# THE CLASSIFICATION, SEMANTICS, AND PERCEPTION OF URBAN PARK SOUNDS: METHODOLOGICAL ISSUES

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## 1 INTRODUCTION

A number of classification systems for environmental sounds have been developed by researchers. These have varied across studies, but often include 'human', 'nature' and 'mechanical' categories[1,2]. Only a few studies have considered the public's own classification of environmental sounds[3,4], yet this is important considering experts and laypeople's classifications and evaluations can differ[5]. If research is to be carried out on laypeople's perception and evaluation of sounds encountered in their daily lives, then the results also need to be framed within the language and sound classification used by laypeople. This means the results can't be evaluated using pre-defined research classification systems as the terminology used will differ to the layperson's descriptions[6]. A few studies have classified soundscapes by using participants' subjective evaluations of the soundscapes via semantic scales[7]. However, it is not clear if the presented adjectives in the scales have any relevance to how the participant would freely evaluate the soundscape and if the scales mean the same thing to each person[8,9]. People's classifications of sounds will also vary across the context they are heard in, not just because there will be different sounds, but the sounds will also mean different things to the individual and evoke different emotions which may influence how the sounds are classified. This paper therefore seeks to identify how people think about and classify sounds within one particular place, an urban park. The effectiveness of the multiple card sort methodology in researching these issues will be explored alongside affective evaluations carried out by semantic differential scales. The resulting classification system is then assessed *in situ* and it's capabilities of being a tool for park users to describe their perceived soundscapes is discussed.

## 2 SOUNDS PERCEIVED IN URBAN GREEN SPACES

Before urban park sounds can be classified, the sounds people perceive need to be ascertained. Fieldwork was carried out, between August and October of 2005, in a variety of 15 urban green spaces in Sheffield, UK (population is roughly half a million). 312 participants (aged 16 to over 70 years; 54% female) who were resting in or passing through the green spaces were asked to name "*three sounds you hear when you are in this park*". After a few blank stares, 867 responses were generated of which 205 were non-repetitive, linguistically different descriptions of sounds heard in urban green spaces. These descriptions are referred to as 'sounds' as they are how the participants described the sounds.

The named sounds varied from 'trees' to 'souped up cars' to 'building ventilation' highlighting the range of sounds perceived and how they are described. The list of 205 sounds went through a series of processes to be reduced down to a manageable number of sounds that could be used in the following classification study, without creating participant fatigue. This included removing slang words, site-specific sounds, affective descriptions and most adjectives as they could alter other participants' classifications. Basic similar phrases were treated as the same sound (e.g. 'talking' and 'chatting'). Six people then reduced the list down to a smaller representative list of urban park sounds by grouping sounds together that they thought were similar. After discussions, inter-rater agreement was 69% and a list of 31 sounds was finalized upon (Table 1). The resulting list was of sound sources and ambient sounds, which is similar to Dubois[3]

**Table 1**. Sounds identified in urban green spaces and used to assess people's classification of urban park sounds.

| | | | | |
|---|---|---|---|---|
| People Playing Games | Birds | People Talking | Aircraft | Buses |
| Construction Work | Crying | Skateboards | Dogs | Leaves |
| Children Playing | Twigs | Machinery | Squirrels | Insects |
| Background Traffic | Cars | Laughing | Swearing | Silence |
| Gate Closing | Water | Bicycles | Shouting | Wind |
| Lawn Mower | Music | Motorbikes | Ducks | Sirens |
| Church Bells | | | | |

# 3 CLASSIFICATION AND ITS RELATED SEMANTICS

To assess how people think about and classify sounds, multiple card sorts (MCS) were carried out. It involves presenting participants with a number of stimuli together which enables them to think about the interaction of certain stimuli in one go, rather than concentrating on one stimulus at a time. The way people sort the cards is considered to represent how they conceptualise the different stimuli or concepts[10]. The associational and semantic links between each of the stimuli or groups of stimuli is more apparent from MCS data, in contrast to methods comparing pairs of stimuli at a time, or rating stimuli separately with Likert based scales.

Multi-Dimensional Scaling (MDS) is a collection of statistical analyses that assesses the relationship between two stimuli, whilst also taking into account their relationship with other presented stimuli. MDS is used to analyse MCSs and can also be used to analyse a number of semantic differential scale results. MDS makes a comparison between the individual ratings for each sound (*a* and *b*), while still accounting for the sounds relationship with all the other sounds, such as *a*'s relationship with *c*, *d* and *e*, as well as *b*'s own relationship with *c*, *d* and *e*. This provides a more accurate assessment of how different stimuli may interact with each other and how they are related, making it ideal for studying semantic associations and classifications.

## 3.1 A Multiple Card Sort and Semantic Differential Scale Study

Between September and November 2006, a convenience sample of 38 participants, aged 18 to at least 78 years old, carried out the MCS in reference to a park they were familiar with. The participants were people approached in a number of public places (cafes, shops, pubs) in the day time, to try and get a sample that didn't consist of students and academics. People were not approached in urban parks themselves to prevent their classification process being influenced by the sounds they happened to hear at that point in time.

The MCS involved presenting participants with a card that each had one of the 31 urban park sounds written upon it. Participants were asked to imagine being in the urban park they had identified and think about how they would feel, their moods and activities that are likely to occur there and particularly the sounds they would hear. They were then asked to sort the cards into groups so that similar sounds were placed together. They could make as many groups as they wanted, with each sound only belonging to one group. The instructions were adapted from Scott and Canter[10]. Any comments the participant made were noted to help analyse the reasons for the sorts. Once they had completed the MCS, participants were asked to give each group a label; it was presumed this would be a cognitive label to represent that sound category. They were also asked to assign the group a word that best represents their overall impression of hearing that sound in an urban park; this provided an affective label associated with that sound category.

The resulting card sort groups were analysed with MDSORT[11], which combines the results from each participant (co-occurrence matrix) and produces a plot of the sounds location within a three-dimensional (3D) space. The more often a sound was grouped together with another sound by the participants, the closer the sounds would be located on the 3D plot. Therefore the distances between the sounds on the plot also represent conceptual differences. To help interpret the 3D plots, the category labels created for each of the participants' groups of sounds were content analysed. This involved collating similar category labels together; the use of a thesaurus helped confirm similarities in meaning. Each participant's original category labels and each category's sounds were then recoded by the new defined system; the most common labels used to categorise each of the 31 sounds could then be assessed. The frequently used labels represented 'cognitive' phrases that were linked to each sound and are referred to as category labels in this paper. The same procedure was conducted with the overall impression responses, which are referred to as affective labels.

Participants also rated each of the 31 urban park sounds on two seven point affective semantic differential scales; unpleasant to pleasant and stressful to relaxing. These adjectives were chosen as they have previously been used to affectively rate the environment[12] as well as soundscapes[8,13]. The results were analysed individually for each sound (averages) and collectively (MDS using MDPREF[11]) to produce similar 3D plots as those produced by the card sorts. The resultant plots for the affective semantic differential scale ratings and the MCS were compared on a scale of 0 to 1 (1 = identical) using PINDIS. All MDS statistical analyses were carried out with NewMDSX software[11].

## 3.2 Multiple Card Sort and Semantic Differential Scale Results

Participants identified 12 parks on the West of Sheffield, located between 0.2 to 3 miles from the city centre ring road. Some sounds were excluded by half the participants as they did 'Not Relate/ Associate' the sounds with their park; others (less familiar and frequent visitors) sorted sounds into categories when they can not actually be heard in the park. The sounds that were most commonly placed together in a category during the MCS are shown in clusters in Figure 1. The conceptual relationships between the urban park sounds can be assessed by the distances between and within the clusters. The results of the semantic differential affective scales are shown in Figure 2. The bigger the distance on the plot between the sounds, the less often they were rated similarly.

### 3.2.1 Semantic Labels Associated with Individual and Groups of Sounds

In the multiple card sorts, participants created between two and nine categories to sort the sounds, with the mean being five. In total, participants generated 105 differently termed category labels that were reduced down to 20 different category labels using content analysis, some of which included all ranges of a concept e.g. Volume equals Silence to Loud. Each individual sound itself was defined by between 10 to 15 different category labels across the participants, with the mean being 12 labels, showing the variety in language used. The affective labels produced more variation than the category labels; 112 different labels in total, which were collated to form 33 affective labels. Each individual sound itself was defined by between 14 and 20 different affective labels; the mean was 17. Sounds that were excluded during the card sorts were not given an affective label. The resulting category labels were expected to provide more concrete cognitive labels, but often participants used affective terms to describe their categories, making the semantics of the two types of labels very similar, see Table 2. In particular the verb 'expect' was used the most (15 people) in both the category and affective labels.

The most common category and affective labels for each sound were identified and these labels were used to define the clusters of sounds identified as similar by the participants (Figure 1). Inspection of the plot shows clear divisions between different types of sounds and how they are described with category and affective labels producing similar divisions. The right hand side of Figure 1 contains the sounds that are 'Expected', while the left hand side has sounds that are 'Not Related to the park' (bar Background Traffic). The sounds on the right are 'Peaceful', 'Pleasant', and 'Enjoyable', while on the left the sounds produce 'Negative Emotions' and are 'Annoying'. There is also a division between 'Natural' sounds on the right, 'People' in the middle and more transportation/mechanical sounds on the left. These divisions show that hearing the 'Expected Natural' sounds is a positive thing, while more mechanical sounds are not related to urban parks and are therefore negatively rated. 'People's' vocal sounds are sub-differentiated by their affective evaluations – positive or negative. Silence is also slightly separated from the 'Natural' sounds as for some people it was 'Not Expected' and even 'creepy'.

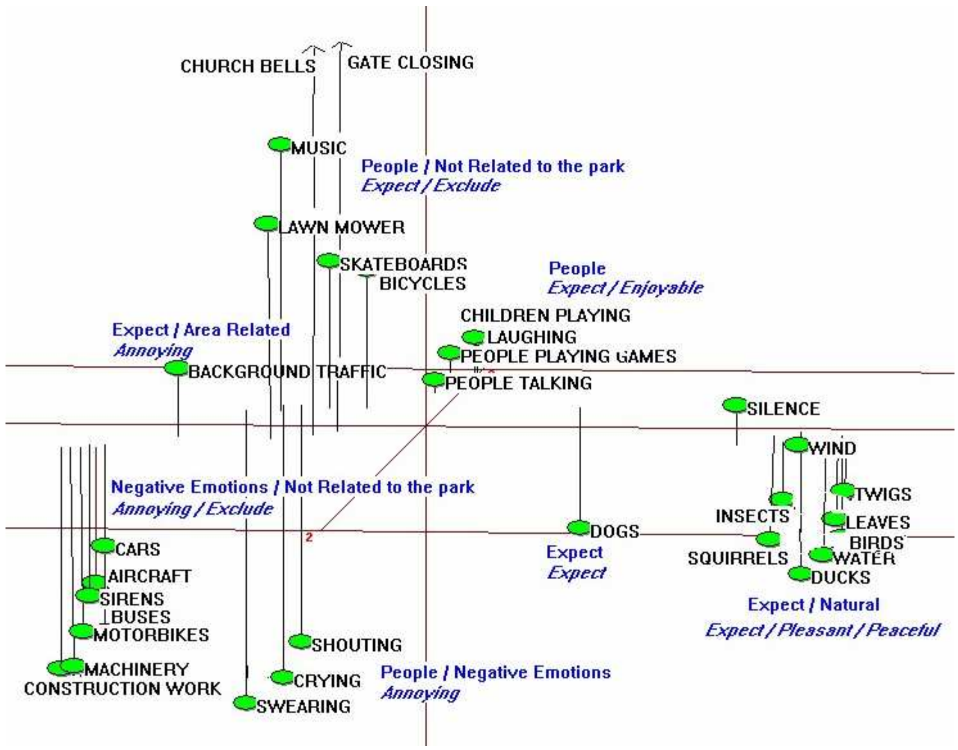


**Figure 1**. 3D plot of participants' classification of urban park sounds; results of a multiple card sort. **Category labels** are in bold blue. ***Affective Overall Impression labels*** are in bold blue italics.

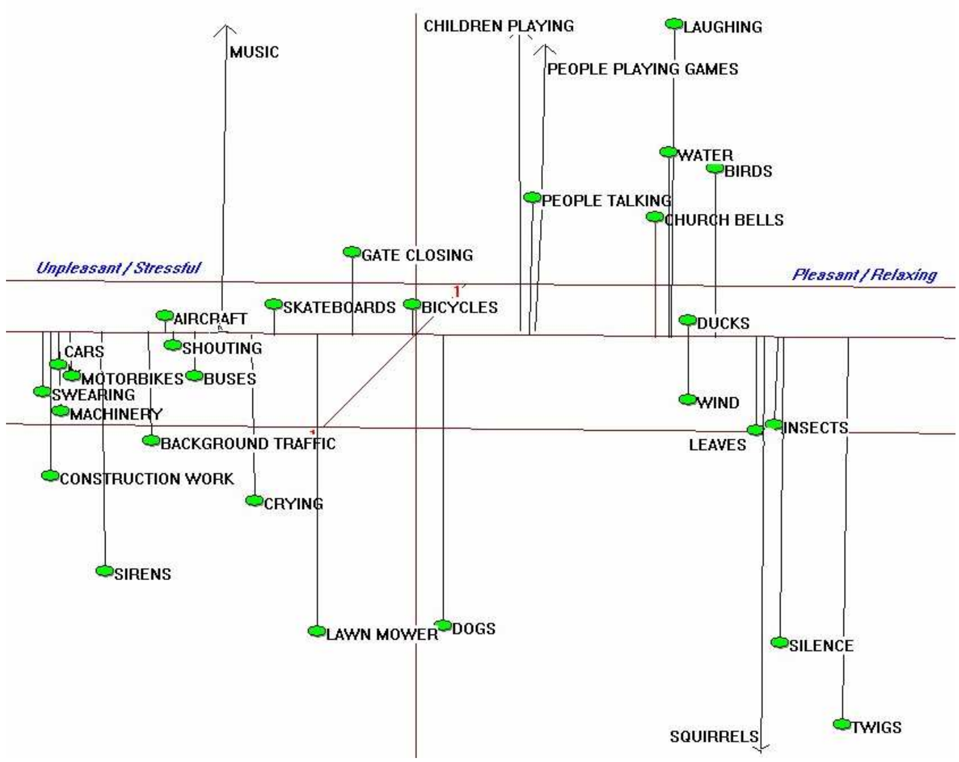


**Figure 2**. 3D plot of participants' affective semantic differential scale ratings of urban park sounds. **Affective dimensions** that sounds were rated on are in bold blue.

**Table 2.** The number of participants who used the top 5 mentioned Category and Affective labels.

| Category Label | Number of Participants |
|---|---|
| Not Related/ Associated to the park | 16 |
| Expect → Don't Expect | 15 |
| People | 15 |
| Negative Emotions | 13 |
| Natural | 11 |
| Volume (Silence → Loud) | 10 |

| Affective Label | Number of Participants |
|---|---|
| Not Related to the park/ Excluded | 15 |
| Expect → Don't Expect | 15 |
| Annoying | 11 |
| Like → Don't Like | 8 |
| Enjoyable | 8 |
| Peaceful → Not Peaceful | 7 |

### 3.2.2 Affective Semantic Differential Scale Results and Classifications

Many (21%) of the results for the semantic differential affective scales produced a skewed distribution, suggesting peoples' affective evaluation of sounds is generally similar. Each sound received the same average rating on the un/pleasant scale and the stressful/ relaxing scale, bar four sounds (which only differed by one Likert point). The 'Natural' sounds were rated more pleasant and relaxing; Water and Birds had an average rating of 7, (the maximum). Ducks, Leaves, Silence, Wind and Laughing were also pleasant and relaxing (rated 6 or 7). The most stressful and unpleasant sounds were Construction Work, Machinery, Sirens and Swearing. The transport orientated sounds were also rated poorly, with an average rating of 2 or 1.

Multidimensional plots of the affective ratings for both semantic differential scales were created, but due to their high similarities [P(0), S(Z,X)=.85], the results were combined to form one affective plot [convergence test in generating the centroid configuration =.96], see Figure 2. The Pleasant/ Relaxing and Unpleasant/ Stressful scale is noted along the horizontal axis. Natural sounds and sounds of people enjoying themselves are at the Pleasant/Relaxing side of the plot, while more mechanical and other people vocal sounds are on the opposite side. This pattern of clustering is similar to that described above for the MCS results. Visual inspection of Figure 1 and 2 indeed shows similarities between the plots. This is confirmed with their moderate statistical match, P(0), S(Z,X)=.42 (calculated with PINDIS[11]), which is potentially only moderate due to the affective semantic scale results not varying much in one dimension, due to the bipolarity of the scales. Cluster groups are not so clearly defined in the affective differential semantic scale results; for example Crying, Swearing and Shouting aren't situated close together like they are in the MCS.

## 3.3 Multiple Card Sort and Semantic Differential Scale Discussion

This study was able to identify the terminology that urban park visitors use to classify sounds that are perceived within urban green spaces. Compared with labels used by researchers[1,2], both similarities (the use of Natural and People categories), and differences (no Mechanical category), were noted. Affect was an important factor in the classification and labelling of the sounds. Consistent with prior research[13], natural sounds were rated positively. The implications of these results are discussed in turn along with comments on the methodological approaches involved.

Urban park users, like researchers differentiate between sounds that are described as Natural and those that are People orientated. In contrast to these commonalities, the researcher derived label, Mechanical, was hardly ever used by urban park visitors, instead affective terms were used to describe such sounds. A Mechanical label may help describe sounds consisting of certain pitches or generated from certain objects, but laypeople associate the sounds with the everyday world continuing around them and these sounds are generally perceived as a negative intrusion into the park. Background Traffic is an exception though as it is rated more positively and gives some people the reassuring sense of things still continuing 'out there' in the world, suggesting caution should be taken with the general assumption that transport sounds are disliked. This confirms the need to not only study the physical attributes of the sound, but also the meaning associated with the sound source that the everyday listener uses to understand, classify and assess their soundscape.

The MCS method used within this study identified the nuances and finer classification levels that can be overlooked by the broader categories often used by researchers. Urban park users split People sounds into three subcategories, dependent on expectancy and affect (Expect/Not Related, Expect and Enjoy, Annoying). The equivalent category to Mechanical sounds was also split into three different subcategories (Expected, People related, and Annoying sounds). The classification system often used by researchers may well represent a higher classification level to the sublevels used by laypeople. Therefore depending on the evaluation and level of detail that is being researched, the terminology used to study the sounds is important. This is emphasised by the description of the sounds generally being object words or categories which reactivate the same neural pathways in the brain as if perceptual stimulation had occurred[14]. The correct terminology is therefore necessary to ensure it relates to the individual so that the relevant meanings and associations are also activated and considered.

Affect was suggested as an important factor in people's classification of urban park sounds in the multiple card sorts, with affective terms being used to label individuals' card sorts when more cognitive descriptive labels had been predicted. These results were supported by the similarity in the location of sounds in the MCS plot and the affective semantic differential scale plot. To some extent the semantic differential scale results added little extra information to that discovered via the MCSs. In fact the MCS was able to show more affective nuances, such as the separation of Background Traffic and Silence, which can not be identified within the results of the semantic differential scales. These nuances also emphasise the importance of making the study relevant to the participant, by focusing on a known place. Peoples lived experiences and interactions with a place are important in shaping how they think about sounds and their environment. The context therefore provides the sounds with a particular meaning which in turn may influence their affective evaluation and how the sounds are classified.

Together the results suggest multiple card sorts have distinct advantages over semantic differential scales. Firstly small nuances can be identified within the MCS that aren't shown in the semantic differential scale results, due to the limitation of scales only varying across a 5 or 7 point range. Secondly MCSs allow other affective or non-affective terms to be used, while still potentially providing the positive to negative distinction derived from semantic differential scale results. Thirdly, issues of true bipolarity of the scale terms have been questioned[8]. Fourthly assessing affective evaluations using semantic differential scales may create the same problems as using researcher defined classifications if the scale terms are pre-defined by the researcher. This limits the participant to answering in a certain way, assessing only a few affective terms (e.g. 4 in this instance) instead of any number of terms that may be generated by the participants (e.g. 33). The process of completing a number of scales can also become monotonous for the participant. In contrast MCSs give the participant more freedom to define and assess items using their own terminology and in a way that is more meaningful to them, as well as being a lot more enjoyable.

This MCS study however did rely on participant's memory of urban park sounds within a familiar place, rather than being *in situ*. This could explain the high use of 'Expected' sounds as a schematised impression of what would be heard in urban parks was being recalled. Participants were not *in situ* due to logistical reasons of getting a substantial number of the public to one place to carry out the sort at the same time, as well as the space (and lack of wind!) needed to carry out a MCS. Having people *in situ* also causes the same problems which could have arisen if audio clips were used instead of written descriptions as stimuli. This would make the classification dependant on the exact sound that was heard and these may generate different results than if other examples of the sound had been heard. For instance with birds, the sound of the dawn chorus would probably be interpreted very differently to a cackle of pigeons; thus choosing the most representative audio clip to be used in a study becomes an issue. Using written descriptions of sounds as stimuli also aids the participant in considering all the sounds and their relationship with one another in one go, in contrast to listening to audio clips one at a time and trying to remember each of them, to be able to assess how they relate to each other. Therefore although the procedure used to carry out the MCS has known downfalls, it is still considered to be more appropriate than semantic differential scales for producing and examining laypeople's classification of urban park sounds.

# 4 THE CLASSIFICATION SYSTEM PUT INTO PRACTICE

In all, seven clusters of sounds could be identified from the MCS study. Using these clusters and their associated labels, types of urban park sounds were identified for the subsequent study. Unfortunately because many of the category labels were ‘Expect’ or involved affective terms, and not descriptive terms, the types of sounds couldn’t be directly defined from the MCS labels. Instead other terms had to be derived on the basis of the sound clusters, sticking to the results and terminology as close as possible. The seven sound types were defined as ‘Natural sounds’, ‘Happy People Sounds’, ‘Sad/Angry People sounds’, ‘Object sounds due to People in the Park’, ‘Sounds from the Surrounding Buildings’, ‘Individual Vehicle or Aircraft sounds’ and ‘Background City/Traffic’.

## 4.1 An *In Situ* Study

The seven listed sound types were presented as part of a questionnaire carried out *in situ* in two urban parks within Sheffield. Four hundred park users, who were just leaving, were asked a series of questions about the park, including their perceived urban park soundscape. Specifically they were asked to name some sounds they’d heard while they were in the park. They were then presented with a description of the seven sound types with examples, alongside lines with a percentage scale ranging from 0 (Didn’t hear) through to 50 (Half) through to 100 (All the time). Participants were asked to make a mark on the line which represented how much of the time they’d heard each of the sound types while they’d been in the park. Then for each heard sound type, they rated the volume at which they had generally heard it, on a 7 point semantic differential scale from quiet to loud. A predominance value was calculated for each sound type, by multiplying the amount it was heard (percentage) by its perceived volume (1 to 7). A highly predominant sound type therefore represents sounds that were heard a lot and at loud levels; values range from 0 to 700.

## 4.2 Results and Discussion

The list of sounds that the participants freely stated was similar to the results of section 2, with a total of 1123 sounds being stated. These sounds were then coded by the same seven sound types, along with a few more relevant categories for the data (Dogs, Peacefulness, Absence of a particular sound, and Others). Two individuals coded the sounds into these eleven categories with inter-rater reliability being moderate ($\kappa$=.64). Most disagreements were over People sounds, in particular the interpretation of ‘people talking’ as Happy instead of a neutral expression. ‘Screaming children’ was also hard to categorise, as depending on the situation this may be the result of different emotions, such as anger, fear, or happiness (e.g. children playing/running around), yet according to the results of the preceding multiple card sort study, screaming should be coded as a negative People sound.

The same coding problems arose *in situ* with participants deciding which categories their perceived sounds fitted into; comments were made such as “I guess the people talking were happy”. Such problems were also highlighted by the ‘contradictions’ between participants freely stated sounds and the percentage of time the seven sound types were heard. For example some participants freely stated hearing ‘screaming children’ but marked 0% for the Sad/Angry People category. These contradictions were supported via comparing the mean predominance levels of each sound type, for those whose first freely stated sound (presumed to be a predominant sound), was categorised as a Sad/Angry People sound; they had a higher predominance level for Happy People sounds ($\bar{x}$=326) than any other sound type, including Sad/Angry ($\bar{x}$=95). These results again suggest that screaming is not necessarily a negative sound and depending on the situation, may indeed be a happy sound.

Together these studies show there are still difficulties in taking laypeople’s classification of sounds (the first MCS study) and presenting them to other people (the *in situ* study, participants and coders) to categorise sounds. The importance of the context and the exact situation and interpretation of events by the perceiver has a big effect on how the sounds will be classified. To try and avoid similar problems again when using these sound types the People labels of Happy and Sad/Angry sounds could be altered to Enjoyable and Annoying sounds respectively. Although this involves affective labels, which were trying to be avoided, it makes the classification system more relevant to the current context and the individual who will be coding the sounds. Therefore the new affectively termed categories allow variations in how the sounds and context are perceived, thus hopefully removing the coding and classification issues that occurred in the latter study.

# 5 OVERALL CONCLUSION

The importance of studying how the general public describe, label and categorise urban park sounds was shown by the nuances and subcategory labels they used in contrast to the broad categories often utilised by researchers. Multiple card sorts were found to be a more useful, flexible methodology for studying semantics and classifications than semantic differential scales. Seven types of sounds were identified by one group of participants which was then presented to a second set of participants in urban parks. Some problems arose with the interpretation of categories by the latter participants and other coders. These issues emphasise the importance of the language used and being presented to participants when describing and seeking evaluations of soundscapes.

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