and Andrews (2013) reported that environments low in both prospect and refuge (signifiers of safety and security) were associated with reduced restorative perceptions and outcomes. Herzog and Rector (2009) noted that a vignette indicating the presence of a threatening stranger reduced restorative perceptions of an imagined natural environment, and Bixler and Floyd (1997) indicated that non-human threats, such as wild animals or risk of getting lost, may also be found in natural environments. These findings correspond with prevailing theories of restorative environments, in that the presence of threat is likely to increase arousal and negative affective appraisals, limiting restoration from stress (Ulrich, 1983), and to impose cognitive demands that limit restoration from directed attention fatigue (Kaplan & Kaplan, 1989; Kaplan, 1995). However, there is a lack of existing research on how the spontaneous associations with the presence or absence of threat linked to birds might relate to restorative potential, and particularly the potential of specific stimuli such as bird sounds.

1.3. Bird sounds as symbols of resources

Bird sounds can be symbols for times of year associated with resources. Sometimes these associations are generated through folklore or cultural knowledge, and at other times they are formed on the basis of personal memories. For example, in Ratcliffe et al. (2013, p. 65) one participant said of the wood pigeon's song, "That kind of reminds me of summer and sort of long, hot summers", and Mynott (2009) notes that the sound of the crane is associated with autumn and bringing in the harvest. Tidemann and Whiteside (2010) describe an Aboriginal Australian story in which the sound of the Channel-billed Cuckoo is associated with both the start of the rainy season and the presence of manna sugar, an energy-rich food source. In hearing bird sounds, listeners may be made aware of the presence of life-giving elements of nature. It is possible that these sounds may have restorative potential through their associations with vitality and biodiversity, perhaps linking to concepts of survival (Ulrich, 1983).

1.4. Bird sounds as symbols of abstract concepts

Birds and their sounds can also be symbolic of positively and negatively valenced concepts. In Australian Aboriginal storytelling, the Laughing Kookaburra's sound serves as a symbol of both merriment (Tidemann & Whiteside, 2010) and new beginnings, such as daybreak. Mynott (2009) indicates that symbolic associations with birds differ with culture and can be concurrent; for example, the owl has been associated with both wisdom and death, and the robin with both life in the depths of winter and concepts of death and sacrifice. Bird sounds, then, can be associated with concepts and events greater than themselves, and can generate affective appraisals based on those symbolic associations. However, it is not known to what extent this might relate to their restorative potential. Also underexplored are potential associations between nature, including bird sounds, and personal symbolism in the form of memories of one's past, and how these too might relate to restorative perceptions as hypothesised by Ulrich (1983).

1.5. Bird sounds as symbols of environments

If bird sounds can symbolise ideas such as summer, food, death, and beginnings, perhaps they can also symbolise the wider environment that they are drawn from, as shown in Shaw et al. (2015) where participants imagined detailed environments based on the sounds that they heard around them. Tidemann and Whiteside (2010) note that, alongside other animals, birds are invoked in folklore and mythology to explain the formation of topographical features and constellations of stars. In Ratcliffe et al. (2013, p. 225), bird sounds were sometimes discussed in the context of being in green spaces such as a garden, and of doing activities in those spaces. For example, one participant said, "We sit and feed and look after the birds a lot, so certainly I would sit and listen to the birds...", suggesting that the bird sounds he described were linked to the act of both sitting outdoors and caring for the birds, linking themes of environments and activities within them. These findings suggest that bird sounds may trigger associations with natural environments and activities in nature, experiences of which are known to be restorative in themselves (e.g. Hartig, Evans,

Jamner, Davis, & Gärling, 2003), but it is not clear how these associations might vary depending on the type of bird sound.

1.6. Aims

This study explored the types of associations and memories generated by listening to 50 bird sounds previously quantitatively rated on perceived restorative potential (PRP). In particular, the study aimed to understand whether a range of bird sounds rated as high, moderate, or low on PRP would generate different associative themes. This mixed-methods approach was undertaken since, as noted above, a single bird sound can be associated with a range of meanings from the practical or instrumental to the highly symbolic or personal, making qualitative techniques most appropriate for identifying these different meanings, which can themselves then be subjected to quantitative analyses. PRP relates to a single meaning (suitability for restoration), making it more appropriate for quantitative measurement. By combining the two techniques, this study aimed to examine associations with bird sounds in participants' own words whilst relating these back to measurable differences in perceived restorative value.

2. Method

2.1. Participants and design

174 adults aged between 18 and 68 ($M = 35.52$ years, $SD = 13.22$), who self-reported ordinarily being residents of the United Kingdom, were recruited from the general population through online and local advertising in London and the South East of England. This took the form of recruitment via social media, academic electronic mailing lists, snowball sampling via email, and posters placed on community and university notice boards. 123 were female, 50 were male, and one did not indicate gender. They were invited to participate in a study about responses to environmental sounds. Participants did not receive financial remuneration for their time, and the study was conducted in accordance with the ethical guidelines of the researchers' University. Participants

were randomly assigned to one of five groups in order to rate a subsample of ten randomly ordered bird sounds. Numbers of participants within each group ranged from 30 to 39.

In this study, participants rated the bird sounds on perceived restorative potential (PRP) and provided qualitative data regarding any associations or memories connected to each sound. 116 participants provided qualitative data connected with one or more bird sounds, and these data form the basis of the qualitative analyses below.

2.2. Materials and stimuli

2.2.1. Measures

2.2.1.1. Perceived restorative potential (PRP)

Perceived restorative potential (PRP) of each bird sound was measured in response to a vignette designed to emulate a state of stress and cognitive fatigue. Staats, Kieviet, and Hartig (2003) and Staats and Hartig (2004) utilised vignettes detailing the presence or absence of attentional fatigue in order for participants to assume the need for restoration, or not, before rating the likelihood of restoration in response to visual stimuli of natural and urban environments. Given that the aim of the present study was to evaluate restorative perceptions of bird sounds, rather than wider soundscapes, use of a vignette measure was deemed more appropriate than use of the well-established Perceived Restorativeness Scale (PRS; Hartig, Kaiser, & Bowler, 1997; Hartig, Korpela, Evans, & Gärling, 1997), which has a largely visuo-spatial focus, or the Perceived Restorativeness Soundscapes Scale (PRSS; Payne, 2013), which does not focus on specific sounds. In addition, the present study's emphasis on many short clips of different bird sounds meant that measuring actual restoration following stress or attentional fatigue was not viable in this paradigm. Measuring the perceived restorative potential of environmental stimuli subjectively, and in response to imagined scenarios, has a reliable and valid basis in research on environmental restoration using visual stimuli (cf. Staats et al., 2003, and Staats & Hartig, 2004) and this study extends its use to auditory stimuli.

The vignette in this study was adapted from Staats et al. (2003) and Staats and Hartig (2004), and describes a scenario in which the participant is both mentally fatigued from work and stressed and upset from an argument with a friend: “You’ve been working very hard recently. Now, after a long day, you really have had it. You have difficulty concentrating and are very irritable. To top it all off, you have had an upsetting argument with a friend and are feeling very stressed out about it. You sit down somewhere to take a break. To what extent would listening to this sound help you to recover in this scenario?”

Participants were asked to indicate the extent to which each bird sound would help them recover from the presented scenario, on a scale of 1 (not at all) to 7 (completely). A pilot study of $N = 47$ participants rated the scenario as conceivable ($M = 4.11$, $SD = .82$) and moderately familiar ($M = 3.00$, $SD = 1.17$) on a scale from 1 (Not at all) to 5 (Completely). These ratings broadly correspond with a pilot study conducted by Staats et al. (2003), in which a similar scenario of attentional fatigue was rated as conceivable (4.2 out of 5) and familiar (3.9 out of 5). PRP scores were averaged per bird sound, across participants.

2.2.1.2. Qualitative item

Participants were asked to respond to the prompt item, “Do you have any memories or associations with this sound? If so, please describe them here,” using a free-text response box.

2.2.2. Stimuli

Audio clips of 50 bird sounds, each 10 seconds in length, were compiled based on the most common bird species in the South-East of England, United Kingdom (UK), in 2011 (British Trust for Ornithology, 2012) and the most common bird species in New South Wales, Australia in 2010 (BirdLife Australia, 2012), as well as bird sounds listed by participants as being restorative or non-restorative in Ratcliffe et al. (2013). A list of species is provided in Table 1. Australian bird species were chosen in order to provide a range of novel bird stimuli because many of their sounds are substantially different to those produced by British birds. Clips of bird songs were used where

relevant to the species, but if no song was made by a species then a typical call was used instead. However, it is noted that birds make a variety of different sounds depending on context. This study only examined one type of sound per bird species, and as such only makes statements about a characteristic sound of each bird, rather than the bird itself. Sounds were sourced from high-quality sound libraries (e.g. British Library, xeno-canto.org) and were used with permission where necessary.

Sounds were reviewed for accuracy by two bird experts, and assigned to one of five sets each containing five randomly selected British bird sounds and five randomly selected Australian bird sounds. The sounds in each set were presented in a random order, and were looped to allow the participant to listen continuously whilst answering questions about each sound. The looping process occurred so that each clip was short enough for participants to make judgments about it in its entirety, but always audible no matter how long they took to answer questions about it. No species names or contextual information about the bird sounds were provided, so as not to influence participants' perceptions of the sounds, and the bird sounds were isolated from other environmental sounds (such as wind or other bird or animal sounds) as far as possible. Participants were asked to listen to the sounds via headphones or earphones where available.

2.2.3. Procedure

Participants provided informed consent, demographics and brief background details, and completed an audio calibration task in order to increase consistency of sound presentation. Details of this task are provided in Appendix A. Participants completed the ratings for a practice sound (chirping crickets), and then rated 10 of the 50 bird sounds (five UK birds and five Australian) on PRP and responded to the qualitative item per bird sound. After completing the ratings for all sounds, participants were thanked and debriefed via a pre-prepared online summary.

3. Analyses and Results

3.1. Analyses

Average PRP scores were calculated per bird sound across participants, and these are shown in Table 1. These scores were calculated based on responses from the overall sample of 174 participants, in order to increase reliability.

Qualitative data were analysed through a version of thematic analysis (Hsieh & Shannon, 2005; Braun & Clarke, 2006; Ratcliffe et al., 2013), enabling identification of key themes. Responses from the 116 participants who provided data on associations and memories with each bird sound were collated and then read thoroughly and repeatedly in order to become familiar with the data. Not all participants provided a comment for every bird sound, but each sound received between 1 and 20 comments (mode = 10). The responses were read individually and again in the context of the whole data set. They were then grouped by bird species. For each species, text in each individual response was analysed at a word level in order to generate codes regarding key concepts. This process occurred for each response within a species, supported by researcher reflections and commentary recorded during the reading and analysis process. When responses for all bird species had been analysed in this way, the codes that were generated were grouped into categories or master themes based on their similarity. Where appropriate, these were then considered in the context of attention restoration theory (ART; Kaplan & Kaplan, 1989; Kaplan, 1995) and stress recovery theory (SRT; Ulrich, 1983) frameworks in order to ground findings in existing theoretical stances where possible. However, responses that did not relate to existing theory are still reported and discussed here in order to understand what further constructs might explain relationships between bird sounds and restorative perceptions.

Following thematic analysis, the data set was segmented into terciles according to whether the relevant bird species had been rated as high, moderate, or low in perceived restorative potential (PRP). 16 bird sounds were rated as high on PRP, 18 moderate, and 16 low. For details of these birds, please see Table 1, below. It is notable that the PRP scores were widely distributed across the

scale of 1 to 7, with many falling below the midpoint. This is discussed further in section 4.2.

Differences and similarities between themes of associations with these three terciles of bird sounds are discussed in the following section. Frequency counts of codes per theme were examined using chi-squared tests, in order to determine whether these codes occurred with significantly different frequency between PRP groups. Where expected cell frequencies were less than five, cells were pooled and exact binomial tests of goodness of fit were used instead. Bonferroni-corrected significance values are presented. Themes are listed in Table 2, along with the frequency of thematic codes occurring per PRP group.

3.2. Qualitative results and discussion

476 qualitative responses were collected from 116 participants across the 50 bird sounds. Associations and memories with the 50 bird sounds were grouped into four main themes: the environment that the sound was associated with; the animal life in that environment; concepts of time and season; and activities in the environment. These themes are shown in Table 2, below. Sub-themes within these main themes revealed differences in associations between birds that had been rated as high, moderate, or low on perceived restorative potential (PRP), and these are discussed below.

3.2.1. Environment

Listening to bird sounds generated memories and associations of particular environments, both natural and built/urban.

3.2.1.1. Natural environments

All bird sounds were associated with a range of natural environments, from nature in general to specific locations, but a series of chi-squared analyses showed that these associations were significantly more frequently observed in the high-PRP group, $\chi^2(2) = 16.25, p < .01$. Associations with public green spaces (such as the countryside, woodlands, and parks) were also significantly more common in relation to high-PRP bird sounds, $\chi^2(2) = 22.27, p < .01$, as were associations with

private green spaces (gardens), $\chi^2 (2) = 23.81, p < .01$. Associations with exotic environments were significantly more frequent amongst bird sounds low in PRP, $\chi^2 (2) = 13.33, p = .02$, as were associations with marine environments, $\chi^2 (2) = 40.36, p < .01$.

3.2.1.1.1. Countryside, woodlands, and parks

One participant noted in response to the Blue Tit: “I associate this sound with nature.” The Greenfinch, rated second highest on PRP, generated “memories of English countryside (nothing specific)” for another participant. These kinds of birds were also associated with woodland and forest environments (“Similar to a call from the tit family so reminds me of walks in British woodlands”, Great Tit) as well as parks (“reminds me [of] walking in Milton Keynes Parklands...”, Goldfinch). Bird sounds rated as high in PRP were associated with greenery in the landscape. This took the form of “trees” (Blue Tit), “garden lawns” (Blackbird) and “hedgerows and fields” (Silvereye). These associations were not exclusive to high-PRP bird sounds, however. Birds that were rated as low on PRP, such as the Magpie and Long Tailed Tit, were also associated with similar environments such as “being in the park...”

3.2.1.1.2. Gardens

High-PRP birds were frequently associated with gardens or the act of being in a garden. In several cases this was participants’ own garden or that of a family member such as a parent or grandparent. For one participant, the association with place when hearing the sound of the Chaffinch was even more specific: “takes me straight to a specific spot at the bottom of my garden”. Associations with family, relatives, or the homes and gardens of family members were also discussed. One participant said, “Reminds me of home, again my parents’ garden because you can hear the birds singing and it sounds similar to the sound I’m listening to.” (Dunnock). For another participant, the sound of the Feral Pigeon generated associations with her grandmother’s garden that were highly positively valenced: “Love this sound - reminds me of being with my Grandmother in

South Africa, and when I was with her all was well with the world.” This is notable given that other participants expressed negative evaluations of the same sound.

3.2.1.1.3. Exotic environments

Eleven bird sounds rated as high on PRP were associated with exotic or tropical environments such as the rainforest, jungle, or zoo (e.g. the White Throated Treecreeper reminded one participant of “jungle afternoons”), but, as noted above, these associations were largely reserved for birds that scored moderately to low on PRP. For example, one participant said of the Australian Magpie: “No, I don't know what this noise is, it makes me think of the jungle a bit,” suggesting that its novelty and the participant’s lack of certainty about the sound may be associated with its exotic imagined environment. While birds associated with jungle environments generally scored low on quantitative measures of PRP, some participants indicated positive affective appraisals due to associations with escape. One noted that Laughing Kookaburra generated associations “only about dreams of travelling and going to the jungle and this makes me happy.” Links with novel, unfamiliar environments were also observed. For example, the Yellow-Faced Honeyeater prompted one participant to say: “I feel like I'd have to be somewhere unfamiliar to hear it. Maybe a zoo or a jungle.”

Moderate to low PRP sounds were also associated with rocky formations such as “... mountains” (Red Kite), “a cliff” (Parakeet), and with “vast space” (White-browed Scrubwren). As one participant put it, “It reminds [me] of when my family visited the Grand Canyon when I was younger.” (Herring Gull). Birds high on PRP were linked to verdant landscapes whereas birds low on PRP were associated with grand, but perhaps more inhospitable, topography. For example, the Cockatoo, a low-PRP bird, generated associations of landscapes very different to those found in the UK: “old, ancient, makes me think of rocks, deserts”.

3.2.1.1.4. Marine environments

Birds that scored moderately or low on PRP generated fewer associations with greenery and more with water-based landscapes, such as “pond lake in my country” (Magpie) and “Memories of being near water in the English countryside” (Carrion Crow). Bird sounds rated as moderate to low in PRP also generated associations with the sea. For example, the Red Kite made one participant think of “the coast”, while the Rainbow Lorikeet was associated with “walking by the beach” for another participant. The sounds of the Herring Gull were often associated with marine environments: “This sound reminds me of the seaside.” The Parakeet was commonly mistaken for a gull, and this led to several participants imagining “coast... marine” environments. Existing research has demonstrated that visiting such environments can have psychological benefits such as increased happiness (Wyles, Pahl, & Thompson, 2014), but in this study birds associated with the sea were not rated as highly restorative. It is possible that other factors beyond associations, such as the fact that these birds make raucous calls, may contribute to these low scores.

3.2.1.2. Non-natural environments and stimuli

Bird sounds in all three PRP groups were associated with built or otherwise non-natural environments to some extent, but these associations were significantly more frequent in the moderate-PRP group, $\chi^2(2) = 12.55, p = .04$. Using exact tests of binomial goodness of fit, associations with the urban environment and with homes/indoors were not significantly different between high- and moderate/low-PRP bird sounds, $ps > .05$. Associations with artificial sounds were more common in the moderate-PRP group, $\chi^2(2) = 9.72, p > .05$, but this difference did not remain statistically significant after correction for multiple comparisons.

3.2.1.2.1. Outdoor settings and buildings

One participant associated the sound of the Parakeet with being heard “in my hometown”, which is not surprising considering that this bird, although not native to the United Kingdom, has established colonies in urban centres such as south London. For another participant, the sound of the Silver Gull “... makes me think of walking around on campus seeing the birds.”

Both of these birds were associated with urban or built environments, and it is notable that they both scored low on PRP. One participant associated the sound of the Goldfinch with “being outside of London”, which may relate to concepts of escape or being away, found in attention restoration theory (Kaplan & Kaplan, 1989; Kaplan, 1995).

Several birds were associated with houses (either the participant’s own or a family member’s) and elements of those buildings. For example, one participant said in response to the Dunnock: “My Grandma's house!” and another said of the Blackbird: “blackbird sitting on the edge of the rooftop”. Another person expressed a negative evaluation of the Collared Dove, audible from inside: “Woodpigeon that sits on our roof and coos all day. I can usually zone out, but once I pay attention to it it really irritates me!” And for other participants still, these sounds were negatively evaluated because of the undesirable behaviour of the birds: “Pigeons roosting in the gutters and crapping all down the house.” (Wood Pigeon). The Willie Wagtail’s sound was rated as moderate to low on PRP and generated associations with caged or domesticated birds, as well as indoor environments, which contrasts with the open green spaces imagined in response to birds higher in PRP: “Bird cages, canaries, stuffy houses.” The sound of the Tawny Owl was rated as relatively high in PRP but generated some associations with built environments in the form of “dark houses”, particularly because of stereotypical associations with horror films.

3.2.1.2.2. Indoor environments and home

Participants described some birds as being associated with home: “Of being at home listening to the birds in my garden on a pleasant spring morning” (Wren). Some birds high in PRP were associated with being indoors but experiencing the sounds of the outdoors remotely. One participant evaluated this as a positive experience: “This is the sound of birds singing that I hear almost every morning from my window. It's very nice to wake up hearing these sounds of nature.” (House Sparrow). Another participant expressed curiosity regarding the incongruity between hearing bird sounds whilst in an indoor environment: “how'd that pigeon get inside” (Feral Pigeon).

3.2.1.2.3. Artificial sounds

Several bird sounds were associated with artificial stimuli, and this observation occurred across groups but most frequently amongst bird sounds rated moderately on PRP. The acoustic properties of these sounds seemed to be a factor in their evaluation of being unnatural, with squeakiness not equated to typical or natural bird sounds. For example, the Starling reminded one participant of "... squeaky toys and technology", and another associated the Crimson Rosella with, "maybe medical equipment, or a squeaky hinge". Some participants used references to science fiction to illustrate their perceptions of the sounds as unnatural. For example, one participant associated the Australian Magpie with "Doctor Who monsters / robots", and another said that the Red Wattlebird "sounds like a light sabre from 'Star Wars'". These birds were from Australia, and their sounds are in some ways dissimilar to those from the United Kingdom to the extent that some participants did not associate them with birds or natural sounds at all.

3.2.2. Animals

Participants tended to imagine birds as the primary form of animal life in environments that they described, but bird sounds rated as low in PRP were sometimes interpreted as or likened to sounds made by other animals.

3.2.2.1. Positive behaviour

Birds high in PRP were more likely to be associated with positive behaviour, including specific descriptions and memories of particular birds and their behaviour, but this did not remain a significant difference after correction for multiple comparisons, $\chi^2(2) = 8.76, p > .05$. These memories were often positively valenced due to the pleasant behaviour of the birds themselves or something or someone associated with them. For example, one participant described how "a pair of blackbirds in my garden have successfully raised three young this year. That makes me happy - and the sound makes me think of that!" The positive valence here may be related to the proximity of the birds and a perceived relationship with them in one's own garden. Another participant described

how the sound of a chicken was associated with positively valenced ownership of birds: “My parents kept poultry. Lots of happy memories.”

In a minority of cases the bird imagined by a participant was not the same as the recorded sound. The participant who had expressed positive associations between the sound of the Feral Pigeon and her grandmother went on to say, “There were always doves in her garden, and so this sound is associated with being with her. Love it!” In another example, a participant imagined a “little red robin sat on a garden shovel patiently waiting for the worms you dig up” in response to the sound of the Dunnock.

3.2.2.2. Negative behaviour

Birds low in PRP tended to be associated with negative behaviour, although this was not found to be significantly more frequent than in other PRP groups, $\chi^2(2) = 5.58, p > .05$. These associations related to negatively valenced instrumental or ecological meanings, either for the bird itself (“hurt crowe [sic]”, Australian Raven) or for other animals that the bird might be interacting with: “This sound makes me look out of the window to see what all the fuss is about. Is the magpie being defensive or aggressive [sic] to another bird or a cat?”

3.2.2.3. Non-bird animals

The frequency of associations of the sounds with birds did not significantly differ between PRP groups, $\chi^2(2) = .85, p > .05$, but low-PRP bird sounds were marginally more frequently associated with non-bird animals, $\chi^2(2) = 11.81, p = .07$. That is, birds that were lower in PRP were often associated with non-avian animals and animal behaviours. When listening to the sound of the Feral Pigeon, one participant expressed a lack of certainty about the origin of the sound: “Either pigeons or another unknown animal”, and another said, “reminds me of my cat’s purr”. The Long-Tailed Tit generated an “association with an insect” for one participant, and the Jay reminded another of “maybe monkeys in the zoo”. Low-PRP birds, such as the Australian

Raven, reminded several participants of negatively valenced non-avian behaviours such as predation or aggression, with one participant likening the sound to a “cat being strangled”.

3.2.2.4. Superstitions associated with birds

Associations with superstition occurred only amongst birds in moderate and low-PRP groups, with two in each group; therefore no frequency analyses were performed. However, where they occurred these associations tended to be culture-specific and negatively valenced. For example, the Carrion Crow, rated as low on PRP, was associated with negative symbolism in one participant’s home country: “It is the sound of crows and I don't associate black crows with anything good. There are a lot of superstitions in Romania related to crows.” On another occasion, a participant identified the sound of the Wood Pigeon as that of an owl, and associated it with the negative symbolism usually attached to that bird: “Where I come from it is said that an owl sings of death, so it was bad luck to hear it in your garden.” It is notable that the sample in this study generated negative symbolic or superstitious associations, whereas in folklore and literature birds and bird sounds have been associated with both positive and negative symbols (cf. Mynott, 2009).

3.2.2.5. Media associations

Associations with birds as portrayed in the media (e.g. television and film) occurred in response to bird sounds across PRP groups, but not significantly more frequently in any one group, $\chi^2(2) = .34, p > .05$. The Tawny Owl generated associations with the television series *Twin Peaks*: “The owls are not what they seem”, as well as “Horror films - dark houses” for another participant. For one participant, the Carrion Crow’s sound reminded them of “Sound of the birds on the playground equipment in movie “The Birds” by Alfred Hitchcock”. In this film crows are negatively valenced stimuli, and it may be that negative perceptions of these birds and their sounds are enhanced by fear-inducing or arousing presentations of such birds in the media. Similarly, the sound of the Silver Gull reminded another participant of “the bad guys in *The Dark Crystal*”. The

Laughing Kookaburra was associated with “Australian films”, suggesting that although such birds are not native to the United Kingdom, participants were still exposed to them via the media.

3.2.3. Time and season

3.2.3.1. Spring, summer, and daytime

High-PRP birds were significantly more frequently associated with the theme of time and season, $\chi^2 (2) = 41.78, p < .01$. In particular, they were more frequently associated with themes of morning and daytime, $\chi^2 (2) = 28.95, p < .01$, as well as spring, summer, and warm weather, $\chi^2 (2) = 44.22, p < .01$. These associations were accompanied by affective appraisals of positive valence and low arousal. For example, the Greenfinch reminded one participant of “a warm cup of coffee when you wake up in the morning and it's really early”; the Blackbird was associated with “peaceful calm days”; and the Wren was associated with “a pleasant spring morning”. Sunshine and warmth were described by several participants in this imagined scene, as well as rain by one participant: “Blackbirds feeding after rainfall”. Spring, summer, and mornings, as well as sunshine and rain, traditionally signify life and new beginnings, perhaps again drawing connections between certain bird sounds as signifiers of vitality. The Blackbird was also sometimes associated with evenings, and it is possible that restorative perceptions of this bird at this time may stem from its connection to the day's end and the beginning of rest.

3.2.3.2. Evening, night, and winter

Exact binomial tests of goodness of fit revealed that associations with evening and night-time, as well as autumn and winter seasons, were not significantly more common in high-PRP bird sounds versus moderate/low-PRP sounds, $ps > .05$. Sometimes these associations arose as a result of perceiving one bird sound as made by a different type of bird (for example, the Wood Pigeon was mistaken for “owls at night” by one participant). The Carrion Crow also generated associations of “winter coming” and of “Halloween, Dusk, Darkness” for participants. It is possible that these associations arose as a consequence of seeing and hearing these birds in winter environments, or

they may be part of a wider symbolic association between these kinds of birds and death or darkness (Mynott, 2009).

3.2.3.3. Childhood

A small number of associations with the period of childhood were also found across PRP groups. An exact binomial test of goodness of fit revealed that these were not significantly more common in response to high-PRP bird sounds versus moderate/low-PRP sounds, $p > .05$. These associations were not described in detail, but were in the context of childhood holidays or homes, or of growing up in a different country. “When I used to live in Tehran and I was young. Childhood memories” (Carrion Crow).

3.2.4. Activities

Bird sounds were linked to a range of different activities in the environments. These included active types of behaviour, such as walking or exercise, as well as more passive kinds such as resting and sitting, and being alone versus in company. High-PRP bird sounds were significantly more frequently associated with active behaviours, $\chi^2(2) = 16.52, p < .01$. Both high- and moderate-PRP bird sounds were also more frequently associated with passive behaviours than were low-PRP bird sounds, but this difference did not remain statistically significant after correction for multiple comparisons, $\chi^2(2) = 6.75, p > .05$.

3.2.4.1. Active

Across PRP groups but especially amongst high-PRP bird sounds, participants associated the sounds and the environments in which they could be heard with a range of active behaviours. The most common of these was walking. One participant associated the Blackbird’s sound with “Walking across hay fields in the summer evenings” and another participant associated the Masked Lapwing with “Hiking, camping, family adventures”. Other types of activities included bird watching and identification, biking, gardening, running, and travelling or going on holiday. For example, one participant associated the sound of the Herring Gull with “holidays in childhood”.

Again, this may relate to a sense of escape or being away commonly described in response to natural environments, and theorised to be a component of restorative experience (Kaplan & Kaplan, 1989; Kaplan, 1995).

3.2.4.2. Passive

Camping was also described in less arousing terms by one participant in response to the sound of the Collared Dove: “Camping out in the woods with the fire beginning to dwindle as we drift off into a slumber.” Indeed, both high and moderate PRP birds generated associations with positively valenced, unarousing or passive activities such as “Sitting in the garden at home” (Greenfinch) or “Lying in a field” (Superb Fairy-wren), as well as “Waking in the morning” (Eastern Spinebill), although notably waking up was sometimes associated with work rather than relaxation: “It reminds me of having to wake early for work” (Brown Thornbill).

Birds low in PRP also generated passive types of actions but these tended to be more negatively valenced and likely to induce fear-arousal, and were framed in terms of the participant being the object rather than the subject of the scenario. For example, the bird rated lowest on PRP, the Red Wattlebird, reminded one participant of “being lost in the woods” and another of being “surprised in the forest”, while the Laughing Kookaburra reminded another participant of “... stuff sneaking up behind you. Scary as shit”.

3.2.4.3. Being alone or in company

In total, 10 comments expressed a connection between listening to bird sounds and the presence or absence of other people in the imagined environment. An exact binomial test of goodness of fit revealed that associations with company were not significantly more common in response to high-PRP bird sounds versus moderate/low-PRP sounds, $p > .05$, but when company was mentioned it was often related to family. For example, one participant associated the Dunnock with “walking with my parents” and another associated the Silvereeye with “summer garden with my

grandma”. Some participants also associated bird sounds with animal company, such as walking their dog.

Being alone in nature was mentioned explicitly twice, and each time in relation to a high-PRP bird sound; for example, one participant was reminded of a “summer garden alone” by the Robin’s sound, and for another participant the Tawny Owl “reminds [me] of a dark forest and being alone”. This corresponds with findings that restoration in nature can be enhanced when participants imagine being alone, instead of in company (Staats & Hartig, 2004). Birds that were low in PRP were not generally described in terms of being either alone or in company, although associations with being lost or surprised in nature were discussed, which may be related to the concept of being alone or lonely.

4. Conclusions

4.1. Associations with bird sounds and relationships with PRP

Thematic content analysis of associations with bird sounds revealed four master themes: environment, animals, time and season, and activities in the environment. High-PRP bird sounds tended to generate associations with green, verdant environments and with concepts of home and one’s garden, while low- or moderate-PRP bird sounds were associated with exotic and marine environments or built spaces. High- and low-PRP sounds were also generally dissociated on the basis of their connections to different times and seasons, especially spring, summer, and daytime. Together, these findings suggest that perceptions of bird sounds as high or low on restorative potential could be linked to the affordances of the environment and environmental qualities that they are associated with. Bird sounds high in PRP may be considered to be so because they are thought to be found in environments where there are plentiful natural resources, connecting with psycho-evolutionary explanations of stress recovery (Ulrich, 1983), but also in environments that are familiar to people, such as gardens and family homes, and therefore are unlikely to be highly exotic or activating. It is notable that listening to a short sound clip of a bird produced associations

with and memories of much bigger environments for many participants, which may be linked to the attention restoration theory (ART; Kaplan, 1995, p. 174) concept of extent, or of “being connected ... to a larger world”. Similar findings were observed by Shaw et al. (2015) when visually impaired participants imagined environments in response to a range of natural sounds, but this study presents the novel finding that listening to individual bird sounds is sufficient to generate associations with wider restorative environments comprising flora, fauna, topography, and climate, as well as activities within those environments.

Our findings build on Cox and Gaston’s (2015) suggestion that non-preferred birds are more likely to be associated with aggressive or otherwise negative behaviour, albeit non-significantly in this study. They also support findings in Ratcliffe et al. (2013) that birds considered to be restorative or non-restorative can be dissociated on the basis of the valence of their associations, and that these associations are often rooted in the meaning of the sound: its ecological, personal, and cultural value. While associations with childhood were not significantly more frequent in any one PRP group in this study, the fact that bird sounds generated associations of the listener’s past is a novel finding. We argue that relationships between restorative environments and past experiences, including childhood, deserve further study. As noted earlier in this paper, bird sounds have variously been described as symbols of positively or negatively valenced concepts, particularly revolving around animal behaviour, time and season, and good versus bad omens (e.g. Mynott, 2009; Tidemann & Whiteside, 2010). This study emphasises the importance of semantic values of natural stimuli – both personal and generic – in understanding perceptions of their restorative potential. It also highlights that individuals can perceive restorative potential, and variations therein, in relation to animals as well as landscape or plant-based stimuli, and that these aspects of natural environments should not be neglected in the context of restoration study.

4.2. Limitations and extensions of the study

The present study was conducted online, and as such it was not possible to precisely control the presentation conditions of the sound clips due to differences in hardware between participants. We also acknowledge that recruitment of participants online and through local advertising limits generalisability of findings to the wider British population. Given the large number of short sound samples involved in the study, however, an online paradigm was judged to be the most efficient method of data collection whilst also minimising participant exhaustion. Steps were taken to achieve consistency in audio presentation between sound clips by requesting that participants use headphones or earphones to listen; by asking them to complete an audio calibration task at the start of the study; by excluding participants who rated the sounds as uncomfortably loud at the end of the study; and by subjecting stimuli to accuracy checks by bird experts prior to inclusion in the study. Participants were asked to complete the qualitative item per bird sound after rating each sound's PRP, in order to minimise spillover of associations into ratings of each sound's restorative potential, but in so doing we acknowledge that participants may have responded to the qualitative item with the PRP scenario in mind. Future randomisation or counterbalancing of the order of item completion would help to address this issue.

Participants in this study were self-reported residents of the United Kingdom, although some reported having visited or lived in Australia and in other countries. Although this led to the collection of informative qualitative data regarding associations with aspects of other countries and cultures, this study does not argue that the themes emerging from this qualitative analysis will automatically be applicable to samples from locations beyond the United Kingdom. Given that this study employed bird sounds from Australia, it would be interesting to explore similarities and differences in themes emerging from associations made by Australian residents in response to these and British bird sounds. Associations between certain birds and the media also highlights the fact that individuals can hear native and non-native bird sounds indirectly, regardless of where they currently live.

While this study focused on birds and their sounds, we acknowledge that birds are only one part of soundscapes drawn from wider environments. As shown in Table 1, the bird sounds were mostly rated around the mid-point of the PRP scale, rarely exceeding a mean score of 5 on a 1- to 7-point range. With this limitation in mind, we do not suggest that bird sounds alone may afford restorative outcomes; rather, we suggest that their role in restorative perceptions may be related to semantic evaluations of these sounds. In so doing this study uses bird sounds as an example in order to understand the values attributed to potentially restorative natural stimuli, including animals such as birds which remain understudied in the context of restorative environments. This study employed one representative type of bird sound per bird species. Clearly, birds make a variety of sounds in different contexts, and responses to these sounds may not generalise to other sounds made by the same species in other settings. However, this study provides insight into human responses to typical bird sounds in the United Kingdom and Australia, and emphasises the importance of meanings, memories, and associations in these responses which has, to date, been understudied in examination of restorative environments.

4.3. Implications

This study indicates that the PRP of specific bird sounds may be related not only to the intrinsic properties of the sounds themselves, but also to associations linked to the sounds – ranging from individual animals to imagined environments and memories of the past. This paints a holistic picture of participants' interpretations of sounds, based on both perceptual and semantic properties. As research on restorative environments continues to expand, we hope that further examination of the role of top-down, meaning-based qualities of environments and their stimuli will shed light on how, and for whom, certain places can aid restoration. This examination would be timely given recent calls for researchers to focus not only on bottom-up, perceptual processing restorative environments and stimuli (e.g. Pretty, 2004; Pretty et al., 2015) in order to understand more about what individuals themselves bring to their own restorative experiences. Such research may be

particularly valuable in conservation practice where evidence regarding the psychological benefits of nature, and the role of positive memories in relation to those benefits, may be a valuable tool in increasing engagement with the outdoor world. In this way, restorative environments research could generate further links with other areas of environmental psychology, including place attachment, place identity, and favourite places.

5. References

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ACCEPTED MANUSCRIPT

Appendix A**Audio calibration task: Text supplied to participants**

So that you hear the sounds at the intended volume, we would be grateful if you could calibrate your computer's volume level by following the instructions below. You will need a retractable ballpoint pen for this part of the task. If you don't have one to hand right now, please come back to this page another time.

- Please turn your computer volume down to the lowest level.
- Click the Play button below. This will start a 30-second sound clip of a ballpoint pen being clicked up and down.
- Click the ballpoint pen in front of you as though you were going to write with it.
- Gradually raise your computer's volume until the sound clip and your own ballpoint pen are as loud as each other. You can repeat this as many times as you like until you are happy.

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Table 1. Categorisation of 50 bird sounds into high, moderate, and low PRP birds, and mean PRP scores per bird species (rated from 1 to 7).

High PRP birds		Moderate PRP birds		Low PRP birds	
Species	Mean PRP score	Species	Mean PRP score	Species	Mean PRP score
Dunnock	5.26	Superb Fairy-wren	3.86	Eastern Whipbird	2.68
Greenfinch	5.23	Starling	3.81	Laughing Kookaburra	2.64
Blackbird	5.06	Eastern Spinebill	3.73	Long Tailed Tit	2.61
Silvereeye	5.03	Coal Tit	3.43	Chicken	2.43
Brown Thornbill	4.67	Crimson Rosella	3.41	Rainbow Lorikeet	2.42
Blue Tit	4.63	Feral Pigeon	3.34	Carrion Crow	2.32
Goldfinch	4.48	Collared Dove	3.32	Cockatoo	2.29
Robin	4.46	Magpie Lark	3.32	Parakeet	2.23
Wren	4.39	Grey Butcherbird	3.27	Noisy Miner	2.13
House Sparrow	4.36	White-browed Scrubwren	3.21	Magpie	2.07
Yellow-faced Honeyeater	4.31	Eastern Yellow Robin	3.19	Masked lapwing	2.03
White-throated Treecreeper	4.26	Grey Fantail	3.04	Herring Gull	1.77
Chaffinch	4.14	Wood Pigeon	3.04	Jay	1.67
Welcome Swallow	4.11	Australian Magpie	3.03	Australian Raven	1.65
Great Tit	3.90	Pied Currawong	3.00	Red Wattlebird	1.50
Tawny Owl	3.90	Willie Wagtail	2.84	Silver Gull	1.50
		GS Woodpecker	2.83		
		Red Kite	2.74		

Table 2. Frequency of codes per theme in high-, medium-, and low-PRP groups of bird sounds.

Theme	PRP group			Total
	High	Medium	Low	
Natural environment	92	52	70	214
Countryside	54	25	21	100
Gardens	24	14	12	50
Exotic	11	15	12	38
Marine	5	6	21	32
Built environment	19	36	10	65
Urban	2	6	3	11
Home and indoors	14	13	3	30
Artificial sounds	15	8	5	28
Birds	51	54	57	162
Non-birds	3	5	15	23
Positive behaviour	10	5	7	22
Negative behaviour	8	10	10	28
Superstition	0	2	2	4
Media	5	4	5	14
Time and season	49	28	30	107
Morning, daytime	28	18	13	59
Evening, night-time	8	1	7	16
Spring, summer, sun	20	14	13	47
Autumn, winter, dark	4	1	1	6
Childhood	7	4	6	17
Active activities	29	19	22	70
Passive activities	12	11	25	48
Alone	2	0	0	2
Company	3	3	2	8

Highlights

- Associations with bird sounds were thematically analysed
- Restorative bird sounds had positive, nature-based associations
- Non-restorative bird sounds had negative, exotic, and non-avian associations
- Findings show relationships between semantic values and restorative perceptions