

The effect of spectral centroid on perceived birdsong in urban forests

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ABSTRACT

Probe into the relationship between spectral centroid and perception of birdsong in urban forests. Spectral centroid (SC) and Spectral centroid bandwidth (SBW) were considered as potential factors affecting perceived birdsong. In this study, we made the subjective evaluation of birdsong in three urban forested area. In the meantime, we collected recordings at each observation site. Finally, through polynomial fitting, the relationship between the SC, SBW, and the pleasantness of perceived birdsong were found. Results show that both of SC and SBW are potential factors and the latter is more important. The trends of SC and SBW with perceived birdsong is opposite.

Keywords: Perceived birdsong, Soundscape, Urban forests

1. INTRODUCTION

Urban forests are important habitats for birds and other animals to live, multiply and commute (1, 2). Birds are well known and special communities in urban areas, distributed widely in urban forests (2, 3, 4). And the birds tend to produce birdsong for declaring the possession of territory and attracting mates, which could be more sensitive to the acoustic environment in urban forests (5, 6). Moreover, birdsong could enhance perceived visual landscape and reduce noise pollution for citizens (7, 8, 9). The birdsong is the most desired soundscape in biophilic city and benefits public health based on its pleasantness (10, 11, 12). Potential factors, such as spectral centroid, impacting on perception of birdsong are still being explored. Thus, this study aims to examine the potential effect of spectral centroid on perceived birdsong in urban forests.

2. METHOD

2.1 Study areas

The observation sites of this study are Jericho Beach Park, Stanley Park and Pacific Spirit Park. These are important forested areas and all located in Vancouver, Canada. Jericho Beach Park (JB) offers plenty of recreation opportunities located on the south side of English Bay, featuring areas of lawns and beaches for recreation and dog walking. Stanley Park (SP) is a world renowned urban park located on a peninsula at the northwestern side of downtown Vancouver, with several beaches and well-maintained paved and dirt trails. Pacific Spirit Regional Park (PP), located in the University Endowment Lands area, has an endless number of trails with enormous logs and large woody debris from decades of logging. Overall, there are a high level of forest cover and a strong attraction for various bird species in all the parks.

2.2 Procedure

A 5-point ordinal category scale was adopted to reply alternatives (13, 14, 15): For the pleasantness values, including “not pleasantness at all (+1)”, “slightly pleasantness (+2)”, “moderately pleasantness (+3)”, “very pleasantness (+4)”, and “extremely pleasantness (+5)”. In addition, while the participants assessed the perceived soundscape, the recordings of environment

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were also recorded on a sound recorder.

The Experiments for gathering perceived soundscape information and recordings were conducted on sunny days except on holidays between 10:00 and 15:00 in February and March 2019. Previous studies have shown that more than 7 trained participants are required to achieve sufficient and accurate results (11, 16, 17, 18). Thus, 13 trained participants were selected at each park in this study, aged 20-35 years old, with normal hearing to response to the questionnaires.

3. RESULT

3.1 Spectral centroid analysis

Spectral centroid (SC) and Spectral centroid bandwidth (SBW) describes the brightness and centralized region of the sound through frequency contents (19, 20). The SC and SBW were obtained from the recordings by Matlab R2018a.

Figure 1 and Figure 2 illustrates the SC and SBW situations in the urban forests. The variance of SC in JP, SP, and PP ranged from 429.8 Hz to 800.8 Hz, 296.7 Hz to 1172.2 Hz, and 432.9 Hz to 1067.9 Hz, respectively. The fluctuation of SBW in these parks ranged between 3256.4 Hz and 7744.2 Hz, 2163.6 Hz and 7237.5 Hz, 2223.7 Hz to 5931.7 Hz. Although the three parks show different frequency conditions for the SC, medians for SC are all greater than 500 Hz, indicating that the observation sites are more affected by high-frequency sound from birdsong. Also, medians for SBW in these parks are all greater than 3.5k Hz, indicating that there are various birdsongs in different frequencies.

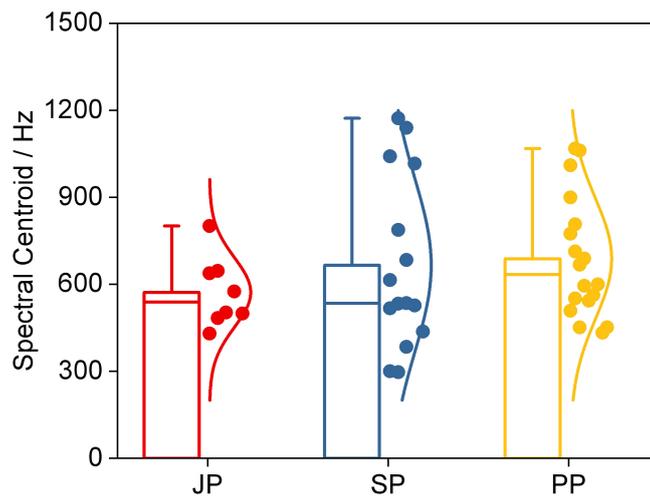


Figure 1 – Spectral centroid in JP, SP and PP

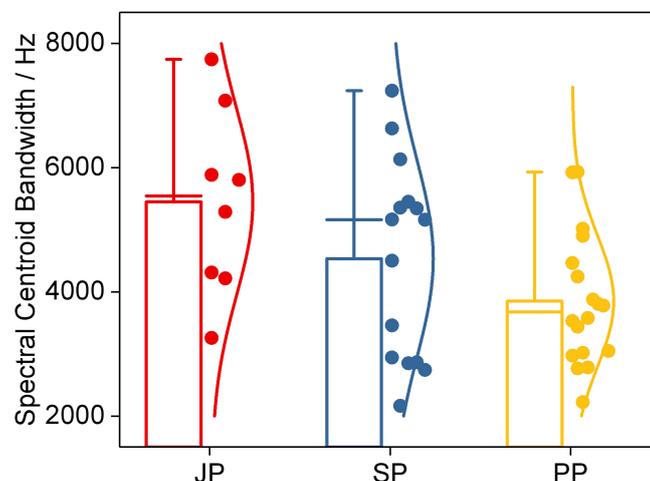


Figure 2 – Spectral centroid bandwidth in JP, SP and PP

3.2 The relationship between spectral centroid and pleasantness of perceived birdsong

Through polynomial fitting, the relationship between the SC, SBW, and the pleasantness of perceived birdsong were plotted in Figure 3 and 4. There were opposite tendencies between SC with decreasing trend and SBW with increasing trend. But there were some uncertain relations when the SC and SBW were lower than 689 Hz and higher than 5015.9 Hz, respectively. Furthermore, the results suggest higher SC may lead to lower human's perception of birdsong owing to increased annoyance and masking affecting pleasantness of perceived birdsong.

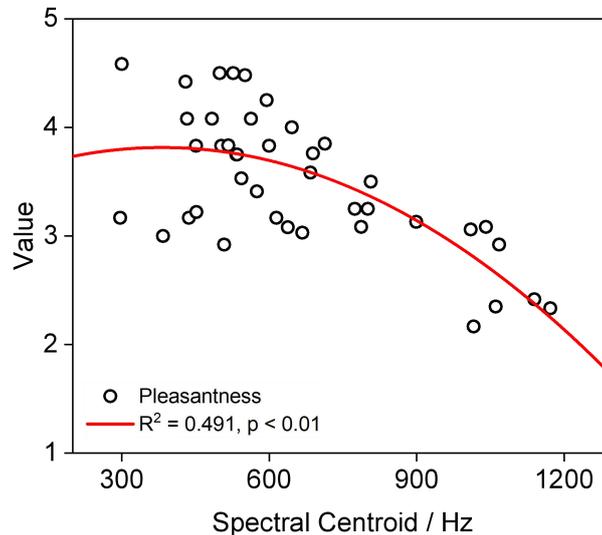


Figure 3 – Polynomial fitting of SC and perceived birdsong

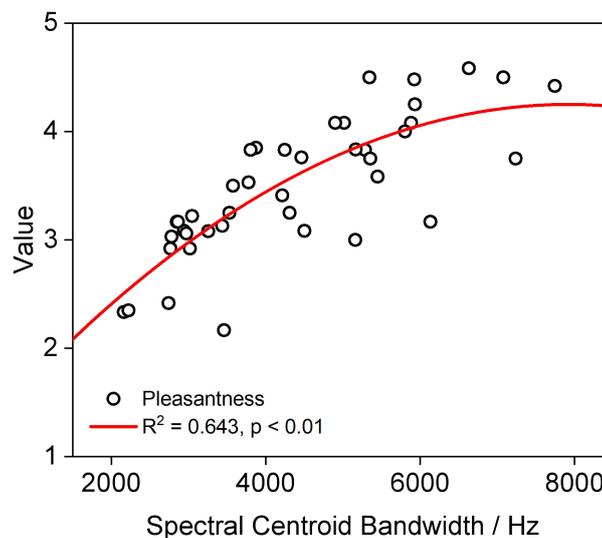


Figure 4 – Polynomial fitting of SBW and perceived birdsong

4. CONCLUSIONS

Birds are dominant creatures that produce abundant sounds in urban forests. Through tests in this study, we found different frequency conditions for the SC and SBW in JP, SP and PP. Moreover, based on polynomial fitting between SC, SBW and perceived birdsong, we observed that both of SC and SBW are potential factors and the latter is more important. The trends of SC and SBW with perceived birdsong is opposite. Thus, the spectral centroid information may be considered in further research, which will be beneficial to the perceived birdsong modelling.

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