

A perceptual model of smellscape pleasantness

Jieling Xiao^{a,*}, Malcolm Tait^b, Jian Kang^c

^aSchool of Architecture and Design, Birmingham City University, 5 Cardigan Street, Birmingham B4 7BD, United Kingdom

^bDepartment of Urban Planning and Studies, University of Sheffield, Western Bank, Sheffield, S10 2TN, United Kingdom

^cSchool of Architecture, The University of Sheffield, Western Bank, Sheffield, S10 2TN, United Kingdom

Abstract:

Smellscape has increasingly attracted attentions across disciplines. However, little research provides a model to help understand the perceptual qualities of smellscape. This paper, taking pleasantness as a perceptual quality dimension, aimed to explore indicators influencing people's pleasantness of smellscape in a selected case. People's natural speaking language was used as resources to understand their perceptions. Grounded Theory was used as a methodological approach in this study in a selected case. Nineteen participants were recruited for smell walking with semi-structured interviews. Overall, nine indicators emerged from participants' descriptions which contribute to their smellscape pleasantness: cleanliness, preference, appropriateness, naturalness, freshness, familiarity, calmness, intensity and purity. Meanwhile, four types of pleasantness were found according to dominant indicators: preference dominated, healthiness dominated, memories and habituation dominated and context dominated. A perceptual model has been developed based on the indicators which can be used to classify smellscape through their dominant perceptual features and evaluate smellscape qualities based on pleasantness.

Keywords:

Urban, pleasantness, indicators, perceptions, Grounded Theory

1. Introduction

1.1. Smells in everyday cities

A shift has been seen in urban theories and policies calling for attentions to people's emotions and experiences influenced by different sensory cues such as sounds, smells and colours. Felt qualities through such sensory experiences project relationships between people and places, reflecting how they live and respond to surrounding environment, which should be understood and explored in current urban policies to create quality places (Davidson & Milligan, 2004; Anderson & Smith, 2001). There is a growth of literature on perceptions of places through smells in the last decade. Smells are inevitable in people's everyday experiences in cities, variously sourced from human activities to building materials and landscape, forming an invisible world around us (Zardini, 2005). The daily associations with smells, such as smells of fresh bread from bakery on the way to bus station in the morning and smells of brewery and cigarette from pubs on the way back home after work, enrich our experiences and make us know better of the places we live. As Tolaas (2010: 153) suggested that 'the study of urban smells provides an additional

Xiao, J., Tait, M., & Kang, J. (2018). A perceptual model of smellscape pleasantness. *Cities*. In press.

dimension to our understanding of cities, enriches our sensual experience and provides input for urban design and architecture to communicate and understand the invisible city’.

In contemporary urban planning and design, as Rodaway (1994) argued, we often underestimated the significance of smells in people's everyday experiences of the social and emotional dimensions of cities. In Western cities, there is a trend of de-odourising public spaces as part of maintaining a social order, reflecting modernist conception of contemporary urban planning. This is inseparable from the situation of industrial pollution in Western cities in history, where smells were mostly associated with poverty, illness and death (Degen, 2014). However, the deprivation of smells makes places placeless and detached from our past. The role of smells in Eastern and Arabic societies are more important for interpersonal relationships and appreciated in many ways (Rodaway, 1994). For example, in China, there has been a history of burning fragrance to scent the indoor space and use aromatherapies. Scents in Arabic culture are embedded in interpersonal relationships. Rodaway (1994:79) stated that Arabic people enjoy and allow one's body odour to greet another as a way showing a close relationship. Compared to Eastern and Arabic societies, the western society has neglected perceptual values of smells for pleasure and identities in everyday cities (Lefebvre, 1991).

Memories of smells link the present and past, interpreting changes of the environment over time or life traditions of the people who live in the place (Reinartz, 2014; Tuan, 1977). As Pallasmaa (2012: 54) described:

‘The most persistent memory of any space is often its smell...a particular smell makes us unknowingly re-enter a space completely forgotten by the retinal memory; the nostrils awaken a forgotten image... The nose makes the eye remember...the scent sphere of a candy store makes one think of the innocence and curiosity of childhood...’

The association of smells in a place with one's past experiences offer an intimacy between people and the place (Rodaway, 1994), which creates place attachments by giving personal meanings through perceived smells (Najafi & Shariff, 2011). People's memories of smells are actually found more durable than visual images (Engen & Ross, 1973). The odour memories can also stimulate ‘odour imagery’ (Herz & Engen, 1996) and evoke emotional responses (Herz, 1998; Schiffman, 1990), which enhance the overall experience in places.

Smells vary geographically, responding to the residence, nature and climate, showing distinct features of places (Porteous, 1985/2006; Duarte, 2017). Smells also reflect social and cultural characteristics of communities and places (Classen, Howes, & Synnott, 1994; el Khoury, 2006). For example, the strong cooking smells in Manchester China Town perceived by its visitors are considered as distinct features of Chinese communities and their food culture, which also give a new and unique identity to the place (Henshaw, 2013: 98). The authentic characteristics of places revealed by smells can contribute to the formation of place identities and demonstrate socio-geographic differences. As (Tuan, 1977:11) argued, ‘odours lend character to objects and places, making them distinctive, easier to identify and remember’. Urban designers and planners should therefore understand and consider smells as resources and design elements for place-making (Henshaw, 2013).

1.2. Smellscape: The concept

Smellscape was first introduced by Porteous (1985/2006) in parallel with the Shafer's (1977) soundscape concept. In soundscape, a recent definition has been given as ‘the acoustic

Xiao, J., Tait, M., & Kang, J. (2018). A perceptual model of smellscape pleasantness. *Cities*. In press.

environment perceived, and/ or understood by a person (through acoustic sensation) in a place (influenced by its context)' (ISO, 2014: 1). Porteous, (1985/2006) describes the fragmented and space-time bounded human experience of places through smells, where the power of memory in perceiving smells was emphasised. Porteous (1985/2006: 91) said: 'the concept of smellscape suggests that, like visual impressions, smells may be spatially ordered or place-related', which should be 'non-continuous, fragmentary in space and episodic in time and limited by the height of our noses from the ground, where smells tend to linger.' Rather than odour, smell was used for the purpose of projecting a neutral attitude. Smellscape in this preliminary study was used in various scales from continents, countries and regions to neighbourhoods and houses.

In the later study by Rodaway (1994: 62), the term olfactory geography was used in preference to describe the link between smells, smell sources, spaces and people in the space. The term olfactory compared to smell is used to emphasise the action to smell and the physiological and neurological mechanism of the sense. In the discussion, olfactory geography seems to be more focusing on the regional scale. Recently, Hoover (2009) used the term 'geography of smell', where 'odour', 'olfactory' and 'smell' all appeared in the description. However, Hoover (2009) didn't explain why the term 'smell' was used in preference. In the discussion, smellscape was also mentioned whilst in line with smell maps, which limited the meaning of smellscape originally given by Porteous (1985/2006). There is a need to standardise the term to describe the interrelationship between humans' perceptions, smells and smell sources, places and context.

In a more recent study, Henshaw (2013:5) adopted the term smellscape, and 'referring to the overall smell environment, but with the acknowledgement that as human beings, we are only capable of detecting this partially at any one point of time, although we may carry a mental image or memory of the smellscape in its totality.' Human's perceptions (the sensational and mental process) in the description are at the centre of the smellscape concept, which need to be explored and understood. Smellscape in Henshaw's work is suggested to explore at different spatial scales: macro (city), midi (district) and micro (street). Compared to the other two terms, smellscape has a focus on the human experiences and considers smell as both an action (to perceive) and substance (constitute the environment). The term smellscape can also across disciplines, i.e. architecture, urban planning and design, landscape and geography.

The term smellscape, thus, is chosen purposely in this paper and can be described as the smell environment perceived and understood by a person (through olfactory sensation, influenced by ones' memories and past experiences) in a place (specific to its context).

1.3. Need for a smellscape perceptual model

Understanding and evaluating the perceptual quality of smellscapes are prior to guide future planning and design of smellscapes. However, most smellscape studies focused on outlining elements composing the smell environment (Tolaas, 2010; Henshaw, 2013; Mclean, 2013) or cultural and historical features of smellscapes in different cities (Classen et al., 1994; Reinartz, 2014). Very few of them have attempted to identify indicators influencing perceptual qualities of smellscapes. Smell preferences and intensities have been frequently studied as main features of smell perceptions in laboratories (e.g. Moncrieff, 1966; Wrzesniewski, McCauley, & Rozin, 1999) and empirical studies (Henshaw, 2013). They are also used as parameters in odour guidance for onsite assessment to produce odour control strategies (DEFRA, 2010; IAQM, 2014). Smells in these guidance are mainly considered as chemicals and waste, which failed to recognise the importance of human perceptions of smells in places. Henshaw (2013) suggested smellscape as an approach to place-making, creating place identities and attachments with smells. The

Xiao, J., Tait, M., & Kang, J. (2018). A perceptual model of smellscape pleasantness. *Cities*. In press.

emotional bonds or response to smellscape can be very different from the perspective of odour controls, considering other parameters such as familiarity (e.g. Ayabe-Kanamura et al., 1998).

In the related field of soundscape research, a perceptual model was developed based on perceptual attributes have been identified through quantitative surveys of a list of descriptors representing two emotional dimensions (Axelsson, Nilsson, & Berglund, 2010). The identified perceptual attributes have been applied in later studies to understand soundscape characteristics and evaluate perceptual qualities of soundscapes (e.g. Aletta, Kang, & Axelsson, 2016; Axelsson, 2015; Jeon, Hwang, & Hong, 2014). A similar perceptual model of smellscape, therefore, can also be developed through identifying indicators contributing to emotional dimensions of smellscape perceptions.

Pleasantness is a key emotional dimension which can be used to measure perceptual qualities of places, representing the hedonic feelings (Mehrabian & Russell, 1974; Russell & Mehrabian, 1977). In soundscape, pleasantness and unpleasantness has been used to measure people's positive and negative feelings as well their satisfaction and dissatisfaction of perceived environment to identify wanted and unwanted features to provide further improvement strategies (e.g. Jennings & Cain, 2013). Henshaw (2013) also suggests, smells in places should be considered as both waste (unwanted) and resources (wanted) to be managed and designed for minimising their negative impacts and enriching/enhancing people's experiences in cities. Understanding the perceptual attributes of smellscape pleasantness helps to identify positive (wanted) and negative (unwanted) elements in the environment, which contributes to future planning and design strategies to achieve a more pleasant smellscape.

1.4. Aim and objectives

This study, thus, aims to investigate indicators influencing smellscape pleasantness and develop a perceptual model to understand perceptual qualities of smellscape accordingly. It took the grounded theory as a methodological and analytical approach to structure the study and analyse data. People's language was used as a source of knowledge to understand smellscape, using a case study method and semi-structured interviews.

2. Methodology

2.1. Grounded theory

Given to limited work has done on perceptual qualities of smellscape, this study took an exploratory inductive approach to construct a perceptual model from interpreting people's descriptions, using the Grounded Theory.

Previous studies, such as by Henshaw (2013) and Balez (2002), suggested people's natural speaking language as a source of knowledge to understand smellscape. Tuan (1991) argued that people's natural speaking language delivers information about people's emotions and personality, describing how they think and feel. People's emotional responses indicate their evaluations of qualities of places, which can be interpreted from their language descriptions, particularly, emotional descriptors (Lang, 1969; Mehrabian & Russell, 1974). Language and the sensory-motor system have been found to share the same structure in the human brain (Gallese & Lakoff, 2005), which means people's language descriptions mediate between environment and their sensory experiences.

Xiao, J., Tait, M., & Kang, J. (2018). A perceptual model of smellscape pleasantness. *Cities*. In press.

The Grounded Theory was developed to investigate social facts without a pre-conceived hypothesis which encourages researchers to explore a field without pre-formed predictions and draw their conceptual categories and models from detailed interpretations of raw data (Glaser & Strauss, 2009). It offers a systematic framework to guide data collection process as data analysis via coding, memo-writing, categorising and theorising (Charmaz, 2006). Meanwhile, in the field of soundscape, which is closely related to smellscape, Grounded Theory has been approved useful to understand people's perceptions and generate parameters contributing to subjective evaluations (see Fiebig & Schulte-Fortkamp, 2004; Liu & Kang, 2016). The application of Grounded Theory will enable this study to stay open to emerged indicators from people's own descriptions and evaluations and construct an evaluation framework grounded from the data.

However, it is necessary to acknowledge cultural impact on the use of language describing emotions and smells. Porteous (1985/2006) and Rodaway (1994) argued people do have some common associations or emotions associated with childhood or widely known stereotypes of smells. However, the linguistic descriptions might vary. Understanding the meaning of the original descriptions in their language context will be important using this approach. In English, it has been argued that there is a shortage of vocabulary related to smells and people feel less familiar in their descriptions of smell and smell environments (Majid & Burenhult, 2014; Porteous, 1985/2006). This has been true with many modernised countries in the Western world, where smells or the sense of smells doesn't play a dominant role in people's work and living. Majid and Burenhult (2014) compared native Jahai speakers and English speakers in their naming of smells and colours, and found people speaking Jahai able to name smells with the same conciseness and level of agreement as colours whilst people speaking English cannot. Thus, in a different language context, the linguistic representations of emotions and experiences might be different. The study presented in this paper took a semi-structured interview method with open-ended questions to gather data on people's in-situ experiences through smell walking. During the data analysis, most codes were from participants' original descriptions and meanings of modifiers were consulted with a native English speaker to ensure meanings are understood within the language context.

2.2. Selection of case

2.2.1. Intermodal transit spaces: Nodes in everyday cities

People's attitudes towards smells vary in sources and contexts (Henshaw, 2013: 86), which suggest studies of smellscapes to be conducted in specific contexts. The study presented in this paper explored smellscapes in urban intermodal transit spaces.

Urban intermodal transit spaces often have railway stations as central components linking different transport modes and surrounding urban spaces in cities. Urban intermodal transit spaces provide various functions for everyday activities, such as retail, restaurant, leisure and transport, and temporary accommodation to large population flows from diverse social and cultural backgrounds (Trip, 2007).

'The station is where city dwellers can buy groceries, use a bank, get a haircut or change money. It is a civic gathering space, where music can be heard, where transit information is dispensed, and where the drama of urban life can be witnessed in full flow' (Edwards, 2013: 173).

Intermodal transit spaces in contemporary cities should be considered as both 'nodes' and 'places', which provide connections between transport and non-transport spaces as well as

Xiao, J., Tait, M., & Kang, J. (2018). A perceptual model of smellscape pleasantness. *Cities*. In press.

inhabited spaces for passengers and local residents (Bertolini, 1996). Such spaces can be meaningful for users and visitors, forming place attachments and identities: 'A transport node or interchange is a place of mixed emotions- excitement tinged with anxiety, happiness at greeting loved ones and sadness when they depart, comings and goings, the beginning and end of a good night out. In urbanized societies, these spaces are often our principal meeting places' (Jones, 2006: 8). Such spaces reflect people's everyday life in cities, providing a rich context to investigate various perceptual features of smellscape. A study of smellscapes in urban intermodal transit spaces fits the wider urban contexts to understand perceptual features of smellscapes.

2.2.2. Sheffield Railway Station and Bus Interchange Taking a case study method, this study is able to understand how physical elements and temporary conditions in real situations influence the overall smell environment and people's perceptions (Yin, 2009). Sheffield Railway Station and Bus Interchange was selected as a typical case of urban intermodal transit spaces with mixed spatial forms, linking different transport modes and surrounding urban spaces in this area such as public square, university space, residential area, lanes and roads. The mixed functions inside Sheffield Railway Station and Bus Interchange are representative and commonly found in urban transit spaces, such as grocery shop, café, bookstore, fast-food restaurants, taxi ranks, etc. Meanwhile, it has mixed architectural and landscape elements whilst has historical and contemporary meanings to the city's urban development (as described in Fig. 1).

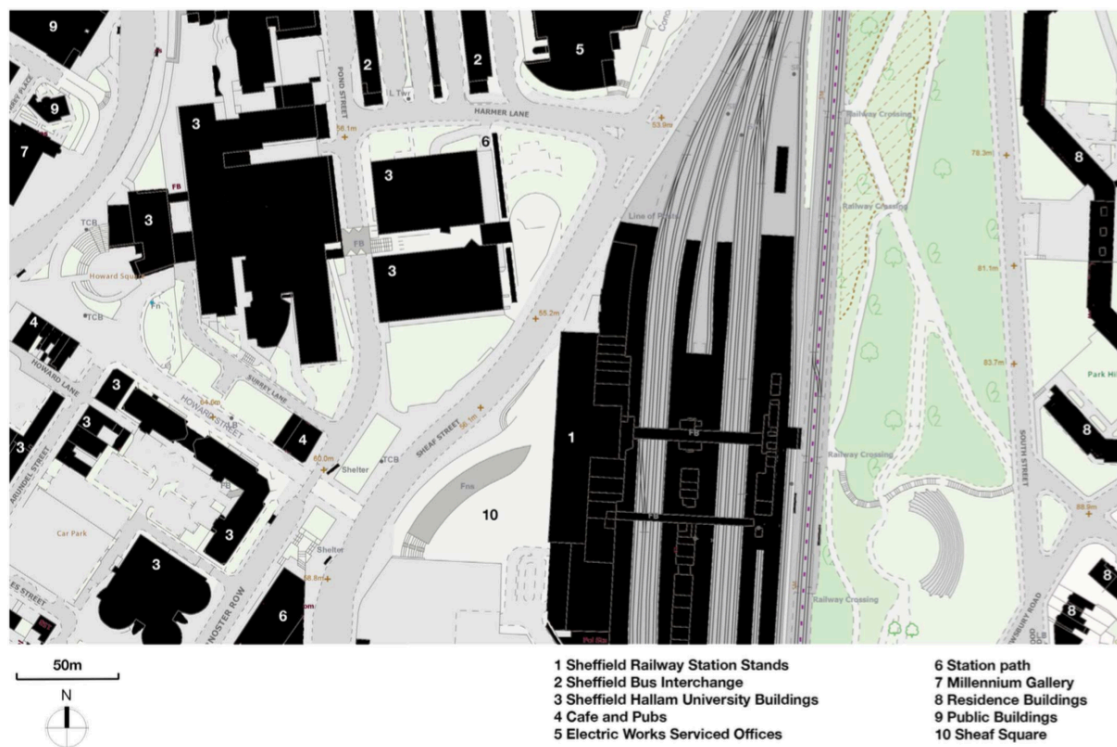


Figure 1 Contextual information of Sheffield Railway Station and Bus Interchange

2.3. Participants

Nineteen participants, native English speakers, were recruited through mixed methods, e.g. randomly approached onsite and snow-balling, following the theoretical sampling process which started with an initial sampling to address on the established research questions. The later

Xiao, J., Tait, M., & Kang, J. (2018). A perceptual model of smellscape pleasantness. *Cities*. In press.

sampling criteria changed to respond to emerged categories throughout the process until emerged categories saturated (Charmaz, 2006). Participants recruited are all able to smell and have a gender balance from a diverse age range, as shown in Table 1.

| Participants' information | | Examples of questions asked at each stop | | | | | | | | | | | | | | | | | | | | | |
|---------------------------|--|--|--------|------|----------|---|---|--------|---|---|-----------|---|---|-----------|---|---|-----------|---|---|-----------|---|---|--|
| Information type | <table border="1"> <caption>Data for Figure 1: Participant Gender Distribution</caption> <thead> <tr> <th>Information type</th> <th>Female</th> <th>Male</th> </tr> </thead> <tbody> <tr> <td>Hayfever</td> <td>1</td> <td>2</td> </tr> <tr> <td>Smoker</td> <td>3</td> <td>2</td> </tr> <tr> <td>Age 50-59</td> <td>1</td> <td>2</td> </tr> <tr> <td>Age 40-49</td> <td>0</td> <td>2</td> </tr> <tr> <td>Age 30-39</td> <td>5</td> <td>2</td> </tr> <tr> <td>Age 18-29</td> <td>3</td> <td>4</td> </tr> </tbody> </table> | Information type | Female | Male | Hayfever | 1 | 2 | Smoker | 3 | 2 | Age 50-59 | 1 | 2 | Age 40-49 | 0 | 2 | Age 30-39 | 5 | 2 | Age 18-29 | 3 | 4 | <p>Questions before walk:</p> <ul style="list-style-type: none"> - Do you have any favourite smells in the city? - Are there any smells you dislike in the city? - Do you often come to the station? <p>Questions at each stop:</p> <ul style="list-style-type: none"> - Do you find any smells in this space? What are they? - How do you like them? - Is the smell environment pleasant to you? - Would you please explain it a bit further? - Is there any aspect in the environment influenced you? - How do you like the overall environment here? <p>Questions after walk:</p> <ul style="list-style-type: none"> - How do you describe the overall smell environment through our walk today? - What kind of smell environment you would prefer to have in such space? - Do you have anything else to share with me about smells and intermodal transit spaces? |
| Information type | Female | Male | | | | | | | | | | | | | | | | | | | | | |
| Hayfever | 1 | 2 | | | | | | | | | | | | | | | | | | | | | |
| Smoker | 3 | 2 | | | | | | | | | | | | | | | | | | | | | |
| Age 50-59 | 1 | 2 | | | | | | | | | | | | | | | | | | | | | |
| Age 40-49 | 0 | 2 | | | | | | | | | | | | | | | | | | | | | |
| Age 30-39 | 5 | 2 | | | | | | | | | | | | | | | | | | | | | |
| Age 18-29 | 3 | 4 | | | | | | | | | | | | | | | | | | | | | |

Table 1 Participants' profiles and examples of semi-structured interview questions asked in smell walking

2.4. Smell-walking and semi-structured interview

Walking is an essential and main transport mode of users within urban intermodal transit spaces, which makes the smell walking method appropriate for exploring users' experiences. The method of walking has been frequently used to explore people's sensory experiences in urban spaces, which can help gain detailed and immediate responses of people's actual experiences and feelings of the surrounding environment to increase the validity of data (Degen & Rose, 2012).

Smellwalking used in this study is informed by Henshaw (2013: 49) took the human nose as a detector of smells to investigate people's perceptions of smell environment through a designed route. The route in the studied case (shown in Fig. 2) was designed and testified after taking several pre-walks which included seven stops with a total length of 0.6 mile. The route was determined to include various considerations of place characteristics whilst with open access, shelter and safety: the surrounding environment, built forms, smells, indoor and outdoor spaces, based on onsite observations.

The semi-structured interview method was chosen to gain an in-depth understanding of smellscape and elicit participants' interpretations of their experiences of the smell environment in studied case. Semi-structured interviews stimulate detailed discussion of the research topic, and help gain new insights into the existing knowledge (Charmaz, 2006). Each participant was taken through the designed route, from Stop 1 to Stop 7 sequentially. At each stop, participants were asked to describe smells detected, their overall experiences of the smell environment and pleasantness. Sub-questions were asked responding to their descriptions to encourage them to give details and further explanations (examples of questions asked were illustrated in Table 1). Smell walks were conducted between July 2014 and February 2015, with an average of 60 min each. Interviews were recoded through a handheld voice recorder and transcribed afterwards.

Xiao, J., Tait, M., & Kang, J. (2018). A perceptual model of smellscape pleasantness. *Cities*. In press.

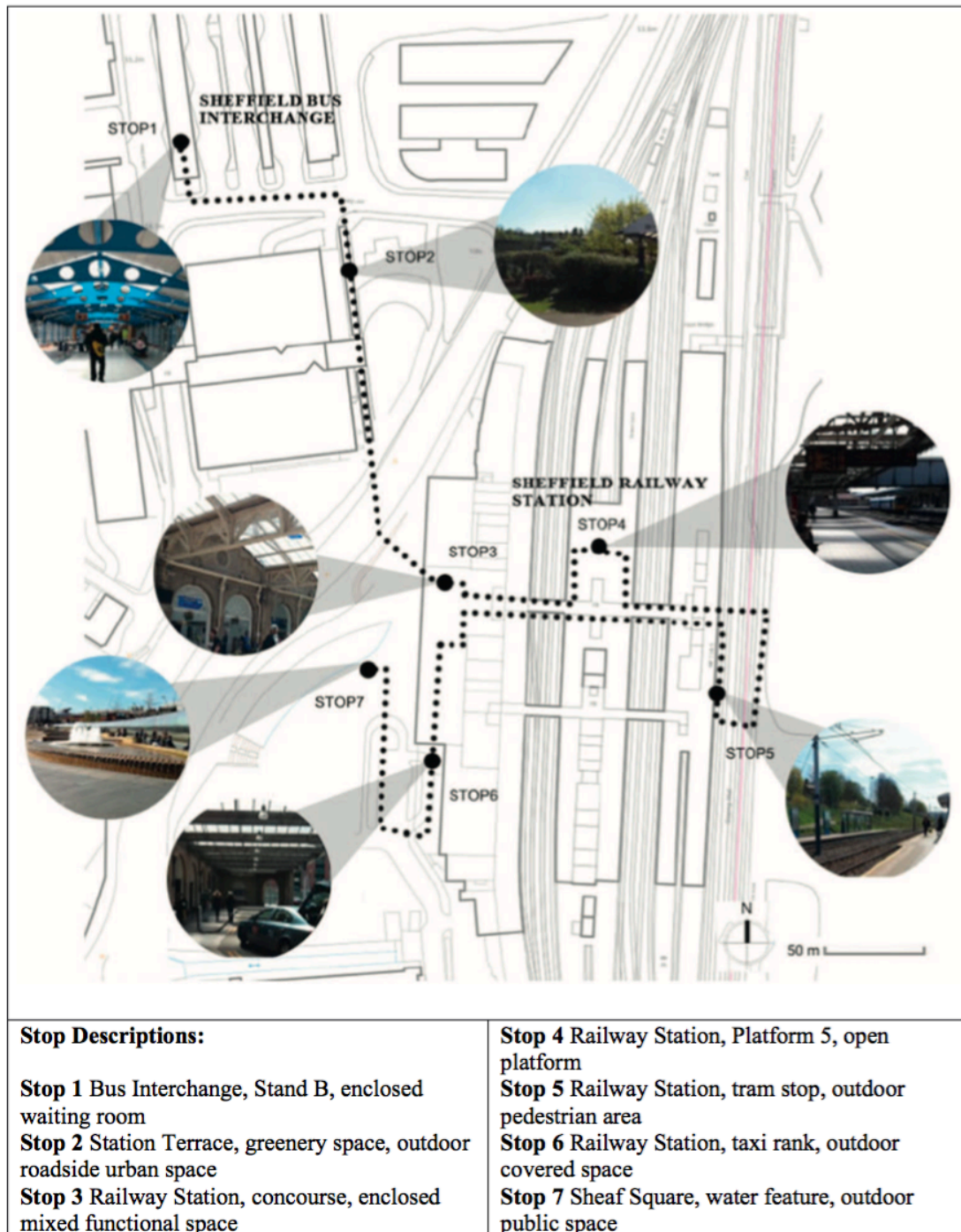


Figure 2 Smellwalking route map with descriptions of stops

2.5. Data analysis

The analysis (as illustrated in Fig. 3) followed the iterative process of coding and memo-writing suggested in the Grounded Theory approach (Charmaz, 2006). Line-by-line coding was used in the initial coding to gain insights into participants' attitudes and experiences and help establish some analytic directions for the subsequent focused coding. In the initial coding stage, codes were

Xiao, J., Tait, M., & Kang, J. (2018). A perceptual model of smellscape pleasantness. *Cities*. In press.

mainly modifiers used by participants to describe features of smells, places, their feelings and evaluations, such as clean, fresh, happy, annoying, etc. In the second round, focused codes were developed for further analysis by summarising the most significant and frequent initial codes, such as familiarity, appropriateness, etc. Memos were written along the process to categorise codes and compare emerged categories.

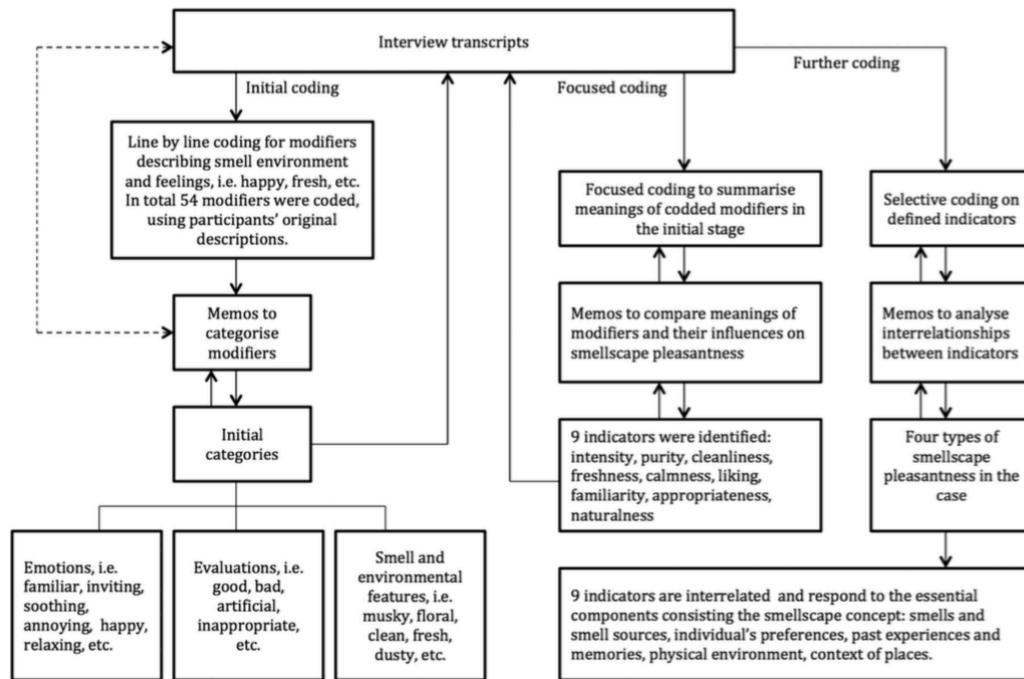


Figure 3 Data analysis process using Grounded Theory in this study

3. Results and discussions

3.1. Indicators of smellscape pleasantness

Intensity (strong-background) of smells is the most basic feature of smellscape, which refers to the strength of smells perceived in a place. People's perceptions of intensity are influenced by their sensitivity to smells determined by physiological conditions as well as ones' cultural- social background and living environment (Henshaw, 2013). Sensitivity to smells set out thresholds of annoyance caused by smell intensity (DEFRA, 2010). For people with high sensitivity or allergies towards certain odourants (i.e. pollen found in the studied case), controlling the smell intensity will be prior to achieve smellscape pleasantness.

Participants found high intensity of smells unpleasant, no matter liked or disliked. Background levels of smells are often more appreciated by participants thinking the environment controlled and man- aged. When smells are at the background level, participants were also more likely to pay less attention to smells which makes the smell environment more neutral. Neutralisation of sensory elements such as sound and smell is argued as a way of controlling strangeness in most western cities to offer a modern look (Degen, 2014). However, influence of intensity on pleasantness may vary in a different context. Rodaway (1994) suggested, compared to western societies, countries like India and China have an intensive smell culture and value smells more, where thresholds of annoyance caused by smell intensity will be much higher. Existence of

Xiao, J., Tait, M., & Kang, J. (2018). A perceptual model of smellscape pleasantness. *Cities*. In press.

cigarette smoke and traffic fumes were found acceptable in the studied case, as a result of people's expectations of both smells in intermodal transit spaces.

Purity (pure-mixed) of smells reflects the diversity of smells perceived in a space. When smells are mixed at a noticeable level, particularly a positive and a negative, participants showed immediate reactions. For example:

'When I went past Starbucks, I smelt some coffee which is nice. But then, the smell from the train is absolutely overwhelming... It is not really good smell experience. When you smell coffee mixed with trains, you won't feel like you smelt a proper coffee. I think coffee smell is good when the smell environment is more neutral I guess. For the moment, I am bothered by the mixed environment of pleasant and unpleasant smells. The pleasant smells won't smell pleasant to me in the mixed environment.' (S12, 27, Male, Age 37, at Stop 4).

Order, purity and cleanliness are sensory values embedded in the contemporary global aesthetics (Degen, 2014). Mixed smells sometimes can cause difficulty for people to identify smells (Balez, 2002), which results in confusion and anxiety, decreasing the level of pleasantness. However, there are combinations of smells which participants found pleasant such as smells of leaves and earth at stop 2(station terrace). Smell sources are essential to the purity factor.

Cleanliness (clean-unclean) refers to the feeling of being in a clean environment with clean smells. On detecting smells associate with waste and pollution such as such as car fumes and cigarette smoke, participants often found the place unclean or unhealthy which reduces the overall smellscape pleasantness. However, when detecting smells associated with cleaning activities or hygienic environments, such as cleaning liquid, soap and hospital smells, participants tended to find the environment cleaner and more positive. For example, two different perceptions of smellscape at stop 1 (Bus Interchange) caused by clean and unclean smells:

'I can still smell the bin from here, so it is not pleasant from me. I would like to smell more clean, like cleaning products...' (S05, female, age 33, at Stop1).

'Not really much smells here. The given moment, I had the feeling of the cleaning product. It made me think of the space is clean, it is positive. But, I don't like this smell in general. It is quite sour and tickling in the nose. But it feels like a clean space. So I had this positive feeling that someone has cleaned this space.' (S12, male, age 27, at Stop1).

Meanwhile, visual cues of unclean or contaminated elements, such as dirty water on the floor, fumes coming out from the car and trash in uncovered bins, in the environment were found reducing the level of cleanliness perceived by participants. However, on seeing a bright and clean space or people cleaning the space, participants were found getting a sense of cleanliness. Cleanliness is a more visual and environmental indicator associated with cleaning activities and appearance of the physical place.

Freshness (fresh-stale) indicates air qualities in the environment and associated with natural elements onsite such as vegetation, water and soil. A sense of freshness was gained by most participants at Stop 2 (Terrace Greenery), Stop 5 (Tram Stop) and Stop 7 (Sheaf Square), which are located outdoors with natural ventilations. However, higher level of freshness was not perceived as pleasant in all conditions. For example, at Sheaf Square, people preferred the freshness of the watery smell in the warm summer, but it would only make them feel colder to smell the water outside in winter, as one participant said:

Xiao, J., Tait, M., & Kang, J. (2018). A perceptual model of smellscape pleasantness. *Cities*. In press.

'It smells like water. I guess it is some chemicals that clean the water. It is fine, I like the smell of water, especially, in summer...The fact that you have water, it is nice. But your nose won't feel that much comfortable to have such a strong freshness in a cold winter. I always wonder they forgot that they have long winters.'(S05, female, age 33, at Stop 7).

People generally felt more 'fresh' in outdoor spaces than indoor spaces which indicates ventilation or airflow is a key element contributing to freshness. The issue of crowding of people, scale and openness of the space were also influencing the quality of air and capacity of oxygen in the space, which thus influence freshness.

Calmness (calm-annoying). Achieving the sense of calmness can make people feel free from stress, undisturbed and relaxed (Russell, 2003). Smells can influence levels of anxiety (Arnot, 1991 cities in Rodaway, 1994). High levels of pleasantness were found among participants at Stop 5 (Tram Stop) and Stop 7 (Sheaf Square) where participants frequently described more 'relaxed' and 'calm'. For example:

'I can smell the trees now. it is nice and clean, like natural smell. Uh, I can smell the trees over than other smells. It is very pleasant. It makes me feel calming. I feel more relaxed in this environment. And it is nice to look at. If you walk through the city, it would be quite stressful. But if you walk pass this place, you will feel more relaxed and pleasant.' (S05, female, age 33, at Stop2).

However, participants felt annoyed by the smells of traffic and not well-designed space at Railway Platform (stop 4) and Taxi Rank (stop6). Annoyance to smells can cause discomfort to people and the cause of annoyance can be various, such as nuisance certain smells, allergies, overpowering smells or unfamiliar smells as well as an un- clean environment (Henshaw, 2013:14). Calmness, thus, is dominantly influenced by perceiver's physiological sensitivity and socio-psychological differences.

Liking (like-dislike). People learnt their smell preferences and nuisances through everyday-life associations and know whether they like or dislike detected smells immediately on perceiving them (Herz, 2006). In Henshaw's work, liking has been considered as a dominant factor to determine whether a smellscape is positive or negative to its perceiver (Henshaw, 2013). There were moments that participants enjoyed smellscapes in the studied case on detecting their liked smells. However, in most situations in the studied case, people tended to evaluate the nuisance caused by disliked smells more often than the pleasantness derived from liked smells. Participants' smellscape pleasantness varied with different levels of acceptance towards disliked smells.

Indeed, smell preference are found varied from individual to individual whilst people are more likely to have similar nuisance towards certain smells (Moncrieff, 1966). Participants were found having si- milar nuisance towards smells of waste, cigarette smoke, traffic fumes and body odours, which are typical in intermodal transit spaces. It is arguable to say that people's evaluations of smellscape pleasantness are naturally and unconsciously influenced by preferences and nuisance, but not determined by the liking factor.

Familiarity (familiar-unfamiliar) played an important part in participants' configurations of smells and places, which had a sig- nificant impact on their smellscape pleasantness. Henshaw (2013) suggested when coming across unknown smells, people are found often refer to smells they know. In the case, participants were likely to feel more pleasant when they are familiar with

Xiao, J., Tait, M., & Kang, J. (2018). A perceptual model of smellscape pleasantness. *Cities*. In press.

the environment and smells within it:

'I like it here [the railway station concourse]. It is more welcome and familiar to me. I like to smell food in stations, though it sometimes makes me feel hungry. But it smells somehow a bit like home.' (S05, female, age 33, at Stop 3).

Two types of smellscape familiarity were found in the studied case: arousal and non-arousal. Arousal familiarity comes from meaningful personal experiences and memories whilst non-arousal familiarity comes from repetitive perceptions of similar smell environments, i.e. the physical environment, smells or atmosphere. Arousal familiarity can enhance people's feelings of the pleasantness of perceived smellscapes. For example:

'I smelt fresh plants here. Well, I don't smell that today, but sometimes you can catch the smells of lavender, and just smells beautiful. It's a good smellscape to me. I was brought up with this kind: plants and trees. I am used to this kind of smell. It has memory.' (S04, male, age 51, at Stop2).

The non-arousal familiarity is a result of habituation of smells. Particularly, habituation to negative smells was found in the studied case can reduce level of unpleasantness. For example:

'I detected the smells of buses and smoke from buses, smells like, maybe petrol. Uh, no, it is not petrol, just smoke. It is a normal city smell...to be honest, I have no particular feelings about it, because I grew up in a city, I am used to it. I think it is not a nice smell to some people, but to me it is neutral. It could be nicer without the smoke. But, I think I am just used to it.' (S09, Female, Age 27, at Stop 2).

In previous studies, positive correlations have been found in laboratory experiments between familiarity and hedonic degrees of perceived smells (Distel et al., 1999). However, reasons behind this were not explained. However, familiarity to smells can help reduce the feeling of being threatened in the environment (Engen, 1991). In contrast, people would feel tense and alert when they detect unfamiliar smells in a familiar context (Porteous, 1985/2006). The indication of security by familiarity of smells and environment might be one of the contributors to smellscape pleasantness.

Appropriateness (appropriate-inappropriate) depends on whether perceived smells matches the physical and social context of a place. Levels of appropriateness are mainly determined by perceivers' expectations. For example:

'I know I said I love the smell of plants. But I don't expect to have gardens around train stations or bus stations unless it is outside the city centre at suburbs. You know. It is normal to me to smell fumes around bus stations. But I'd like it to be neutral if possible, without any smells or with a bit smell of some nice cleaning liquid.' (S04, Male, Age 51, at Stop 5).

Expectations are much influenced by ones' past experiences and functions of places as well as people's visual perceptions of the physical environment. For example, seeing a café in the middle of the space, people would expect to smell coffee. Expectations would set out a number of conditions to achieve appropriateness in a place, which thus influence the overall pleasantness. High level of appropriateness can increase acceptance of an environment with bad smells such as diesel fumes at the railway platform (Stop 4) whilst inappropriateness of good smells in the environment can also devalue the general quality of smellscape such as smells of food at taxi

Xiao, J., Tait, M., & Kang, J. (2018). A perceptual model of smellscape pleasantness. *Cities*. In press.

rank (Stop 5).

Naturalness (natural-artificial) is similar to appropriateness, which seeks for congruency between olfactory perception and perceivers' expectations. However, appropriateness emphasises the congruence between smells, smell sources and place context whilst naturalness emphasising the congruence between smells and the physical environment or the physical existence of smell sources. It refers to whether perceived smells are from artificial sources such as perfumes, air freshener and scented products, or from natural elements such as grass, flowers and soil. For example:

'I just wish to have some everyday normal smells except the bins and toilet smells. I don't want them to pipe some false non-existing smells. I don't mind smelling light coffee smell, the flowers, but not the air fresheners or sprays so often to hide the train smells. I just want natural. If I walk past a café, I am fine with the coffee smell, if I walk past the flowers, I am fine with the floral smells because it is nice fresh smell, but I wouldn't mind smell nothing, either.' (S06, female, age 54, at Stop 3).

A good example to demonstrate influence of naturalness is the smellscape at Stop 7 (Sheaf Square). With the running waterscape on-site, participants expected a natural watery smell. Although many participants considered the waterscape as natural elements, some participants detected chlorine smell and considered it as a chemical smell which is unnatural and did not match the preconceptions about flowing water. The absence of naturalness in this case devaluated the overall smellscape pleasantness at this stop to some participants.

3.2. Types of pleasantness in intermodal transit spaces

Variations of pleasantness in people's explanations indicate that indicators work at different strengths with different participants in different situations. Comparing participants' descriptions, certain indicators were identified playing dominant roles in their evaluations of smellscape pleasantness, showing dominant perceptual features of perceived smellscapes. Overall, four types of smellscape pleasantness or unpleasantness were (see Table 2): preference/nuisance dominated (liking), healthiness dominated (cleanliness and freshness), memories and habituations dominated (familiarity), and context dominated (appropriateness).

Preference and nuisance dominated. The preference dominated pleasantness or nuisance dominated unpleasantness is influenced more by smells and smell sources whilst less impacted by appearance of environment. Purity and intensity of smells had much impact on the level of pleasantness or unpleasantness of this type. Participants in the studied case mostly preference smells less mixed and at a lower intensity. However, smell preferences vary from individual to individual (Henshaw, 2013; Moncrieff, 1966). The preference dominated smellscape pleasantness in this sense is more personal, which probably does not happen simultaneously to others (i.e. memory associated preference towards train smells found in the case). Compared to preference dominated pleasantness, nuisance dominated unpleasantness was found more frequently in the studied case across most stops. Although people turned to have similar nuisance towards certain smells (Moncrieff, 1966), differences existed among participants towards smells of vegetation, cigarette smoke, smells of diesel and coffee. When such smells were detectable, participants were found annoyed and stressful.

This type of smellscape pleasantness is highly associated with freshness and cleanliness of the smell environment. Enforcing non-smoking in public spaces and cleaning frequencies were

Xiao, J., Tait, M., & Kang, J. (2018). A perceptual model of smellscape pleasantness. *Cities*. In press.

indicated in the case as important to achieve healthiness dominated smellscape pleasantness. Unlike the preference/nuisance dominated type, healthiness dominated pleasantness or unpleasantness can be controlled by separating, limiting and removing pollution and waste related smells from the environment.

| Type | Sub-category | Description | Interview excerpts |
|-------------------------------------|-----------------|--|--|
| Preference and nuisance dominated | Preference led | Most participants in the study were found to have an immediate recognition of liked and disliked smells in a space. When there are distinct and dominant in a space, people's smell preferences will have a dominant impact. Particularly, when there are not any disliked smells. | <i>'I like the smellscape here actually. I don't know whether it is related to my personal preferences, but the fact of arriving and smelling the coffee makes me feel good and relaxed.'</i> (S05, female, age 33, at Stop 3) |
| | Nuisance led | Contrarily, when there are smells that participants disliked, even at a low intensity, their smellscape pleasantness will be reduced. For example, some disliked smells of pasty and burgers, which were commented as oily and greasy and devalued the smellscape pleasantness. | <i>'I often can smell Burger King, it smells like burgers, fries and something like that. It is not pleasant to me. I would prefer the smell of sandwiches than Burger King because it won't smell so oily and unhealthy.'</i> (S07, female, age 24, at Stop 3) |
| Healthiness dominated | Hygiene led | In this type of pleasantness, participants' evaluations are mostly based on the detections of waste, sanitary smells and the visual perceptions of a clean or unclean environment. | <i>'You know, when we are on the platform someone just opened the backdoor of Burger King, the smell of rotten food almost made me vomit. And when we get out, the cleaner parked the trash bin there, again, I smelt the rotten food.'</i> (S10 Female, age 28, at Stop 3) |
| | Pollution led | Pollution, including traffic fumes, cigarette smoke and other unhealthy chemicals, has significant negative influence on people's perceptions of the pleasantness of smellscape, particularly when the smell is strong. When they detected smells indicating a cleaner and healthier environment, they would feel more pleasant. The healthiness dominated type happens in preconceived unclean and polluted spaces. | <i>'Diesel ... It is very unpleasant. Every time when I smell it, I feel like I have to protect my lungs. Because it is something I believe is unhealthy for my respiration system.'</i> (S14, age 43, male, at Stop 4) <i>'It smells cleaner and fresh. The smell of water really helps and the running water makes the air clean. I like it. Physically, it is nice and open, you can move freely around it. And, in terms of smells, I like the freshness.'</i> (S18, Male, Age 35, at Stop7) |
| Memories and habituations dominated | Memories led | People's familiarity with smells and surrounding environments plays an important role in this case, which is not necessarily related to preference. This type of pleasantness was also found to be personal, varying among perceivers, different environmental settings, smells and smell sources. | <i>'I don't mind the train smell, 'cos it reminds me of going away. I don't use trains for business or work. Mine would be for pleasure. All I remember is pleasurable journeys. So, I quite like the smell of the train, it is not something that I experience everyday neither, for me, I'd be going for a trip on a train, which is a pleasurable experience anyway, so, I don't mind smelling the train.'</i> (S06, female, age 54, at Stop 4) |
| | Habituation led | In some cases, it is not a particular experience from memories but a repeated habitation that leads to people's perceptions of the pleasantness of certain smellscape. Similarly, this is very personal and influenced by participants' everyday routine and living environment | <i>'I just detected some cigarette smoke... Honestly, I have no particular feelings for it...I have couple of friends smoke quite a bit. I guess I am just used to it. I know some people are strongly against it. And I guess, the traffic smell, I am just used to that as well. I quite like to walk around Sheffield. Inevitably, you can smell quite a lot of fumes. But, if you compare some place like London, Sheffield is not so bad. I don't mind to smell fumes here.'</i> (S01, male, age 22, at Stop 2) |
| Context dominated | Function led | Participants would judge their smellscape pleasantness based on the function of space and expectations of smellscape in that particular functional places. This will also be influenced by the visual perception of the space and whether it matches participants' preconceptions of its function. | <i>'The train smells a lot stronger here, you can't actually smell anything else. I am at the train station at the platform, I know where the smells are coming from, so, it is not something unusual, and platforms normally have this sort of smell, it is not that overpowering and unusual. It won't make me feel 'oh, hang on a min, there is sth wrong'. So, I wouldn't expect this smell to be in bus station.'</i> (S09, female, age 27, at Stop 4) |
| | Purpose led | This type of pleasantness is based on people's purpose of visiting target spaces. This happens, particularly when the smellscape is not perceived as pleasant to others with a different purpose of visiting or in other contexts. | <i>'Well, it is a train station, I expected to smell the smells of trains. So, it is not that unpleasant to me, because I know what it will smell like. But, it might be different if I am here travelling for work or holiday.'</i> (S17, female, age 38, at Stop 4) |

Table 2 Types of smellscape pleasantness and unpleasantness in the studied case.

Memories and habituations dominated. In this category, ones' memories and past experiences of perceived smellscape play dominant roles in specific contexts. Two types of familiarity (arousal and non- arousal) responded to two types of pleasantness. Pleasantness caused by memories of a particular experience in the past is often meaningful to the perceiver. Actually, memories of smells and associated behaviours were found enhancing people's emotional experience towards perceived smells (Herz & Cupchik, 1995). Positive memories can lead to enhanced pleasantness whilst negative memories can cause increased un- pleasantness. Habituations to certain smells increased familiarity to smells and However, the habituations dominated type in the studied case often lead to less unpleasantness of smellscape which are commonly perceived negative (e.g. traffic fumes, cigarette smoke, crowded spaces, lack of seats).

Context dominated pleasantness. In this category, context of places played a dominant role, which includes spatial functions and physical appearance. But, it is also influenced by people's purposes of visiting. The context is important in the first sense whether participants have positive or

Xiao, J., Tait, M., & Kang, J. (2018). A perceptual model of smellscape pleasantness. *Cities*. In press.

negative preconceptions of smells and the environment. Natural smells and elements in the environment in the studied case were positive to participants' pleasantness of smellscapes. In Bus Interchange and Railway Station, participants had negative preconceptions such as crowds, traffic and car fumes, associated with travel and transport. However, appropriateness resulted from such expectations made smellscapes at stop 4 (railway platform) and stop 6 (taxi rank) acceptable. Although participants at these stops did not feel pleasant of the perceived smellscape, unpleasantness caused by smell nuisance or lack of cleanliness and freshness was reduced.

3.3. Interrelationships between indicators

Smellscape as the human-perceived smell environment of a place within its context, is therefore influenced by individual's characteristics, and suggesting human perception as the centre of the concept. The pleasantness of those smellscapes perceived by a perceiver responds to different elements that make up the concept: smells and smell sources, physical environment, context of place, individual differences in preferences, sensitivity, past experiences and memories, and so on. Indicators generated from the case demonstrated key perceptual features of elements that compose the smellscape concept and in turn influence smellscape pleasantness, as illustrated in Fig. 4. Cleanliness and freshness based on participants' descriptions are more associated with the designed and managed physical environment, i.e. surface materials, openness of space, landscape features, cleaning frequencies. Purity and intensity are found in closer relation to types and scale of smells and smell sources, i.e. whether it is urine or coffee in the space. However, calmness, preference and familiarity are found to be more strongly related to perceivers' individual smell preferences, nuisance and habituation of certain smells. Appropriateness and naturalness are found more related to people's preconceptions, expectations and the context.

Comparing strengths of indicators among the four types of pleasantness in the case study, they can be divided into basic indicators, primary indicators and secondary indicators. Basic indicators have direct relations to smells and smell sources which are essential smellscape components, specifying and distinguishing smellscapes from other sensoryscapes. Basic indicators include purity, intensity and cleanliness. Basic indicators have close relations to the physical environment. Unlike purity and intensity, cleanliness also involves visual perceptions in the evaluation and associates with the sense of a 'healthy and hygienic' environment, which was considered prior of achieving pleasantness by participants.

However, in most situations in the case study, people's evaluations of pleasantness are based on appropriateness and liking, directly relating to contexts of places and individual's preferences, past experiences and memories. Therefore, liking and appropriateness can be considered as primary indicators, which have more decisive power in people's evaluations of smellscape pleasantness. The rest of the indicators: familiarity, freshness, naturalness and calmness, are secondary indicators, but in working together with basic indicators, contribute to the primary indicators, changing with the context of places, physical environment and individuals. Weightings of indicators in different contexts might vary, which need further investigations in future studies.

4. Conclusions

This study took an inductive qualitative approach and investigated people's perceptions of smellscapes through people's descriptions of the smell environment and their experiences onsite. Using the pleasantness dimension, nine indicators have been identified influencing the perceptual quality of smellscapes: intensity, purity, cleanliness, freshness, calmness, liking, familiarity, appropriateness and naturalness. Although each indicator has specific meaning and

Xiao, J., Tait, M., & Kang, J. (2018). A perceptual model of smellscape pleasantness. *Cities*. In press.

influence, they are inter-related and respond to components composing the smellscape concept: smells and smell sources, people's preferences and past experiences, context of places and the physical environment. The perceptual model in line with the smellscape concept also provides a communicational tool among urban planners and designers to describe and assess qualities of smellscapes.

The derived indicators work at different strengths in different contexts influencing levels of smellscape pleasantness. Four types of smellscape pleasantness were found in the studied intermodal transit spaces: preference and nuisance dominated, healthiness dominated, memories and habituations dominated, context dominated. Temporal factors in intermodal transit spaces have much impact on perceptual indicators such as traffic and passenger flows, weather and smells people bring with them. Management of smell sources, ventilations and vehicle access, seating can control influences of such temporal factors. Discussion or application of indicators thus needs to refer to the temporal conditions onsite.

The indicators based smellscape pleasantness model constructed in the paper could be developed into a smellscape protocol to identify positive and negative perceptual features of smellscapes, setting out objectives for smellscape planning and design. It can be developed into a smellscape protocol which can be applied in large-group fieldwork to collect data for quantitative studies, which can be used to support findings from observations and qualitative interviews as well as provide a more generalised conclusion on the investigated smellscape quality. However, validations are needed to apply the model in a different language and cultural context. Further research is needed to investigate physical elements influencing each indicator to inform detailed smellscape design strategies based on established objectives in specific contexts.

Acknowledgement

Jieling Xiao is a lecturer in environmental design at Birmingham School of Architecture and Design. The work included in the paper is from her doctoral work completed at Department of Urban Planning and Studies, University of Sheffield, supervised by the second author and third author.

References

- Aletta, F., Kang, J., & Axelsson, Ö. (2016). Soundscape descriptors and a conceptual framework for developing predictive soundscape models. *Landscape and Urban Planning*, 149, 65–74.
- Anderson, K., & Smith, S. J. (2001). Emotional geographies. *Transactions of the Institute of British geographers*, 26(1), 7–10.
- Arnot, C. (1991). Relaxed with the soothing essence of mum. *The Independent*, 23 July, 13.
- Axelsson, Ö. (2015). How to measure soundscape quality. Euronoise conference, Maastricht, The Netherlands, 2015 (pp. 1477–1481). . Available at: <http://www.conforg.fr/euronoise2015/proceedings/data/articles/000067.pdf>.
- Axelsson, Ö., Nilsson, M. E., & Berglund, B. (2010). A principal components model of

Xiao, J., Tait, M., & Kang, J. (2018). A perceptual model of smellscape pleasantness. *Cities*. In press.

soundscape perception. *The Journal of the Acoustical Society of America*, 128(5), 2836–2846.

Ayabe-Kanamura, S., Schicker, I., Laska, M., Hudson, R., Distel, H., Kobayakawa, T., & Saito, S. (1998). Differences in perception of everyday odors: A Japanese-German cross-cultural study. *Chemical Senses*, 23(1), 31–38.

Balez, S. (2002). Characterisation of an existing building according to olfactory parameters. First international workshop: Architectural and urban ambient environment, Février, 2002 (pp. 1–11). . Retrieved from: <https://halshs.archives-ouvertes.fr/halshs-00596759/document>.

Bertolini, L. (1996). Nodes and places: Complexities of railway station redevelopment. *European Planning Studies*, 4(3), 331–345.

Charmaz, K. (2006). *Constructing grounded theory: A practical guide through qualitative analysis*. London: Sage.

Classen, C., Howes, D., & Synnott, A. (1994). *Aroma: The cultural history of smell*. New York: Taylor & Francis.

Davidson, J., & Milligan, C. (2004). Embodying emotion sensing space: Introducing emotional geographies. 523–532.

Degen, M. (2014). The everyday city of the senses. In Paddison, R. & McCann, E. (Eds.). *Cities and social change* (pp. 92–111). London: Sage.

Degen, M. M., & Rose, G. (2012). The sensory experiencing of urban design: The role of walking and perceptual memory. *Urban Studies*, 49(15), 3271–3287.

Department for Environment, Food and Rural Affairs [DEFRA] (2010). *Odour guidance for local authorities*. London. Retrieved from: https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/69305/pb13554-local-auth-guidance-100326.pdf.

Distel, H., Ayabe-Kanamura, S., Martínez-Gómez, M., Schicker, I., Kobayakawa, T., Saito, S., & Hudson, R. (1999). Perception of everyday odors—Correlation between intensity, familiarity and strength of hedonic judgement. *Chemical Senses*, 24(2), 191–199.

Duarte, F. (2017). *Space, place and territory: A critical review on spatialities*. London: Taylor & Francis.

Edwards, B. (2013). *The modern station: New approaches to railway architecture*. London: Taylor & Francis.

el- Khoury, R. (2006). Polish and deodorize. In Drobnick, J. (Ed.). *The smell culture reader* (pp. 18–28). Oxford: Berg Publishers.

- Xiao, J., Tait, M., & Kang, J. (2018). A perceptual model of smellscape pleasantness. *Cities*. In press.
- Engen, T. (1991). *Odor sensation and memory*. Westport: Greenwood Publishing Group.
- Engen, T., & Ross, B. M. (1973). Long-term memory of odors with and without verbal descriptions. *Journal of Experimental Psychology*, 100(2), 221.
- Fiebig, A., & Schulte-Fortkamp, B. (2004). Soundscapes and their influence on inhabitants—New findings with the help of a grounded theory approach. *The Journal of the Acoustical Society of America*, 115(5), 2496.
- Gallese, V., & Lakoff, G. (2005). The brain's concepts: The role of the sensory-motor system in conceptual knowledge. *Cognitive Neuropsychology*, 22(3-4), 455–479.
- Glaser, B. G., & Strauss, A. L. (2009). *The discovery of grounded theory: Strategies for qualitative research*. London: Transaction Publishers.
- Henshaw, V. (2013). *Urban smellscape: Understanding and designing city smell environments*. London: Routledge.
- Herz, R. S. (1998). An examination of objective and subjective measures of experience associated to odors, music, and paintings. *Empirical Studies of the Arts*, 16(2), 137–152.
- Herz, R. S. (2006). I know what I like: Understanding odor preferences. In Drobnick, J. (Ed.). *The smell culture reader* (pp. 190–203). Berg Publishers: Oxford.
- Herz, R. S., & Cupchik, G. C. (1995). The emotional distinctiveness of odor-evoked memories. *Chemical Senses*, 20(5), 517–528.
- Herz, R. S., & Engen, T. (1996). Odor memory: Review and analysis. *Psychonomic Bulletin & Review*, 3(3), 300–313.
- Hoover, K. C. (2009). The geography of smell. *Cartographica: The International Journal for Geographic Information and Geovisualization*, 44(4), 237–239.
- Institution of Air Quality Management [IAQM] (2014). *Guidance on the assessment of odour*. London. Retrieved from: <http://www.iaqm.co.uk/text/guidance/odour-guidance-2014.pdf>.
- ISO, T (2014). 43/SC 1/WG 54, 12913-1 acoustics–soundscape–part 1: "Definition and conceptual framework". International Organization for Standardization, 1559–1564.
- Jennings, P., & Cain, R. (2013). A framework for improving urban soundscapes. *Applied Acoustics*, 74(2), 293–299.
- Jeon, J. Y., Hwang, I. H., & Hong, J. Y. (2014). Soundscape evaluation in a catholic cathedral and buddhist temple precincts through social surveys and soundwalks. *The Journal of the Acoustical Society of America*, 135(4), 1863–1874.

- Xiao, J., Tait, M., & Kang, J. (2018). A perceptual model of smellscape pleasantness. *Cities*. In press.
- Jones, W. (2006). *New transport architecture: Travel hubs in the 21st century*. New York: Sterling Publishing Company.
- Lang, P. J. (1969). The mechanics of desensitization and the laboratory study of human fear. *Behavior therapy: Appraisal and status* (pp. 160–191). New York: McGraw-Hill.
- Lefebvre, H. (1991). *The production of space*. Vol. 142. Oxford: Blackwell.
- Liu, F., & Kang, J. (2016). A grounded theory approach to the subjective understanding of urban soundscape in Sheffield. *Cities*, 50, 28–39.
- Majid, A., & Burenhult, N. (2014). Odors are expressible in language, as long as you speak the right language. *Cognition*, 130(2), 266–270.
- McLean, K. (2013). *Smellmap: Glasgow*. Proceedings of the 26th International Cartographic Conference, 25-30 August 2013, Dresden, Germany.
- Mehrabian, A., & Russell, J. A. (1974). *An approach to environmental psychology*. Cambridge: The MIT Press.
- Moncrieff, R. W. (1966). *Odour preferences*. London: Leonard Hill.
- Najafi, M., & Shariff, M. K. B. M. (2011). The concept of place and sense of place in architectural studies. *International Journal of Human and Social Sciences*, 6(3), 187–193.
- Pallasmaa, J. (2012). *The eyes of the skin: architecture and the senses*. New Jersey: John Wiley & Sons.
- Porteous, J. D. (2006). Smellscape. In J. Drobnick (Ed.). *The smell culture reader* (pp. 89–106). Oxford: Berg Publishers Original work was published in *Progress in Human Geography*, 9(3), pp.356–378.
- Reinarz, J. (2014). *Past scents: Historical perspectives on smell*. Urbana: University of Illinois Press.
- Rodaway, P. (1994). *Sensuous geographies: Body, sense and place*. London: Routledge.
- Russell, J. A. (2003). Core affect and the psychological construction of emotion. *Psychological Review*, 110(1), 145–172.
- Russell, J. A., & Mehrabian, A. (1977). Evidence for a three-factor theory of emotions. *Journal of Research in Personality*, 11(3), 273–294.
- Schafer, M.R. (1977). *The soundscape: Our sonic environment and the tuning of the world*. Vancouver: *Destiny Books*.
- Schiffman, H. R. (1990). *Sensation and perception: An integrated approach*. West Sussex: John Wiley & Sons.

Xiao, J., Tait, M., & Kang, J. (2018). A perceptual model of smellscape pleasantness. *Cities*. In press.

Tolaas, S. (2010). The City from the perspective of the nose. In Mostafavi, M. & Doherty, G. (Eds.). *Ecological urbanism*. Baden: Lars Müller Publishers.

Trip, J. J. (2007). What makes a city? Planning for 'Quality of Place'. The case of high-speed train station area development. Vol. 12. Amsterdam: IOS Press.

Tuan, Y. F. (1977). *Space and place: The perspective of experience*. Minneapolis: University of Minnesota Press.

Tuan, Y. F. (1991). Language and the making of place: A narrative-descriptive approach. *Annals of the Association of American Geographers*, 81(4), 684–696.

Wrzesniewski, A., McCauley, C., & Rozin, P. (1999). Odor and affect: Individual differences in the impact of odor on liking for places, things and people. *Chemical Senses*, 24.6(1999), 713–721.

Yin, R. K. (2009). *Case study research: Design and methods* (fourth edition). London: SAGE.

Zardini, M. (2005). Toward a sensorial urbanism. In Zardini, M. (Ed.). *Sense of the City: An Alternate Approach to Urbanism* (pp. 17–27). Montreal, QC: Lars Muller Publications.