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Determining the influence of Age & Gender on Soundscape Perception

A QUANTITATIVE DATA ANALYSIS

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Summary

Issues of noise exposure have become a relevant topic in modern day society. There is established research available regarding the topic of noise, yet there is little known about the psychological and physiological factors that influence how an individual's well-being is affected by noise exposure. Soundscape studies have proven to be a capable method for exploring these aspects. Further research in understanding what role psychological and physiological factors play a in the perception of sounds can contribute to the current empirical foundation on soundscape perception, aiding in finding universally applicable theories. Therefore, this research aims at finding to what extend demographical characteristics of people have an influence on soundscape perception. One limitation of research in this field is that empirical findings can be limited to the context in which the research was conducted. Therefore, a large dataset was provided comprising of effectively 1108 cases from multiple cities and countries. All research conducted was done in line with the protocols defined by the ISO 12913 series, which standardized the research in the field of soundscape studies. Clustering analysis was done in order to categorize all cases based on their most dominant sound sources. Non-Parametric correlation tests, either Pearson rank order or Kendall's Tau-b, were used to determine the existence of a correlation between the soundscape perception and demographic characteristics. Soundscape perception, the dependent variable, was calculated as the perceived Pleasantness and Eventfulness, while age and gender were the demographical characteristics used as independent variables. This process was repeated on all the defined clusters, as well as on the dataset as a whole. The results indicate a correlation between the demographic attributes and soundscape perception in certain clusters and when the dataset was being analyzed in it's entirety. Considering these results are obtained from a dataset that contains multiple contexts, they will aid in the pursuit towards new empirical theories on the phycological and physiological influences related to soundscape perception.

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1. Introduction

Noise exposure has become an important issue in modern society (Cassina et al., 2017). As stated by the World Health Organization (2011), exposure to high levels of noise might increase risk of heart attacks caused by depression or hypertension. Noise, especially environmental noise, has been studied in the past. These studies became more focused on the perception of soundscapes, which can be defined as the "*acoustic environment as perceived by people in context*" (International Organization for Standardization, 2014). Soundscape analysis is seen as a capable method to identify tranquil areas, which can contribute to beneficial health effects such as: redressing sensory overload, improved well-being and recovery from illness (Pheasant et al., 2010). A better understanding of the human perception of sound has a aided in the pursuit of modifying existing environmental characteristics in such a manner, that these health benefits are provided (Aletta et al., 2018; Aletta & Kang, 2019; Jian Kang et al., 2016).

While the findings of established research, and the observed positive health effects, are observed (Aletta & Kang, 2019; Erfanian et al., 2019; Jian Kang et al., 2019; Y et al., 2017), soundscape studies seem to have the limitation that the findings are not universally applicable (Cassina et al., 2017; Hong & Jeon, 2015), meaning that findings obtained in a certain context might differ within another. Moreover, the context in which soundscapes are perceived might vary vastly due to a complex interplay factors, such as: the visual quality of the location, it's function or the socio-cultural characteristics of the perceiver (Brambilla et al., 2013; G. Brown et al., 2014; J. Kang & Zhang, 2010; Jian Kang & Schulte-Fortkamp, 2011; Preis et al., 2015; Yong Jeon et al., 2011a, 2011b). In order to overcome this limitation, it is beneficial to conduct research on urban soundscape perception in multiple locations and collect a catalogue of participant data that is diverse in terms of geographical, social and demographical characteristics.

The University College London has been collecting data on soundscape perception through a multitude of studies part of the overarching Sound Scape Indices Project, to be further called the SSID project. Conducted by the Institute for Environmental Design and Engineering, the project aims at providing new insights that could contribute to the characterization, design and management of urban soundscapes. The project has certain objectives by establishing a large comprehensive dataset, namely to characterize soundscapes, determine key factors that influence soundscape quality, establish metrics to assess soundscapes and demonstrate the applicability of these metrics by developing frameworks for soundscape prediction, design and standardization (Mitchell et al., 2020). The SSID project has been implementing the ISO 12913 series on soundscapes into the contributing studies. This standardized protocol will be implemented into this study for the collection of data and the analysis.

1.1 Research Problem

To contribute to these objectives this research project aims at determining the existence of a general correlation between the perception of soundscapes and demographic characteristics, focusing on the data that states a participant's age and gender. Previous research has already established the existence of a correlation between these variables (J. Kang & Zhang, 2010; Liu et al., 2013, 2018, 2019), which is still limited to the context these studies. By using a more comprehensive dataset, which consists of results from various origins, a more general statement can be made regarding the existence of a correlation between soundscape perception and demographic characteristics.

This dissertation is divided in the following section: In chapter 2. Theoretical Framework all the relevant concepts and their relationships will be explained. This chapter will mainly dive into how the construct of soundscape perception was adapted for this research. Chapter 3. Methodology will discuss the two parts of the data collection process. In the first section the approach to fieldwork will be discussed, as data collection has been conducted to contribute to the dataset that will be provided by the UCL for further analysis. The second section of this chapter will discuss the characteristics of the provided dataset and the overall approach to the quantitative data analysis. Chapter 4. Results will go over the findings of the qualitative analysis, followed by Chapter 5. Discussions. This chapter will discuss and interpret the results of the data analysis. Finally, the dissertation will end with chapter 6. Conclusion, which provided a conclusion that is drawn from the information provided by this dissertation.

2. Theoretical Framework

This chapter will discuss the relevant concepts that were utilized for the development of this research. An overview of definitions, concepts and their relationships will be provided. These are relevant for the research design, ensuring that all relevant factors regarding soundscape perception are measured and analyzed.

Figure 1 portrays the interrelated factors that make up the process of soundscape perception, as they have been adapted from ISO 12913 Part 1. (International Organization for Standardization, 2014). A soundscape finds its origin in sound sources, this is in essence every entity that has the ability to produce sound. These emitted sounds from sources are then distributed through time and space. The emitted sound is then affected by the physical conditions of the environment resulting in the acoustic environment (International Organization for Standardization, 1996a, 1996b; Jian Kang, 2007). It is the acoustic environment that will be sensed and interpreted by a human being, which will result in a response. A response is the short-term emotional and behavioral response to the perceived acoustic environment, it is this outcome that will be measured and analyzed during the research. Responses have an influence on, and are influenced by, context. The International Organization for Standardization (2014) defines context as *"the interrelationship between person, activity and place in space and time"*. This implies that physical and psychological have an impact on how an individual's sound perception. Physically, context can influence auditory sensation by, for example, a combination of weather conditions, hearing impairment or the usage of hearing aids. Psychologically, context can influence the interpretation of the auditory sensations. An individual will form an attitude towards a sound source by converting the sensations into meaningful information, this is done on a conscious and unconscious level. The information is produced on a basis of demographic characteristics, like cultural background or reason to visit a certain place. During the research the context will be limited to age and gender.

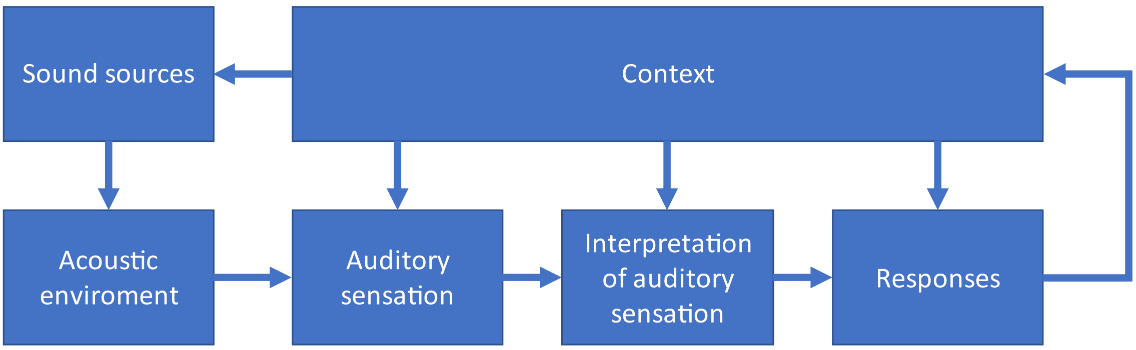


Figure 1 Conceptual model of soundscape perception.
Note: Adapted from Acoustics — Soundscape — Part 1: Definition and conceptual framework, p. 2, by the International Organization for Standardization 2014, Copyright 2014 by the ISO.

Based on the information above, it is expected that the soundscape perception will differ between demographics. As their context's will differ based on different overall past experiences, physical differences (gender of age wise) and intentions as to why being at a place. What essentially comes down to factors that determine and individual's preference.

3. Methodology

This section will explain the methodologies used for both the field work and the secondary data analysis. In order to contribute to the data collection for the SSID project, the same methodologies must be implemented in this research (Mitchell et al., 2020). When the data collection is complete, a dataset, also containing previous results, will be provided for secondary analysis. This chapter will further explain how ISO 12913 Part 2 and 3 were implemented for the collection and analysis of the data (International Organization for Standardization, 2018, 2019).

3.1 Data Collection

During the fieldwork soundwalks are done in combination with questionnaires. While there are many approaches towards the collection of soundscape data, the protocol here was designed for the collection of large datasets. These would be suitable for design and modeling purposes, which is addressing the limitations of smaller scale data collection as seen in most soundscape studies (Engel et al., 2018; Zhang et al., 2018). These studies are only able to identify the soundscapes of existing locations, meaning that one can never truly know the effect of a location design on soundscape perception. A model that would predict the outcome of soundscape perception would be a very valuable tool for location design, for this reason.

As of now the UCL has been maintaining a large dataset containing data on nearly 4000 participants, 59 locations in 10 cities over multiple countries, being: the UK, China, Spain and Italy. All these intermediate projects followed the same protocol implemented by the SSID project (Mitchell et al., 2020).

This dissertation will contribute to the collection of data as a collaboration between the RUG and the UCL. The data collection process will take place in the Noorderplantsoen between the 11th and 13th of March.

The protocol was designed for gathering data in situ, by a combination of questionnaires and the collection of audio-visual data that allows for the reproduction of the acoustic environment for, for example, laboratory studies. The audio-visual data is collected through a multitude of sources, this being: acoustic sound level measurements, environmental sound recordings, binaural recordings and 360° video recordings.

This allows the collection of data on soundscape perception on larger scale for quantitative analysis, which can for example be used for the training of machine learning, as well as being able to control environmental conditions for laboratory experiments that want to answer questions that cannot be addressed during in situ soundscape assessment. This mainly deals with verifying the amount of influence visuals have on sound perception (during a questionnaire). Therefore, it is important that both audio and visual recordings are done in sync with the questionnaires.

For the on-site procedure the protocol defines two stages: recording and questionnaire. The first being the stage where audio-visual recording are being made for lab experiments. In other words, prior to the questionnaire 15 minutes of audio-visual data are captured using:

- 360° video at a minimum of 4k resolution
- Spatial audio using a First order Ambisonic microphone
- Objective data using a Class 1 Sound Level Meter (calibrated using a calibrator at 94dB)

Note that this data will not be used for this thesis, as only the questionnaires are relevant for the quantitative analysis done in this paper, but it is part of the on-site process, nonetheless.

During the questionnaire stage binaural sound is captured and questionnaires are being held. Each questionnaire takes roughly 10 minutes and binaural recordings are done in sync with each set of questionnaires for 30 seconds. This is done by wearing a binaural recording system worn by someone standing by the participants. A combination of binaural recordings and the questionnaire results in a redundancy of data, which allows for verification of the perceptual responses with corresponding sound data. The questionnaire itself will be provided by the UCL and is a slightly altered version of the questionnaire prescribed by ISO 12913 Part 2. There will be both an English and Dutch version, as well as digital and on paper.

The protocol also defines in which manner data should be labeled. Since a lot of data is collected through various sources, it is important to properly label them in order to identify and bundle them. The guidelines ensure that all audio-visual data is coupled with the right questionnaire responses and that it is done in an efficient and consistent manner.

The labeling has been divided into multiple layers of factors that influence the perception. From top to bottom there are three layers, this being: location, session and individual (Aumond et al., 2017). Location level data contains the information regarding the location that does not change on day-to-day basis, this for example being the **Location**. Session level data makes as distinction between each measuring session on the same location, this is labeled with the **SessionID**. This contains the location name followed by a number that increases with each new session. All data collected is coupled with the accompanied sessionID in order to make a distinction between days, since the following labels will have a continuous index value. In order to bundle multiple participants together, a **GroupID** will be added under the sessionID. This makes it possible to couple one binaural recording, which is done simultaneously when a participant fills in the questionnaire, with multiple participants. It also ensures that missing data from questionnaires can be interpreted from others that are in the same group, like date-time or location data. The group ID is formatted using two letters from the **locationID**, followed by SessionID and finally the index number of the group. On the individual layer one would have the index number of the questionnaire. See table 1 for a schematic overview.

Level of Information	**Example Label**				**Factors Measured at This Level**
Location	NoorderPlantsoen				GPS Location
SessionID	NoorderPlantsoen1		NoorderPlantsoen2		Session Notes, audio-Visual Data Capture
GroupID	NP101	NP102 … etc	NP201	… etc	Binaural Recordings
Questionnaire	1, 2, 3	4, 5 … etc	25, 26	… etc	Questions, Date-Time

Table 1: Data labelling
Note: Adapted from The Soundscape Indices (SSID) Protocol: A Method for Urban Soundscape Surveys—Questionnaires with Acoustical and Contextual Information (p. 5), by Mitchell A., Oberman T., Aletta F., Erfanian M., Kachlicka M., Lionello M., Kang J. 2020, Applied Sciences, 10, p. 2397. Copyright 2020 by MDPI AG.

The questionnaire is split in multiple sections and as already mentioned, is based on the questionnaire provided by ISO 12913 Part 2.

After filling in a consent form the questionnaire begins with four questions, asking the participant to identify sound sources. These Sound Source Identifiers (A. L. Brown et al., 2011; Guastavino, 2007) are categorized as: traffic noise, other noise, sounds from human beings and natural sounds. These are labeled as **SSI01** to **SSI04**.

The next section will ask the participant to fill in eight scales, which can later be used to calculate the soundscape perception on a two dimensional model (Axelsson et al., 2010). The Perceived Affective Quality scales are measured on scale from Strongly Disagree (1) to Strongly Agree (5). The scales that are included are: Pleasant, Chaotic, Vibrant, Uneventful, Calm, Annoying, Eventful and Monotonous. These are labeled as **PAQ01** to **PAQ08**. This quantifies the responses as seen on figure 1.

Next are five questions regarding the participant's impression of the acoustic environment. It asks about the acoustic quality, if the sounds are fitting for the environment, the perceived loudness, how frequent one visits the location and if they would like to visit again. These are labelled as **SSS01** to **SSS05**.

The following section regards question about the WHO-5 well-being index, asking about how participants have been feeling over the past two weeks. It is aimed at gathering data about a participants psychological well-being (Hall et al., 2011; Topp et al., 2015). These questions are labeled as **WHO01** to **WHO05**.

The final, and most important, section of the questionnaire comprises of questions regarding demographic information. This includes age, gender, occupational status, educational level, ethnicity and whether a participant was a local or tourist. These are labeled as **AGE00**, **GEN00**, **OCC00**, **EDU00**, **ETH00** and **MISC03**. There is also a final prompt where participants can provide additional comments on the sound environment if they so desire. Note that the question regarding educational level was adapted to fit the Dutch educational system.

Participants on-site are picked at random. They are asked if they are willing to participate in a research study. It is explicitly stated that one is either a student or researcher. The general topic and purpose of the questionnaire is explained followed by formally asking for consent. Groups can participate under one binaural recording but have to fill out a separate form. Questions regarding the questionnaire should be answered as neutral as possible in order to not influence a participant's decision making.

3.2 Data Analysis

In order to determine the existence of a correlation, the following values will be used from the dataset: the SSID values, the PAQ values, age and gender. All cases that have incomplete data regarding these values will be filtered out of the analysis. The data will be checked for normality in advance using Kolmogorov-Smirnov/Shapiro-Wilk tests.

The soundscape perception data will be analyzed by adapting the guidelines of ISO 12913 Part 3. The soundscape perception of the participants will be determined by calculating the pleasantness and eventfulness (Axelsson et al., 2010). The ISO describes two formulas that simplify the eight perceptual dimensions of the PAQ values to a two dimensional plot (International Organization for Standardization, 2019). This implies that pleasantness will be presented as an x value and eventfulness as a y value. The formulas are presented below:

$$P = (p - a) + cos45° \cdot (ca - ch) + cos45° \cdot (v - m)$$

$$E = (e - u) + cos45° \cdot (ch - ca) + cos45° \cdot (v - m)$$

These radial formulas allow for the calculation of the two-dimensional plot. The cos and sin functions cap the range of the coordinates at ±9.66. The letters represent the values of the perceived affective quality as filled in by the participants, this being: annoying (a), calm (ca), chaotic (ch), eventful (e), monotonous (m), pleasant (p) uneventful (u) and vibrant (v). See also figure 2 for a visual representation of the spectrum of possible outcomes on the perception of soundscapes.

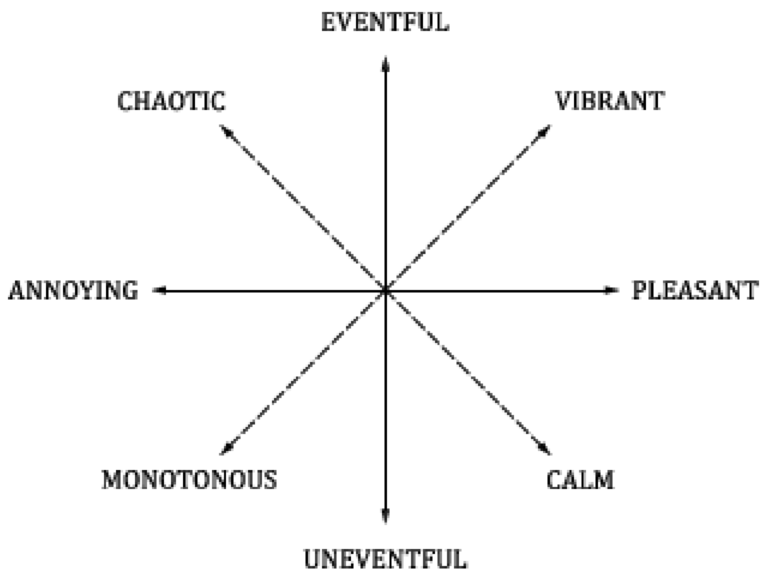


Figure 2 A visual representation of the calculated soundscape perception spectrum.
Note: Reprinted from Acoustics — Soundscape — Part 3: Data analysis, p. 6, by the International Organization for Standardization 2029, Publisher. Copyright 2019 by the ISO.

K-Mean clustering will be used for clustering analysis. Using the using the sound source identifiers filled in by the participants, cases will be grouped together with similar acoustic environments. This being based on the categories of traffic, natural, human and other sounds. The purpose of this study is to analyze the psychological factors that influence the soundscape perception, thus by grouping similar sound sources together the physical factors play less of a role when interpreting the results.

Lastly, for determining an existing correlation between the dependent and independent variables, either Kendall's Tau-b or Spearman's rank order will be used. This depends on the distribution of the dependent variables. The variables being: age (continuous/ordinal), gender (dichotomous), the calculated pleasantness (continuous) and the calculated eventfulness (continuous). All analysis has been performed through the usage of IBM SPSS Statistics version 26.0.

4. Results

This chapter will present the final dataset that was provided after the fieldwork was completed. The overall characteristics of the participants will be discussed, followed by the quantitative data analysis, which consist of cluster analysis, testing for normality and determining a correlation between soundscape perception and the demographic characteristics of age and gender.

4.1 General characteristics

After the filtering of incomplete results, 1108 participants remained for the analysis. The average age of the participant is 34,75, with a ratio of 496 males, 597 females, 4 non-conforming and 11 who did not specify their gender. Table 2 below describes the participants characteristics, the high diversity in age and the fairly even ratio of men and women are beneficial for the analysis.

While the analysis only focusses on age and gender, other demographic characteristics were collected as well. The dataset mainly contains participants that where either employed (633) and/or studying (359) at the time of filling in the questionnaire, note that the sum of all occupational statuses exceeds the number of participants, since multiple responses were allowed. Most participants had some form of a degree. In terms of the ethnical diversity of the dataset, most participants identified as "white" (787), while "Asian / Asian British" is the second largest group (153).

Characteristics		**Frequency (N)**	**Valid Percentage (%)**
Age	Youth (≤24)	362	32,7
	Adult (25–59)	627	56,6
	Elderly (≥60)	119	10,7
Gender	Male	496	44,8
	Female	597	53,9
	Non-conforming	4	0,4
	Rather not say	11	1
Education	Some high school	22	2
	High school graduate	167	15,2
	Some college	147	13,4
	Trade/Technical/Vocational training	49	4,5
	University graduate	397	36,2
	Some postgraduate work	55	5
	Postgraduate degree	260	23,7
	Missing (System)	11	
Occupation	Employed	633	57,1
	Unemployed	33	3
	Retired	77	6,9
	Student	359	32,4
	Other	40	3,6
	Rather not say	17	1,5

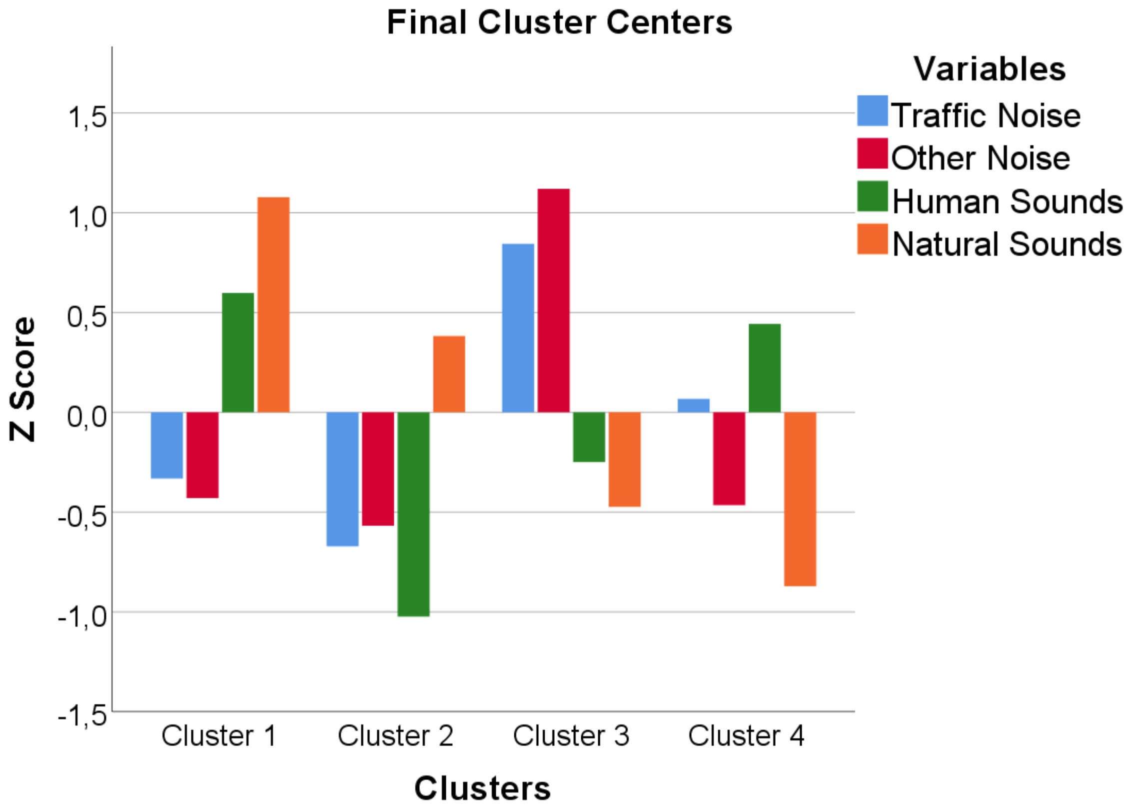
Ethnicity	White	787	71
	Mixed / multiple ethnic groups	60	5,4
	Asian / Asian British	153	13,8
	Black / African / Caribbean / Black British	30	2,7
	Middle Eastern	19	1,7
	Rather not say	29	2,6
	Other ethnic group	21	1,9
	Missing (System)	9	
Total		1108	100

Table 2 Demographic characteristics of the participants

4.2 Determining the sound source compositions

Graph 1 shows the outcome of the cluster analysis. To achieve the results all soundscape identifiers where calculated to their respective z-score counter parts and where used as input. Even though all variables use the same scales, using z-scores allowed for a better visual interpretation of the results. In advance a number of four clusters was defined, this is done in accordance of the four types of sound sources as presented in the questionnaire. Clustering participant responses based on their interpreted perception of sound sources has been proven an effective method in the past (Aletta & Kang, 2019; Rychtáriková & Vermeir, 2013; Yong Jeon et al., 2011c, 2013). K-Mean clustering works by computing the average value for each of the input variables, which in this case are the four types of sound sources. Then, over the course of ten iterations the closest mean values to all cases are determined. The closest mean value to a case represents the cluster it belongs to.

Since the input variables where calculated to z-score, negative values are seen. While the questionnaire did not allow for negative input values, the distance between answers remains the same. The middle line of the graph represents the average perception of the sound sources within a cluster. Positive values represent an overabundance of a particular sound source, while negative one represents the absence. In this manner it can be seen that cluster 1 contains a lot of natural sounds and sounds from human beings, likely due to many questionnaires done in urban parks. It will be identified as the Human- Natural-dominant cluster. Cluster 2 shows solely natural sounds, which can be due to some locations lacking a large amount of people. This cluster will be defined as the Natural-dominant cluster. Cluster 3 shows a combination of traffic and mechanical noise and will be defined as the Traffic-dominant cluster. The final cluster can be interpreted as a mix of sources; thus, it is defined as the Mixed source cluster. It should be noted that all 1108 cases have been evenly distributed over the clusters and that the difference between all clusters is deemed significant with all p-values being equal to 0.



Graph 1 Final cluster centers based on the identified sound sources

4.3 Testing for normality

After the cluster analysis, normality checks where done in order to determine which correlation test would be the most suitable, being either Pearson rank order (normally distributed) or Kendall's Tau-b (not normally distributed). Normality checks where done per cluster, per dependent variable (gender and groups) as well as on the dataset as a whole. This process was done for the independent variables separately (pleasantness and eventfulness), so in total 50 normality checks were done. The outcome was deemed normally distributed if all cases of the dependent variables had a p-value > 5, thus accepting the null hypothesis of a normally distributed population. As an example, looking at table 3: in cluster 3 pleasantness and eventfulness where both normally distributed, meaning that a Pearson rank order could be run. On the other hand, when looking at table 4: In the case of cluster 4 eventfulness was deemed not normally distributed, as adults had a p-value < 0.05.

	Pleasantness		Eventfulness	
	Male	Female	Male	Female
Cluster				
1	0	0	0,053	0
2	0,018	0	0,354	0,237
3	0,294	0,957	0,221	0,08
4	0,058	0,411	0,174	0,076
All	0	0	0,036	0,015

Table 3 Results Shapiro-Wilk Tests on gender

	Pleasant ness			Eventful ness		
	Youth (≤24)	Adult (25–59)	Elderly (≥60)	Youth (≤24)	Adult (25–59)	Elderly (≥60)
Cluster						
1	0,001	0	0,002	0,908	0,84	0,916
2	0,002	0	0,023	0,219	0,705	0,316
3	0,846	0,331	0,499	0,517	0,136	0,912
4	0,639	0,72	0,513	0,403	0,015	0,169
All	0,001	0	0	0,121	0,29	0,075

Table 4 Results Shapiro-Wilk Tests on age categories

4.4 Determining the correlation between soundscape perception and demographics

Finally, the correlation tests have been conducted, table 5 and 6 show the outcome of the analysis. Note that for the data that was found to be normally distributed, the Pearson rank order was used instead of Kendall's Tau-b. Statistically significant correlations were found in certain cases. In the case of gender positive correlations were found in three situations. In cluster 1 eventfulness shows a positive correlation towards women with $\tau b = 0.14$ and $p = 0.005$. In cluster 2 a positive correlation was found towards women on pleasantness with $\tau b = 0.137$ and $p = 0.012$. When all cases were tested together a positive correlation was found towards women regarding pleasantness, with $\tau b = 0.051$ and $p = 0.041$. All other cases where deemed insignificant.

In the case of age having a correlation with soundscape perception: two positive and one negative correlation of statistical significance were found. In cluster 2 a positive correlation was found for pleasantness, $r_s = 0.116$ and $p = 0.025$. This implies that overall sound was deemed more pleasant as one got older. The same principle holds true for the tests done on all cases together. When all cases where tested, a negative correlation was found for eventfulness, $r_s = -0.068$ and $p = 0.024$. This implies that surroundings where interpreted as less eventful as one got older. On the other hand, as age increases, the surroundings were perceived to be more pleasant, with $\tau b = 0.097$ and $p = 0$.

	Pleasantness		Eventfulness	
	Correlation Coefficient	Sig.	Correlation Coefficient	Sig.
Cluster				
1	0,026	0,605	0,14	0,005
2	0,137	0,012	0,078*	0,234
3	0,025*	0,644	-0,048*	0,365
4	-0,05*	0,936	0,107*	0,107
All	0,051	0,041	0,036	0,153
	*Pearson Coefficient			

Table 5 Correlations between gender and Soundscape Perception

	Pleasantness		Eventfulness	
	Correlation Coefficient	Sig.	Correlation Coefficient	Sig.
Cluster				
1	0,089*	0,066	-0,037*	0,543
2	0,116*	0,025	-0,055*	0,402
3	-0,36*	0,499	--0,39*	0,461
4	0,108*	0,1	-0,002	0,966
All	0,097	0	-0,068*	0,024
	*Pearson Coefficient			

Table 6 Correlations between age and Soundscape Perception

5. Discussion

Based on the results of the analysis: age and gender play a role in the perception of soundscapes. Similar results where established in previous research.

In the case of gender it was found in previous research that women react emotionally stronger towards certain sounds than men, this could explain the fact that women tend to perceive human and natural sounds more pleasant (Croome, 1977; Mehrabian & Russell, 1974; Yang & Kang, 2005). It could also explain why women perceived the human sound cluster as more eventful as they process these sounds differently, for example being more receptive to the sound of crying babies. An additional explanation could be that that women tend to be less tolerant towards low-frequency noise compared to men, considering human made sounds as low-frequency sounds when compared to natural sounds like birds and wind (Verzini et al., 1999). It has been shown in previous studies that women and men process spatial audio in different manners (Simon-Dack et al., 2009).

In the case of age influencing soundscape perception: it has been established in past research that there is a difference between age groups in terms of soundscape perception (Yang & Kang, 2005). It was found that there was a difference in the perception of sound between age groups for urban and natural areas. This could explain the overall result where pleasantness increases with age. It also explains the increase in pleasantness found in the cluster with natural and human dominant sound sources (Tse et al., 2012). Additionally, Yang & Kang (2005) stated that as age went up, the preference for natural and cultural-related sounds increased. The analysis also shows that when age increases, the pleasantness does so as well. At the same time, the eventfulness decreased. This is also seen in the study of (Çakir Aydin & Yilmaz, 2016) where a similar division in age categories was used. This study showed that younger participants noted a lower pleasantness in relation to the other age categories. They claimed that with an increase in age the more pleasant the sound environment is perceived. Regarding the results that show a decrease in eventfulness when age increases: this is addressed by Yang & Kang (2005) who described a phenomenon where people lose interests in unnatural sound sources and build and tolerate natural ones more as age increases. It was stated that the neural processing of sounds changes as age increases. Furthermore, as age increases the context wherein a soundscape is perceived changes (Yang & Kang, 2005). This has to do with life experience, which has an influence on what emotional responses are associated with certain sounds.

Overall, the correlations that where found significant do not seem to be strong. It has been shown that demographic characteristics other than age and gender do to play a greater role in affecting the perception of soundscapes (Yu & Kang, 2008).

6. Conclusion

This study aimed at finding a correlation between soundscape perception and demographic characteristics. A combination of fieldworks and secondary data analysis was conducted in order to achieve this goal.

Using the large dataset provided by the UCL, a multitude of correlation tests was conducted. First all questionnaires were clustered in order to group responses from similar sound environments together. This showed that female respondents had a stronger sense of eventfulness when being in a sound environment that was dominated by natural and human sounds. This also showed that natural sounds where perceived as more pleasant as age increased.

When analysis was run over the entire dataset female respondents had an overall stronger sense of pleasantness. This was also observed with age, as age increased there was an overall increase in perceived pleasantness. Lastly, the analysis showed an overall decrease in perceived eventfulness as age increased.

These insights will further pave the way towards universally applicable theories on the perception of soundscapes. In particular, this dissertation contributes to the understanding of social and demographic characteristics that have an influence on soundscape perception. This is beneficial for soundscape planning and design, as proven theories allow for the possibility to predict the effectiveness of soundscape designs on the physical and psychological well-being.

Considering the fact that solely age and gender were included in this research as demographic attributes, further research is suggested to determine the effects of other demographic characteristics on soundscape perception.

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