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The development of highway nuisance perception

Experiences of residents along the Southern Ring Road in Groningen, the Netherlands

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Abstract
The perception of highway nuisance i.e. noises, air pollution and barrier-effects, is associated with negative effects on health and quality of life. This study aims to gain a deeper understanding of the development of highway nuisance perception among residents. Interviews were conducted with residents in 32 households living along the Southern Ring Road, a highway which crosses various neighbourhoods in the city of Groningen, the Netherlands.

Various themes emerged from the interviews which were important in the development of residents' perceptions of highway nuisance. For example, our interviews showed that residents who had not explicitly chosen to live next to a highway were more acutely affected by the negative externalities of that highway later. Perceived environmental changes, often due to governmental actions such as new/extended noise barriers, removal of trees and newly constructed buildings causing noise reflection, also played a role in the interviewees' development of nuisance perception. In addition, the interviewees indicated that expectations about future highway developments influenced their current perception of highway nuisance: described as anticipation effects. Interviewees also indicated that recent information about the potentially harmful effects of air pollution increased their concerns about living near the highway. A final theme discussed were differences in the extent to which residents were able to develop coping strategies to reduce the amount of highway nuisance perception.

The participants' experiences indicate the importance of further integration between the planning of highway infrastructure and the broader environment in order to reduce nuisance perceptions and improve residential quality near highways.

Keywords:
Highway nuisance perception, development, residents, urban highway, interviews

Introduction

Highway infrastructure is associated with negative physical and psychological health effects through noise and air pollution (e.g. Appatova et al., 2008; National Institute for Public Health and the Environment, 2013; Shepard et al., 2010; Stansfeld et al., 2000), and visual and physical obstructions, i.e. barrier effects (e.g. Arts, 2004; Tillema et al., 2012), especially in residential areas. Increased attention has therefore been paid to mitigating the negative impacts i.e. nuisances of highways. Examples of these measures include noise barriers, insulation of residences, more silent asphalt and cleaner traffic (Ministry of Infrastructure and the Environment, 2015; Rijkswaterstaat, 2015). Nevertheless, mitigating nuisance from infrastructure such as highways in residential areas appears to be a difficult task (e.g. Weber, 2013), partly because of differences in how the exposed negative effects of infrastructure are actually *perceived* by people (e.g. Fields, 1993; Hamersma et al., 2015; Miedema and Vos, 1999; Tudor et al., 2015). In other words, whereas some people perceive nuisance from highways, others do not. When nuisance is perceived, this can result in psychological stress (Stallen, 1999) and a reduction in residential satisfaction (e.g. Hamersma et al., 2014; Kroesen et al., 2010). This underlines the relevance of understanding nuisance perception.

The perception of noise and air pollution has been frequently studied and found to be associated with several environmental and personal factors, including source proximity, environmental quality, government perception, expected changes in the polluting source, socio-demographics, psychological aspects, source awareness and coping (e.g. Guski, 1999; Fields, 1993; Hamersma et al., 2015; Miedema and Vos, 1999). Nevertheless, to date, most of these studies have focused on other infrastructural contexts, on explaining one type of nuisance, or on quantifying relationships with residential satisfaction , often at a single moment in time. Previous studies have not dealt in detail with how the overall perception of highway nuisance evolves in interaction with residential experiences in the broader living context. According to Gifford (2007), perceptions of the environment are formed in interactions between individuals and their physical settings. Greater understanding of the interaction between the residents' highway nuisance perception and broader residential experiences could be of added value in understanding why highway nuisance perception does, or does not, develop in certain cases.

This paper aims to explore motivations behind the development of highway nuisance perception among residents during the residential experience. To this end, we adopted a qualitative case study approach based on in-depth interviews. The use of such a qualitative approach facilitates the exploration of phenomena in relation to experiences in daily life (Elliott, 1999; Eyles, 1998; Wakefield et al., 2001). Interviews were conducted with people from various backgrounds. This way, we aimed to address the views of the 'silent majority' which often go unheard in, for example, public meetings (e.g. Woltjer, 2000; Tillema et al., 2012). All our interviewees lived along the Southern Ring Road, an urban route joining two highways and passing through the outskirts of the city of Groningen, the Netherlands. At the time the interviews were conducted, the residents of the neighbourhoods along the highway were facing an imminent highway adjustment project. The research context chosen is interesting not only because it allows the study of the development of highway nuisance perception in a densely populated area, but also reflection on its relationship to future changes.

Increasing our knowledge of the experiences of the broad range of residents regarding the effects of pollution could be of value to traffic policy and planning practice in optimizing mitigation and environmental quality (e.g. Henningsson et al., 2015; Weber, 2013). This paper could thus provide insights for increasing residential satisfaction near highways or other infrastructure.

A literature review: factors influencing nuisance perception

The presence of a highway can foster various negative externalities which can influence the residential context. Tillema et al. (2012) summarize these effects into three types of highway nuisance: noise, air pollution and barrier effects. The literature reveals several environmental and personal factors which could play a role in understanding whether or not highway nuisance perception develops among residents. Studies of different types of nuisance, such as noise and air pollution, and of different types of traffic are discussed simultaneously.

Environmental factors and nuisance perception

The development of nuisance perception could be related to the environmental circumstances in which a person lives. Several studies have found a relationship between the perception of noise and air pollution nuisance and people's actual proximity to the pollution source, often measured by *calculated exposure*, but with variation in the strength of this effect (e.g. Hamersma et al., 2015; Miedema and Vos, 1999; Schreckenberg, 2010). Along the same lines, studies found that noise nuisance perception is lower for residents living in insulated residences, as they are better protected against high exposure (e.g. Fields, 1993).

Studies also found indications of relationships between nuisance perception and the broader *perceived environment*. For example, the study by Hamersma et al. (2015) found associations between the perceived attractiveness of the environment, perceived greenery and residents' perception of highway noise, air pollution and barrier-effect nuisance. The study by Gidlöf-Gunnarsson and Öhrström (2007) also indicated that proximity to greenery seems to mitigate the perception of noise nuisance. The relationship between noise perception and noise barrier design has also been studied. In general, nuisance perception seems to decrease when the view of the road is reduced (e.g. Banjung et al., 2003). Joynt and Kang (2010) argued that transparent and vegetative barriers are regarded as more pleasant, but this is not reflected by lower nuisance perception. The type of barrier and the residents' engagement in the design of barriers were also found to be important in this respect (Joynt, 2005; Nederveen 2007). Associations were also found between people's *thoughts about the government* and the perception of nuisance (Guski, 1999; Kroesen et al., 2008; Saksena, 2007). If people fear a cause of nuisance, for example pollution, they usually hope that the government will protect them from it. In the context of noise perception, Guski (1999) indicated that when people feel that the actions of the authorities are insufficient, this can increase the amount of nuisance perceived.

Another relevant factor mentioned in the literature in understanding nuisance perception is the influence of expectations of future environmental changes. Studies seeking to explain noise nuisance perception found indications that people's reactions to noise are more negative when an increase in noise is expected, whereas they are more positive when a decrease is expected: *anticipation effects* (Brown and Van Kamp, 2008; Hatfield et al., 2001; Job et al., 1996).

Personal factors and nuisance perception

Several studies also referred to more personal aspects which could explain why differences in nuisance perception happen. Hamersma et al. (2015) found that factors such as *socio-demographic and attitudinal* factors were associated with the perception of highway nuisance. For example, they found that people with a negative attitude about cars, non-highway users, home owners and older people had higher nuisance perceptions regarding a highway. In general, studies seem to argue that traffic nuisance perception has much more to do with attitude than with socio-demographic factors (e.g. Fields, 1993;

Miedema and Vos, 1999). For example, Fields (1993) concluded that noise perception was related to attitudinal factors such as fear of danger, noise sensitivity and noise prevention beliefs, whereas it was much less related to aspects such as income, age, home ownership and education.

Related to the latter, studies found indications of a relationship between people's *awareness or information* about the potential or actual effects of the polluting source and their perception of nuisance. For example, a study by Hamersma et al. (2015) found that people who indicated an explicit preference for a highway location when making their location choice, reported lower perception of highway nuisance. This finding points to the potential importance of residential self-selection in understanding nuisance perception, i.e. people's tendency to make residential choices based on travel behaviour, abilities, needs and preferences (e.g. Mokhtarian and Cao, 2008; Van Wee, 2009). Nevertheless, the study by Nijland et al. (2007) found no proof that the number of noise sensitive people was lower in high compared to low noise exposure areas. One of the explanations for their findings was that people were perhaps not aware beforehand that they were noise sensitive, or that other residential characteristics were more important to people. Compared to noise and barrier aspects, the presence of air pollution is even less visible; invisibility could decrease awareness of the potential health effects of air pollution (Bickerstaff, 2004; Saksena, 2007). Studies found indications that the amount of perceived air pollution nuisance is related to people's experiences of air pollution or knowledge about its potential negative effects (e.g. Saksena, 2007). The media could also increase the awareness of air pollution (e.g. Bickerstaff and Walker, 2001; Saksena, 2007). This suggests that information could play a role in the perception of nuisance.

A final aspect we would like to address because it is indicated as important to understanding nuisance perception in studies is people's *ability to cope* with a situation. According to Miedema (2007), being able to cope with daily background stressors is important for human wellbeing and health. Lazarus (1991) relates the idea of coping to a person's belief and confidence in somehow being able to manage a problem. He defined two categories of coping strategies: problem-focused strategies, aimed at actively changing or eliminating the source, and emotional strategies which focus on influencing the attitude of people to the source. In the context of air pollution, studies indicated that people sometimes seem to emotionally disassociate themselves from air pollution by associating the problem to other areas and not to their own neighbourhood, which is known as cognitive dissonance (e.g. Bickerstaff and Wakefield, 2001; Saksena, 2007). In the context of aircraft noise, Kroesen et al. (2008) indicated an important relationship between people's ability to cope and the perception of nuisance.

To conclude, studies point to several factors as potential determinants of nuisance perception regarding highway or other infrastructure. In the remainder of this article we will try to gain a deeper understanding of the factors which play a role in understanding the development of highway nuisance perception among residents.

The study area: Southern Ring Road in Groningen, the Netherlands

The residential context selected for this study is the Southern Ring Road area in Groningen, a city of approximately 200,000 residents in the northern Netherlands. The Southern Ring Road, hereinafter also referred to as 'highway', serves as part of the A7 highway, connecting the West of the Netherlands to the German border area. The highway was constructed between 1965 and 1970 and passes through several neighbourhoods in the city (Figure 1). The neighbourhoods surrounding the highway contain both old and more modern residences. Most neighbourhoods surrounding the highway have a high population density and a considerable number of the residences are apartments. Nevertheless, there are also some areas along

the highway with a lower density and more detached and semi-detached dwellings, for example in the Rivierenbuurt, Buitenhof and Hoogkerk areas (Figure 1). The neighbourhoods house people of all ages.

At the time of study, a recent ministerial order had been issued (the 'Tracébesluit') for the substantial redevelopment of the Southern Ring Road and its surroundings (Ministry of Infrastructure and the Environment, 2015), after a planning process lasting several years. These plans aim to improve 1) accessibility, by adding extra lanes and connections; 2) liveability in the city, by routing the highway underground or below grade in the landscape and including more greenery; and 3) traffic safety, by including separate crossings and fewer access ramps (Southern Ring Project, 2015). The adjustment project is controversial; at the time of the study some protest groups were still opposing the project decision in court. Execution of the project is planned to start in late 2016 (Southern Ring Project, 2015).

Methodology: in-depth interviews with residents along the Southern Ring Road

We interviewed residents from 32 homes in close proximity to the Southern Ring Road to develop an understanding of experiences with highway nuisance. Four interviews were conducted with couples living in the same residence, resulting in a total of 38 participants. The residents we interviewed all lived within 250 metres of the highway. Table 1 provides background information on all the individual respondents; Table 2 gives a summary of those background variables.

All respondents were invited to participate by a letter providing information about the research. Invitation letters were distributed in several streets near the Southern Ring Road. We actively approached residents by ringing their doorbells a few days after the letter was delivered, at different times during the day for several days for a maximum of three times in case no contact was reached. Residents were also given the opportunity to inform us about their intention to participate or not to in advance or afterwards. As it proved difficult to find a sufficiently large group of residents who perceived nuisance from the highway, some residents were also approached by snowballing, i.e. through personal recommendation by other interviewees or by neighbourhood representatives, or by their participation in an earlier questionnaire on the same research topic (see Hamersma et al., 2014). We thus tried to reach as broad a range of residents as possible with respect to highway nuisance perception and ensuring variation in neighbourhood, length of residence, homeowners and renters, age and household type. New respondents were approached and interviewed until a sufficient variation in perceived highway nuisance perception was reached and until saturation was reached in the variety of motivations provided by residents behind the development of highway nuisance perception (Hennink et al., 2011; Ritchie and Lewis, 2003).

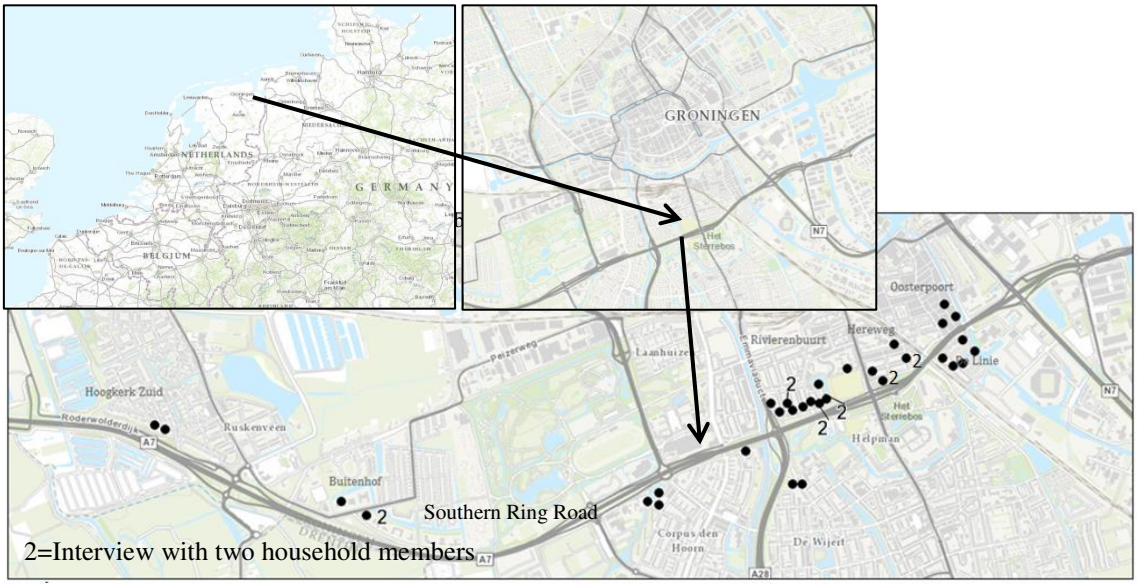
The interviews were conducted between April and June 2015 and varied in length between 30 and 120 minutes. Most interviews were conducted in the interviewee's home. When interviews were held with couples, we spoke with both members of the couple at the same time. Both interviewees were asked to reflect on each other's motivations. The interviewees were informed that the interview was about their broad residential experience and the focus on the 'Southern Ring Road' was not explicitly mentioned in the invitation, to ensure answers were unbiased. Semi-structured interviews were conducted with open-ended questions. The interviews started generally by asking about the decision to locate to the area and current residential satisfaction. If the highway was mentioned by interviewees at this stage, this was an early indication of its importance to the speaker. After the general start, the perceived negative effects of the highway were discussed further. We only discussed negative effects explicitly mentioned by interviewees. We tried to grasp what and how factors were important in understanding the development of residents' current nuisance perception of the highway. More specifically, we discussed the residents' perceptions of highway nuisance by reflecting back on 1) their location choice, 2) its development during

their residential experience and the coping strategies developed, and 3) their thoughts about future changes to their location. We varied the order in which we asked the questions according to participants' responses to improve interview flow and responsiveness (Quinn-Patton, 1990; Wakefield et al., 2001).

The interviews were taped, transcribed and analysed by thematic coding. More specifically, we manually looked for overarching themes or patterns in the motivations given by residents for the development of highway nuisance perception. The key themes were identified based on the relevance to the research objectives, the frequency a theme was mentioned, and the extent to which it marked out differences between groups of residents (e.g. Wakefield and Elliot, 2000; Wakefield et al., 2001), and were discussed by the researchers in the team. Although themes were primarily based on the motivations of residents thus following an inductive approach, we linked the themes that were found back to existing literature. As such, the coding process was based on a combination of an inductive and deductive approach (Hennink et al., 2011; Ritchie and Lewis, 2013).

For ethical reasons, the interviewees' informed consent to participate had to be ascertained (e.g. Ritchie and Lewis, 2003). All residents were informed beforehand about the general purpose of the study to gain insight in their broad residential experience, the research team, the handling of data and the duration of the interview. After the interview, we provided further specific details about the research aims, in case people were interested. We also acknowledged that participation was voluntary and gave people the option to withdraw from the interview at any time and to check their transcripts afterwards, complemented by a signed letter of consent.

Figure 1: Map of research area (the respondents' homes are marked with dots)



NB To guarantee anonymity, the respondent numbers are not presented in the map
Source: ESRI, 2015.

Table 1: Overview of interviewees

Nr	Gender	Age	Neighbourhood	Car owner-ship	Type of house	Household type	Home owner	Distance from highway (metre)[2]	Noise level (Based on MER, 2014)[3]	Highway Noise nuisance reported	Highway Air pollution nuisance reported	Highway Barrier effect nuisance reported	Any highway nuisance reported
1	Male	60+	Hoogkerk-Zuid	Yes	Detached	Two-person	Yes	<50m	55-60	No	No	No	No
2	Male	60+	Hoogkerk-Zuid	Yes	Detached	Two-person	Yes	<50m	55-60	No	No	No	No
3	Male	40-60	Buitenhof	Yes	Terraced	Family	Yes	50-150m	55-60	Yes	No	No	Yes
4a[1]	Male	40-60	Buitenhof	No	Terraced	Family	No	50-150m	50-55	Yes	Yes	No	Yes
4b[1]	Female	40-60								No	Yes	No	Yes
5	Male	20-40	Corpus	Yes	Apartment (7th floor)	Two-person	Yes	<50m	55-60	Yes	Yes	No	Yes
6	Male	20-40	Corpus	Yes	Apartment (6th floor)	Two-person	Yes	<50m	55-60	No	No	No	No
7	Female	40-60	Corpus	No	Apartment (5th floor)	One-person	No	50-150m	50-55	No	Yes	No	Yes
8	Male	20-40	Wijert	No	Apartment (3rd floor)	One-person	Yes	<50m	60-65	No	No	No	No
9	Female	20-40	Wijert	Yes	Apartment (3rd floor)	One-person	Yes	50-150m	55-60	No	No	No	No
10	Male	60+	Wijert	Yes	Apartment (3rd floor)	One-person	No	50-150m	55-60	Yes	Yes	No	Yes
11	Female	20-40	Rivierenbuurt	No	Apartment (5th floor)	One-person	Yes	<50m	60-65	No	No	No	No
12	Male	60+	Rivierenbuurt	Yes	Apartment (6th floor)	Two-person	Yes	<50m	60-65	Yes	Yes	No	Yes
13a[1]	Male	60+	Rivierenbuurt	No	Apartment (3rd floor)	Two-person	No	<50m	55-60	No	No	No	No
13b[1]	Female	60+								Np	No	No	No
14	Female	40-60	Rivierenbuurt	No	Apartment (3rd floor)	One-person	No	<50m	55-60	No	No	No	No
15	Female	60+	Rivierenbuurt	No	Apartment (3rd floor)	One-person	No	<50m	55-60	No	No	No	No
16	Female	20-40	Rivierenbuurt	Yes	Apartment (ground floor)	Two-person	No	<50m	55-60	No	Yes	No	Yes
17	Female	60+	Rivierenbuurt	Yes	Semi-detached	One-person	Yes	50-150m	55-60	Yes	No	No	Yes
18a[1]	Male	40-60	Rivierenbuurt	Yes	Semi-detached	Family	Yes	<50m	55-60	No	No	No	No
18b[1]	Female	40-60								Yes	Yes	No	Yes
19a[1]	Male	60+	Rivierenbuurt	Yes	Semi-detached	Two-person	Yes	<50m	55-60	No	No	No	No
19b[1]	Female	40-60								Np	Yes	No	Yes
20	Male	40-60	Rivierenbuurt	Yes	Apartment (ground floor)	Two-person	Yes	150-250m	55-60	Yes	No	No	Yes
21	Male	40-60	Herewegbuurt	Yes	Terraced	Family	Yes	50-150m	55-60	Yes	Yes	No	Yes
22a[1]	Male	60+	Herewegbuurt	Yes	Detached	Two-person	Yes	<50m	60-65	No	Yes	No	Yes
22b[1]	Female	60+								Np	Yes	No	Yes
23a[1]	Male	60+	Herewegbuurt	Yes	Detached	Two-person	Yes	<50m	55-60	No	No	No	No
23b[1]	Female	40-60								No	No	No	No
24	Female	40-60	Herewegbuurt	Yes	Terraced	One-person	Yes	150-250m	50-55	No	No	No	No
25	Male	40-60	Linie	No	Apartment (2nd floor)	Family	No	150-250m	55-60	No	Yes	No	Yes
26	Male	20-40	Linie	Yes	Apartment (3rd floor)	Two-person	No	150-250m	55-60	Yes	Yes	No	Yes
27	Male	20-40	Linie	Yes	Apartment (ground floor)	Family	No	<50m	55-60	No	No	No	No
28	Female	60+	Linie	Yes	Terraced	One-person	No	<50m	60-65	No	No	No	No
29	Male	60+	Linie	Yes	Detached	Two-person	Yes	150-250m	50-55	No	No	Yes	Yes
30	Female	20-40	Oosterpoortbuurt	Yes	Apartment (1st floor)	Family	No	<50m	60-65	No	Yes	No	Yes
31	Female	20-40	Oosterpoortbuurt	Yes	Apartment (1st floor)	One-person	No	<50m	60-65	No	No	No	No
32	Female	40-60	Oosterpoortbuurt	Yes	Detached	One-person	Yes	<50m	55-60	Yes	No	Yes	Yes

[1]Interviews were conducted with two persons within the same household

[2]Dwellings of all respondents living within 50 metres from the highway are positioned directly alongside the highway (although most of times noise barriers are situated between houses and highway). This does not apply to dwellings of interviewees living 50 metres or more away from the highway.

[3]Milieu Effect Rapportage (MER) Aanpak Ring Zuid (´Environmental Impact Assessment Southern Ring Project´)

Table 2: Summary of respondent background information

Socio-demographics	Subcategory	# Interviewees
Gender	Male	20
	Female	18
Age	20-40	10
	40-60	14
	60+	14
Distance from highway	<50m	25
	50-150m	8
	150-250m	5
Neighborhood	Buitenhof	3
	Corpus	3
	Herewegbuurt	6
	Hoogkerk-Zuid	2
	Linie	5
	Oosterpoortbuurt	3
	Rivierenbuurt	13
	Wijert	3
Car ownership	Yes	28
	No	10
Type of house	Apartment	19
	Detached	8
	Terraced	5
	Semi-detached	6
Household type	Family	9
	One-person	12
	Two-person	17
House owner	Yes	23
	No	15
Distance from highway	<50m	25
	50-150m	8
	150-250m	5
Noise level	50-55 DB	5
	55-60 DB	25
	60-65 DB	8
Any highway nuisance reported	Yes	20
	No	18
Highway noise nuisance reported	Yes	11
	No	27
Highway air pollution nuisance reported	Yes	15
	No	23
Highway barrier effect nuisance reported	Yes	2
	No	36

Findings: The development of Southern Ring Road nuisance perception in residents

Below we present the main findings of our analysis with regard to the development of nuisance perception regarding the Southern Ring Road. The themes which appeared from the interviews as important to understanding the development of highway nuisance perception include the level of highway awareness when making a residential location choice, the role of a changing environment, future highway plans, increased information, and the individual ability to cope. The findings were structured by the themes which appeared from the interviews as being relevant in the development of (any type of) highway nuisance, instead of by type of highway nuisance. As such, different types of highway nuisance (noise, air pollution etc.) could be discussed within several themes (awareness, ability to cope etc.)[1]. In describing the themes, we selected some quotes which were most appropriate in visualizing the different viewpoints among residents on the chosen themes.

[1] More specific information about the thematic coding process could be provided by the authors on request

Awareness of choosing to live in a highway location

One of the aspects which appeared important in the thinking behind residents' current level of nuisance perception was the extent to which they were aware of choosing housing near the Southern Ring Road.

Most residents indicated that they had known about the presence of the highway when they chose their residential location. Several explicitly evaluated positive aspects of the highway in their location choice. For example, a group of interviewees mentioned that they preferred a location near a highway for accessibility reasons, to reach activities such as work, and family and friends. Some residents even mentioned that proximity to the highway made it easier to plan their trips. As one man pointed out:

'Strategically, this is an ideal location for journeys southward. I can see whether there are traffic jams. If I spot a traffic jam on the viaduct in the morning when I am about to leave, I take an alternative route. That takes a little bit more time, but you avoid the traffic jam.' (Respondent #1, male, 60+, <50m from highway)

A number of other advantages of the presence of the highway were also evaluated positively by residents in their location choices. For example, a few residents mentioned that having the highway in front of their house instead of other houses gave them a greater sense of privacy. The respondents who mentioned privacy were usually women. As one woman said:

'We could also have lived in front of another flat. That I would have disliked more, because you feel that others can see you. So from that perspective, I thought that living next to a highway would be an advantage.' (Respondent #16, female, 20-40, <50m from highway)

Three older interviewees who live directly next to the highway emphasized positive liveliness aspects created by a view of the highway, which they valued in their residential location choice. For them, living along the highway gave them something to look at, which they appreciated.

'At one point, they wanted to construct a noise barrier which would have reduced our view of the highway. We circulated a questionnaire in the neighbourhood, and 90 percent turned out to oppose this. Older people like to watch trucks and cars, because they are something to look at.' (Respondent #13a, male, 60+, <50m from highway)

Several other residents did not specifically see the advantages of the highway when they chose to live near it, but indicated that they had evaluated the potentially negative effects of the highway in their location choice and felt they would be bearable. Some mentioned that they based their evaluation of potential highway nuisance on previous experience of living near roads and highways. For example, a woman indicated that her previous home had also been near a highway and she had not perceived a severe nuisance at that time as she got used to it. Based on this, she was not really concerned about the proximity of the highway when choosing her current residence.

'The house we lived in before was also near a highway, with a lot of traffic which we got used to. I have the feeling that the location we have now is even quieter, perhaps because of the noise wall.' (Respondent #16, female, 20-40, <50m from highway)

Other interviewees indicated that they had evaluated the potential nuisance of the highway by checking it before choosing their current residence. They listened to the noise and observed the presence of the highway by visiting the place several times before deciding to buy or rent their home. On the basis of that evaluation, they judged the situation acceptable. As one man said:

'Well, I checked beforehand whether I would be bothered by the highway because of the nuisance or cars passing. Before I decided to buy the house I visited it several times, at several times of the day, during peak and off-peak times, but I did not perceive any highway nuisance.' (Respondent #8, male, 20-40, <50m from highway)

However, another group of interviewees mentioned that they made a less well-informed decision to live near the highway. They indicated that they were much less or only partly aware of the potentially negative effects of the highway when deciding where to live because they focused on other aspects which they judged at that time as being more important, such as the positive characteristics of the house or the neighbourhood. Awareness of the negative effects of the highway increased for some of these residents as they lived in the neighbourhood and experienced the effects of the nuisance. As one man indicated:

'At that time, the highway was not really a factor in our considerations compared to other things. But as you live here, you get a better feel for what it means. I think the negative effects have started outweighing the positive effects.' (Respondent #20, male, 40-60, 50-150m from highway)

Several interviewees also indicated that although they were aware of the highway noise when they chose the location, they thought less about the potential effects of air pollution as those were less 'perceptible'. When living in the area, these residents noticed a fine dust on for example their laundry and their balconies, which made them more aware of the potentially negative effects of air pollution. One woman mentioned:

'I didn't realize the potential effects of air pollution beforehand. I checked the noise of the highway and thought…This is ok. However, I only started to notice the effects of air pollution when I experienced the dust and smell on my balcony. That is something you only start to experience when living here...' (Respondent #7, female, 40-60, 50-150m from highway)

The group of interviewees who felt surprised by the negative effects of the highway were particularly prone to indicating that they currently perceive highway nuisance. A few residents who were negatively surprised by the presence of the highway also indicated that they would be more alert about checking for potential nuisance were they to move again.

In contrast, some residents also indicated that they had discovered the advantages of a location near the highway in terms of accessibility only after living in the area. For example, one woman indicated that her interest in good accessibility by car grew after buying a car:

'Well, initially, I didn't have a car. Now I have one, it is easy to park it nearby. You can easily access the highway, which is really convenient. I therefore now value the positive effects of the highway over its negative effects.' (Respondent #31, female, 20-40, <50m from highway)

A changing residential environment

Another aspect which seemed important from the interviewees' stories concerning the development of residents' perception of nuisance from the Southern Ring Road were perceived changes in the direct environment.

For example, several interviewees indicated that the perception of nuisance was related to seasonal differences. Many interviewees mentioned that the extent to which they perceived nuisances from the highway was dependent on the direction from which the wind blows. Some interviewees indicated that the highway is more present in the summer period when they spend more time outdoors. A few residents also indicated to perceive more nuisance from the highway in rainy periods when the rain on the pavement creates an extra noise when cars drive over it.

'The nuisance of the highway is most present in rainy periods, because rain creates a kind of noise.' (Respondent #11, female, 20-40, <50m from highway)

Interviewees also referred to more structural changes. For example, several residents who had already lived in the area for a long time indicated that the volume of traffic on the highway had increased over time and that this had caused their perception of nuisance to increase. As one woman pointed out:

'When we chose to live here, it was a nice location and it was 1986. It was 1 September, and on 15 September the Eastern Ring Road opened. Because of this the traffic intensity near my house on the Southern Ring Road also increased.' (Respondent #17, female, 60+, <50m from highway)

Others indicated that their perception of nuisance had changed either positively or negatively due to changes in the physical aspects of the highway infrastructure. For example, during our interviews, three residents noted the previous change to the highway in 2008 which included the construction of additional lanes and a tunnel under the Southern Ring Road. Two indicated that their situation had improved because of the adjustment project as the highway nuisance decreased following improvement to the traffic situation and from the construction of noise barriers. However, another interviewee pointed out that the amount of noise had increased because of the placement of a noise barrier.

'The noise of the highway has increased since they built the screens there. Perhaps they are too low and perhaps they reflect the noise to higher floors of the building, such as the fifth floor where I live.' (Respondent #11, female, 20-40, <50m from highway).

Several interviewees also mentioned that changes in the wider environment had affected their perception of nuisance. A typical example mentioned by interviewees was the construction of buildings in the surroundings, causing noise reflection and a perceived increase in nuisance perception. As one interviewee noted:

'I don't remember being so negative about the highway initially. At the time we chose the location, the noise screens were one metre higher, and those buildings (points to some buildings) were not there yet. In my opinion the arrival of those buildings also had an impact on noise reflection. It feels as though the noise is being pumped through the gaps between the buildings.' (Respondent #4a, male, 40-60, <50m from highway)

The presence of trees was also mentioned several times in relation to the interviewees' awareness of the highway. It is noticeable that all the residents who mentioned trees indicated that they felt trees to have a relaxing effect on their perception of nuisance. Some residents indicated that their awareness of the highway was increased after the removal of trees in the surrounding area. As one older woman said:

'At a certain point they [the local government] decided to build on a field over there, from which they had to remove the trees. Those trees reduced the amount of noise and dust coming from the highway. Every tree they removed made a difference. Instead of minimizing nuisance, they maximized nuisance by doing that.' (Respondent#7, female, 40-60, 50-150m from highway)

Residents who talked about an increase in nuisance perception because of environmental changes also often referred to government policy and action. The Dutch government mainly bases its mitigation actions on exposure calculations (Rijkswaterstaat, 2014). Calculations are based on models including several factors to estimate the amount of exposure at a specific location. Several interviewees reported that they felt that the calculations do not reflect what they actually perceive. Some residents also mentioned some disappointment at government actions and their perception of their ability to influence them. As one respondent indicated:

'We did measure the exposure level ourselves, however…they were always higher than the government's calculations. However, they refused to measure here because the measurement pole is further away. Actually you should place such a pole at the traffic lights, where cars accelerate. Because that makes a lot of noise. They work with averages, but you also have peak load, you should take account of that.' (Respondent #12, male, 60+, <50m from highway)

<u>Anticipation of future highway adjustment plans</u>

During the interviews, several residents described a relationship between their thoughts about the Southern Ring Road adjustment project and their current perception of highway nuisance.

Interviewees expressed different attitudes towards the proposed highway adjustment plans. Some residents who were actively opposed to parts or all of the plans indicated that they were becoming increasingly stressed by the presence of the highway because of what they were hearing about the future highway adjustment plans and how involved they felt in them. This was especially true of interviewees from the Rivierenbuurt and Wijert areas (Figure 1), where residents expected conditions to get worse. As one interviewee put it:

'I dislike everything about the way we're being involved. They do not take us seriously. Maybe I am more annoyed by the presence of the highway because I am now so concerned about the new plans.' (Respondent #10, male, 60+, <50m from highway)

Conversely, some interviewees who expect improvement in conditions where they lived spoke more calmly about the presence of the highway. One interviewee living in an area where the highway will be routed underground under a park indicated that the information she had received about the future highway plans reassured her about the highway. Knowing that the future is likely to be better than the present made it easier to deal with the present.

'My perception of highway nuisance first increased when I heard about plans for development. They wanted to build the highway on pillars, an awful idea. At that time I heard every car passing and was really annoyed. Now, I am more calm about it, also because the current plans sound more positive to me. They will build the highway underground, under a park.' (Respondent #32, female, 40-60, <50m from highway)

Increased information about the effects of air pollution

In several interviews residents explicitly indicated that their concerns about the effects of living near the Southern Ring Road increased as they read or heard more about the potential negative effects of air pollution while living in the area. This information was obtained from the increasing attention being paid to air pollution in the media or from protest groups against the highway adjustment project.

Several residents mentioned that they were not sure about the effects of air pollution on their health and that their awareness of this potential danger increased on the strength of information they obtained on the subject while living in the area. It was also noticeable that several residents who talked about having more information about air pollution also indicated a lack of trust in government actions and the announced highway development project. Some interviewees described how their sensitivity to information about air pollution was triggered by the dust they experienced around their homes, potentially coming from highway traffic pollution. A few residents indicated taking more account of such information because of concerns about the health of their children. For example, one woman indicated that her concerns about the potential danger of air pollution increased after her first child was born.

'Some time ago I spoke with a doctor from the National Institute for Public Health and the Environment [in Dutch: RIVM]. The directives they have, legally accepted norms, that is…., they still know very little about it [pollution]. This woman also acknowledges that although there are norms, this doesn't mean that concentrations below the norm are not harmful. Especially now I have my son and as I am pregnant again, I am more aware of the potential negative effects of air pollution.' (Respondent #30, female, 20-40, <50m from highway)

Some interviewees also indicated that the extent to which they were influenced by information about the potential impact of air pollution was related to their own health. Some residents stated that they did not really feel that air pollution was affecting their health as they did not perceive any related health effects. One resident, however, indicated that his awareness of the potential consequences of air pollution was increased by personal health problems. At one point he had been hospitalized due to lung problems, which made him more aware of the potential danger of air pollution.

'I was in the hospital some years ago with a severe lung infection. I almost didn't survive. Before that time I was not really aware of air quality, but since then I have become more aware of the potential dangers of air pollution.' (Respondent #21, male, 40-60, <50m from highway)

The perceived ability to cope with highway nuisance

A final theme we would like to address as it appeared relevant in how residents talk about their development of Southern Ring Road-related nuisance perception is the extent to which interviewees found ways to cope with the negative presence of the highway.

Some residents indicated that coping measures were not necessary as they felt the negative effects of the highway for their residential location were negligible. Those interviewees indicated that the position of their home or its features made it easier to deal with highway nuisance. For example, because their balcony or garden was positioned on the 'good side' of the house, they were able to close windows or felt that they had a well-insulated house.

Several other interviewees referred to ways in which they learned to focus less on the negative effects of the highway: more emotional coping strategies (Lazarus, 1991). Many of them mentioned that they try to see the highway as a part of the city life in which they live and not to focus on it. They indicated that every residential location has positive and negative effects which you have to deal with. As one woman indicated:

'Well, I have something like, what can I do about it, why would I concentrate on it. I try to think about other things.' (Respondent #4b, female, 40-60, <50m from highway)

Several interviewees also indicated that their perception of noise nuisance from the highway has decreased during the period they live in the neighbourhood, because they got used to it. Some residents visualised this by referring to a situation they had in which visitors asked about their problems with highway noise. As one man indicated:

'Sometimes if I have visitors they notice the noise from the highway and ask me if I am not bothered by it. But I've got used to its noise.' (Respondent#5, male, 20-40, <50m from highway)

Some interviewees reported specific strategies to escape permanently or temporarily from the negative effects of the highway and thus control them: more problem-focused coping (Lazarus, 1991). Some interviewees indicated that they found ways to reduce the amount of nuisance in the house, such as placing air grids, not sleeping in the most noisy rooms or putting plants on the 'cleaner side' of the house. Strategies such as going to a friend's place, or going camping were mentioned as temporary escape options. Respondents found these possibilities made living near the highway more bearable. As one man indicated:

'There is more noise behind my house than in front. But anyway, we have a mobile home on a camp site, and we go there every summer.' (Respondent #12, male, 60+, <50m from highway)

Another group of residents, however, mentioned having more problems to cope with the presence of the highway, especially the noise, because of its persistence. These residents indicated feeling more sensitive to nuisance and they could not find a way to avoid noticing it. One man indicated that he would find himself particularly focusing on highway noise while in bed, which sometimes caused sleeping problems.

'My wife goes to bed and falls asleep in 15 minutes. I go to bed and don't drop off that quickly...And if I am unlucky I am awake for 3 hours and then I notice how noisy it is.' (Respondent #4a, male, 40-60, <50m from highway)

We also observed notable differences in how residents described nuisance perception in relation to their perceived ability or inability to move house easily. For instance, several residents with rental homes indicated that they were less concerned about the highway and related future developments because they could easily leave if they wanted to. In contrast, homeowners who reported nuisance perception sometimes mentioned potential concerns they had about selling their homes to future buyers. Some differences were also found with regard to income: people mentioned a low income as a reason for having fewer possibilities to easily move and find a suitable residence for a low price. We also observed a difference on this point between residents we spoke to with respect to age. Younger interviewees seemed more relaxed in the way they talked about coping with highway nuisance. They often indicated that they would just move if they stopped being satisfied with the situation. Some of the older residents, however, indicated that they could not easily move if things got worse, due to their advanced age. As one older resident, living in front of the highway, argued:

'Well, look, I am almost 80 and he is 84, you don't think about moving at that age.' (Respondent #13b, female, 60+, <50m from highway)

Discussion of research findings

The interviewees' stories revealed several teams as being important to understanding the development of highway nuisance perception among residents. Below we discuss our findings further against the backdrop of the themes which emerged from interviewees' statements.

The first theme discussed was the interviewees' *awareness of selecting a highway location*. The fact that all the residents we interviewed had moved to the area after the highway was constructed could reflect residential self-selection where people selected themselves into the area based on, for example, accessibility preferences or lower sensitivity to nuisance (e.g. Nijland et al., 2007; Van Wee, 2009). Indeed, the majority of the residents we interviewed indicated that they were aware of the highway and evaluated it in their location choice. Some evaluated the proximity to the highway positively by referring to accessibility gains, privacy reasons and liveliness aspects. Others were already familiar with living close to nuisances or evaluated its negative aspects compared to other positive aspects in their location search process and judged them to be bearable. Nevertheless, based on our interviewees' stories, we found that there were also residents who made a less informed choice, which could be interpreted as bounded rationality (Simon, 1957). Several residents indicated that they were negatively surprised by the presence of the highway after their location choice, as they took less account of the potential nuisance of the highway when choosing their current residential location. This could explain why self-selection into these areas is sometimes not found (e.g. Nijland et al., 2007). In addition, some residents indicated that they became more aware of the negative aspects, or, to the contrary, the positive aspects of a highway location through experiencing them after their location choice, which they would take into account in future moves. Both could be signals of later self-selection (e.g. Van Wee, 2009).

The second theme which emerged from the interviews as important in the development of nuisance perception were perceived *changes in the residential environment*. Interviewees mentioned changes in the design of the Southern Ring Road, but also changes in other aspects of their wider living environment such as the removal of trees which influenced their evaluation of the highway both positively and negatively. These findings support studies who have found relationships between environmental aspects and nuisance perception (e.g. Gidlöf-Gunnarsson and Öhrström, 2010; Hamersma et al., 2015). It also indicates that despite an increasing awareness of the interrelationship between the planning of Dutch

highway infrastructure (under the responsibility of the national government) and its broader environment (under the responsibility of the regional/local government), interventions by the two sides are not currently naturally intertwined (e.g. Heeres et al., 2012; Rebelgroup Advisory, 2015). In line with the literature (e.g. Guski, 1999; Kroesen et al., 2008; Healey, 1998), some residents also mentioned that a sense of having no influence over government actions created a distrust of government, which in turn resulted in an increased perception of nuisance. This indicates the importance of creating sufficient opportunities for citizen involvement in environmental and infrastructure planning (e.g. Arnstein, 1969; Healey, 1997).

A third important theme in the emergence of nuisance perception was *expectations regarding the plans* to redesign the Southern Ring Road. Some residents indicated that stress about the highway increased because of the highway adjustment plans or the way they felt involved in those plans. Others, however, indicated that an expected improvement to the current situation relaxed their perception of nuisance. This is in line with research indicating that the perception of nuisance can already change before any actual change in nuisance levels, described as anticipation effects (e.g. Chernobai et al., 2011; Guski, 2004; Henneberry, 1998). This could also explain why the study by Hamersma et al. (2014) found that a higher highway nuisance perception is associated with an expected decrease in residential satisfaction due to highway adjustment plans. Our findings suggest the added value of accounting for the time and stage of highway projects in understanding and comparing nuisance perception levels among residents (e.g. Flindel, 2015; Tillema et al., 2012;).

A fourth theme reported by several interviewees were increased concerns about living near the Southern Ring Road due to *information about air pollution* they received during their residential experience. The potentially negative effects of air pollution have attracted increasing attention from the Dutch media. This indicates the role of media and publicity in creating awareness, as was also found by other studies (e.g. Bickerstaff and Walker, 2001; Saksena, 2007). Interviewees also mentioned factors which influenced the extent to which they were affected by information about air pollution, such as having children, changes in their health situation, concerns about future highway adjustments and trust in government actions. This suggests that residents react differently to the same information (e.g. Dunwoody and Griffin, 2015; Yang et al., 2014).

The fifth theme we identified as important in our interviewees' nuisance perception was the extent to which they were able to cope with highway nuisance during their residential experience. Whereas some residents mentioned that characteristics of the house, such as insulation or a garden on the 'good' side, made coping with highway nuisance easier. Others mentioned having developed problem-focused strategies (Lazarus, 1991) to eliminate or at least have some control over nuisance, such as installing ventilation grids or going camping, or emotional coping strategies (Lazarus, 1991) such as getting used to the noise, or finding ways not to pay attention to it.. Related to this, some interviewees 'rationalized' their highway location choice by indicating that every location has its advantages and disadvantages which need to be dealt with, which can be explained as cognitive dissonance (e.g. Bickerstaff and Walker, 2001). Other residents indicated that they could not find proper ways to cope, resulting in highway-related nuisance perception. The importance of coping ability in understanding nuisance perception is also emphasized by other studies (e.g. Kroesen et al., 2008; Stallen, 1999).

In discussing the themes, the role of (changing) *socio-demographics* and *attitudes* was also noticed, although drawing conclusions based on qualitative data should be approached cautiously. For example, we noticed that residents described their older age, house ownership and low income as reasons for perceiving less flexibility to move elsewhere as a final coping strategy to highway nuisance perception. However, on the contrary, some residents mentioned their young age, house renting position and financial possibilities

as reasons for being flexible in moving elsewhere in case highway nuisance should increase. These differences are also often found in the literature on moving and explained by higher perceived or actual costs of moving (e.g. Hamersma et al., 2015; Lu, 1999; Speare, 1974). The importance of both aspects in residents' perception of transport-related nuisances is also addressed in other studies. (e.g. Hamersma et al., 2015; Saksena, 2007; Wardman and Bristow, 2004). Furthermore. residents described advantages of the residential location in proximity of the urban highway if they owned or after they bought a car, which supports studies finding a relationship between usage of a polluting source and residential satisfaction close to the polluting infrastructure (e.g. Hamersma et al., 2015; Kroesen et al., 2010) Although no generalizations could be made based on the present study, the findings provide several indications for the relevance of socio-demographics in understanding attitudes towards the presence of the highway in the residential environment.

Finally, although this research mainly aimed to study factors relevant to understanding differences in the development of highway nuisance perception in residents, some general observations about the importance of nuisance perception within the broader living context can be made. It was notable that it took some time to find a sufficient number of residents who perceived any structural nuisance from the highway. This is in line with the quantitative study by Hamersma et al. (2014) in the same research area, which revealed that only a small percentage of people perceived considerable highway nuisance. Several residents also mentioned perceiving more nuisance from neighbours than from the proximity of the highway. Furthermore, regardless of the nuisance perceived, most people indicated that aspects of their home or neighbourhood which they valued, such as accessibility gains from highway proximity or the short distance to the station and the city centre, compensated for the negative effects of the highway. This underlines the importance of noticing the *broader environment* in understanding residential satisfaction near highways (e.g. Hamersma et al., 2014; Nijland et al., 2007).

Conclusions and recommendations

In this research we aimed to gain a deeper understanding the development of highway perception in a residential context using interviews with residents from 32 homes located along the Southern Ring Road in Groningen, the Netherlands. As distinct from other often quite specific studies on nuisance perception regarding various types of infrastructure, this research studied the development of overall highway nuisance perception in interaction with the broader residential living context. Moreover, by interviewing residents from different backgrounds, we also gave a voice to the broader 'silent majority', who, as emphasized by other studies (e.g. Woltjer, 2000), often go unheard at public meetings, events and protests. Our findings suggest that considerations in residents' location choices, changes in the environment, anticipation of highway adjustment, increased information and coping strategies were important themes in understanding the development of residents' nuisance perception. Our study revealed a variety of views among residents and provided several examples of how the experiences of residents in their broader living context influenced and compensated for how nuisance is perceived, which underlines the interaction between persons and their physical settings (e.g. Gifford, 2007).

The interviews provided several insights for highway infrastructure planning policy. For example, our research underlined that it is important to realize that reducing highway nuisance perception goes beyond following calculated exposure levels and related environmental norms only. The stories of interviewees showed how nuisance perception is related to residents' experiences in the broader environment. For example, many interviewees mentioned (changing) environmental aspects as influencing their nuisance perception levels, which in their view are currently insufficiently taken into account in calculations, such

as increased traffic intensity, the impact of wind, trees and building reflection. As perceptions of residents vary, it is difficult to adjust governmental actions for mitigation to every specific situation and individual resident. However, governments could better account for perceptions of highway nuisance by being more aware of the potential interaction between (changes in) the design of the broader environment and the perception of highway nuisance, and by investing in attractive environments. Related to this, taking account of residents' knowledge of the environment and enabling effective communication and participation in planning highways and related (re)development in a community could help calm nuisance perception by creating a sense of influence (e.g. Guski, 2004; Nederveen, 2007). In communicating with residents, it could also be worthwhile to make use of noise/air pollution exposure measurements on particular locations (preferably by independent organizations) to reduce distrust in exposure calculations and support governmental mitigation actions. Furthermore, by showing the variety of motivations in residents, the findings suggest that highway planning policies need to account for resident characteristics. For example, although no generalizations could be made, we encountered differences in the views held by older and younger residents on their relationship with the highway. Some residents indicated that their older age was a reason for enjoying watching the traffic on the highway as it brings liveliness. None of the younger residents explicitly mentioned this point. In addition, their advanced age was mentioned by residents to indicate a lower flexibility of moving elsewhere if dissatisfied with current or future developments. Such characteristics of the existing or desired population of residential areas could be incorporated into decisions about the design and the planning process of highway and other infrastructure in order to increase residential satisfaction. Additionally, our results showed that despite residents all having moved into the neighbourhood after the Southern Ring Road had been constructed, not all residents were equally aware of the potential negative effects when choosing to live in the area. It is worth considering the information provided, for example by real estate agents, housing associations or municipalities, to increase awareness of the potential future consequences of choosing to live near a highway. Related to this, it is worth thinking about differentiating policy between new highway development and adjustment projects in residential areas. In the former case, people have had less chance to voluntarily choose to live near highways, which could result in a greater opposition to plans (e.g. Van Wee, 2009). Finally, the fact that several residents provided problem-focused and emotional coping strategies, such as cognitive dissonance, as well as compensating factors in order to deal with nuisance perception in the broader residential environment could be seen as a positive sign of a personal capacity for dealing with negative situations. Nevertheless, this should not prevent the government from mitigating actual exposure to ensure public health and residential quality.

Despite this paper's contribution to more in-depth insights into the development of highway nuisance perception, we note some limitations which could be analysed further in future research. Firstly, this paper is based solely on one case. Our case-selection method enabled the investigation of nuisance in depth by considering both the past and the future, but further generalization could be achieved by studying different cases to compare different highway settings at different locations, with distinct population demographics, historical backgrounds, etc. Secondly, the study's qualitative design provided in-depth knowledge of residents' perceptions of highway nuisance over time, but limits the possibility of describing firm relationships. Longitudinal research could further investigate the relationship between past and future events and nuisance perception that our research findings suggest. Thirdly, this study provided an understanding of the relationship between future highway projects and residents' current nuisance perception, but did not go into detail on how those expectations about the highway change projects or experiences with participation in projects are actually formed. This could be picked up by future research.

In conclusion, our interviews showed examples of the interrelationships between the residents' living experience and their nuisance perception levels, which underlines the importance of moving towards more integrated policy and planning, connecting highway infrastructure and the environment (Heeres et al., 2012; Ministry of Infrastructure and the Environment, 2014; Tillema et al., 2012). Taking a broader view and accounting for the characteristics of the residential context in mitigating highway nuisance could relieve stress and head off future protests against highway development.

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References

- Appatova, A.S., Ryan, P.H., LeMasters, G.K., Grinshpun, S.A., 2008. Proximal exposure of public schools and students to major roadways: a nationwide US survey. Journal of Environmental Planning and Management, 51 (5), 631–646.
- Arts, J., 2007. Nieuwe Wegen? Planningsbenaderingen Voor Duurzame Infrastructuur. Faculty of Spatial Sciences, Groningen.
- Arts, J., 2004. Environmental Impact Assessment for Transport Infrastructure Projects. In: G. Linden and Voogd. H (Eds), Environmental and Infrastructure Planning, 231–276. Groningen, Geo Press.
- Arnstein, S.R., 1969. A Ladder of Citizen Participation. Journal of the American Institute of Planners 35 (4), 216–224.
- Aylor D.E., Marks, L.E., 1976. Perception of noise transmitted through barriers. Journal of the Acoustic Society of America 59, 397–400.
- Banjung, Z., Lili, S., Guoqing, D., 2003. The influence of the visibility of the source on the subjective annoyance due to its noise. Applied Acoustics 64, 1205–1215.
- Bickerstaff, K., 2004. Risk perception research: socio-cultural perspectives on the public experience of air pollution. Environment International 30, 827–840.
- Bickerstaff, K., Walker, G., 2001. Public understandings of air pollution: the localisation of environmental risk. Global Environmental Change 11, 133–145.
- Brown, A.L., van Kamp, I., 2008. Response to a change in transport noise exposure: Competing explanations of change effects. Journal of the Acoustical Society of America 125 (2), 905–914.
- Chernobai, E., Reibel, M., Carney, M., 2011. Nonlinear Spatial and Temporal Effects of Highway Construction on House Prices. Journal of Real Estate and Financial Economies 42, 348–370.
- Dunwoody, S., Griffin, R., 2014. Risk information seeking and processing model. In: Cho, H., Reimer, T., McReimer, K.A. (Eds.), The SAGE handbook of risk communication, 102–117. Los Angeles, Sage Publications.
- Elliott, S.J., Cole, D.C., Krueger, P., 1999. The power of perception: health risk attributed to air pollution in an urban industrial neighbourhood. Risk Analysis 19 (4), 615–628.
- Elverding, P., 2008. Sneller en Beter; Advies Commissie Versnelling Besluitvorming Infrastructurele Projecten, Den Haag.
- Heeres, N., Tillema, T., Arts, J., 2012. Integration in Dutch planning of motorways: From 'line' towards 'area-oriented' approaches. Transport Policy 24, 148–158.

- Fields, M., 1993. Effect of personal and situational variables on noise annoyance in residential areas. Journal of the Acoustical Society of America 93 (5), 2753–2763.
- Gidlöf-Gunnarsson, A., Öhrström, E., 2007. Noise and well-being in urban residential environments: the potential role of perceived availability to nearby green areas. Landscape Urban Planning 83, 115–126.
- Gifford, R., 2007. Environmental psychology: Principles and practice (4th ed.). Colville WA, Optimal Books.
- Guski, R., 1999. Personal and social variables as co-determinants of noise annoyance. Noise and Health 1(3), 45–56.
- Guski, R., 2004. How to forecast community annoyance in planning noisy facilities. Noise and Health 6, 59–64.
- Hamersma, M., Tillema, T., Sussman, J., Arts, J., 2014. Living close to highways: the impact of perceived highway externalities on (changes in) residential satisfaction. Transportation Research A 59, 106–121.
- Hamersma, M., Heinen, E., Tillema, T., Arts, J., 2015. Residential moving intentions: the case of highway locations. Transportation Research D 35, 130–141.
- Hatfield, J., Job, R.F., Carter, N.L., Peploe, P., Tayler, R., Morrell, S., 2001. The influence of psychological factors on self-reported physiological effects of noise. Noise and Health 3(10), 1–13.
- Healey, P., 1997. Collaborative planning. Shaping places in fragmented societies. London, MacMillan.
- Henneberry, J., 1998. Transport investment and house prices**.** Journal of Property Valuation and Investment 16 (2), 144–158.
- Henningsson, M., Blicharska, M., Antonson, H., Mikusinski, G., Gőransson, P. Angelstam, L. Folkeson, S. Jőnsson, 2015. Perceived landscape values and public participation in a road-planning process – a case study in Sweden. Journal of Environmental Planning and Management 58(4), 631–653.
- Hennink, M., Hutter, I., Bailey, A., 2011. Qualitative research methods. Los Angeles, Sage.
- Job, R.F.S., Topple, A., Hatfield, J., Carter, N.L., Peploe, P., Taylor, R., 1996. General scales of community reaction to noise are more stable than scales of annoyance. In: Crocker, M.J., Ivanov, N.I. (Eds.), Proceedings of the 4th International Congress on Sound and Vibration, St. Petersburg, Russia, 1431–1437. Auburn Alabama, International Scientific Publications.
- Joynt, J.L.R., 2005. A sustainable approach to environmental noise barrier design. Dissertation. University of Sheffield, Sheffield, UK.
- Joynt, J.L.R., Kang, J., 2010. The influence of preconceptions on perceived sound reduction by environmental noise barriers. Science of the Total Environment 408, 4368–4375.
- Kroesen, M., Molin, E., Vos, H., Janssen, S., van Wee, B., 2010. Estimation of effects of transportation noise annoyance on residential satisfaction. Transportation Research D 15, 144–153.
- Lazarus, R.S., 1991. Emotion and Adaptation. New York, Oxford University Press.
- Miedema, H.M.E., Vos, H., 1999. Demographic and attitudinal factors that modify annoyance from transportation noise. Journal of the Acoustic Society of America 105 (6), 3336–3344.
- Ministry of infrastructure and the Environment, 2014. Vernieuwing MIRT in een oogopslag. Den Haag, Ministry of Infrastructure and the Environment.
- Ministry of infrastructure and the Environment, 2015. MIRT Projectenoverzicht. Den Haag, Ministry of Infrastructure and the Environment.

- Ministry of Infrastructure and the Environment, 2015. Interview with Noise Advisor.
- Mokhtarian, P.L., Cao, X., 2008. Examining the impacts of residential self-selection on travel behavior: a focus on methodologies. Transportation Research Part B 42(3), 204–228.
- National Institute for Public Health and the Environment, 2013. Summary of the second Netherlands Research Program on Particulate Matter (BOP II). Bilthoven, RIVM.
- Nederveen, J., 2007. Ruimtelijke inpassing van lijninfrastructuur. Een onderzoek naar de geschiktheid van inspraakreacties voor het beoordelen van lijninfrastructuurontwerpen. Dissertation, Technische Universiteit Delft, TRAIL.
- Project Southern Ring Groningen, 2015. www.aanpakringzuid.nl.
- Quinn-Patton, M., 1990. Qualitative Evaluation Methods 2nd Edition. Beverly Hills, Sage Publications.
- Rebelgroup Advisory, 2015. Vernieuwing MIRT – Een verkenning naar meekoppelkansen bij Beheer, Onderhoud, Vervanging en Renovatie in het kader van Vernieuwing MIRT, Ministerie van Infrastructuur en Milieu (I&M), Den Haag.
- Rijkswaterstaat, 2014. Geluid langs Rijkswegen.
- Ritchie, J., Lewis, J., 2003. Qualitative research practice. London, Sage Publications.
- Saksena, S., 2007. Public Perceptions of Urban Air Pollution with a focus on Developing Countries. East-West Center Working Papers: Environmental Change, Vulnerability, and Governance Series 65, 1–29.
- Shepherd, D., Welch, D., Dirks, K.N., Mathews, R., 2010. Exploring the Relationship between Noise Sensitivity, Annoyance and Health-Related Quality of Life in a Sample of Adults Exposed to Environmental Noise. International Journal for Environmental Research and Public Health 7(10), 3579–3594.
- Simon, H.A., 1957. Models of Men. New York, John Wiley & Sons.
- Stallen, P.M., 1999. A theoretical framework for environmental noise annoyance. Noise and Health 1(3), 69–80.
- Stansfeld, S.A., Haines, M.M., Burr, M., Berry, B., Lercher, P., 2000. A review of environmental noise and mental health. Noise and Health 2 (8), 1–8.
- Tillema, T., Hamersma, M., Sussman, J., Arts, J., 2012. Extending the scope of highway planning: accessibility, negative externalities and the residential context. Transport Reviews 32 (2), 745–759.
- Tudor, C.A., Iojâ, I.C., Rozylowicz, L., Pătru-Stuperiu, I., Hersperger, A.M., 2015. Similarities and differences in the assessment of land-use associations by local people and experts. Land Use Policy 49, 341–351.
- Van Kamp, A., Job, R.F., Hatfield, J., Haines, M., Stellato, R.K., Stansfeld, S.A., 2004. The role of noise sensitivity in the noise–response relation: A comparison of three international airport studies. Journal of the Acoustical Society of America 116 (6), 3471–3479.
- Van Wee, B., 2009. Self‐Selection: A Key to a Better Understanding of Location Choices. Travel Behaviour and Transport Externalities?, Transport Reviews 29 (3), 279–292.
- Wakefield, S., Elliot, S.J., 2000. Environmental risk perception and well-being: effects of the landfill siting process in two southern Ontario communities. Social Science & Medicine 50, 1139–1154.
- Wakefield, S.E., Elliot, S.J., Cole, D.C., Eyles, J.D., 2001. Environmental risk and (re)action: air quality, health, and civic involvement in an urban industrial neighbourhood. Health and Place 7 (3), 163–177.

- Weber, M., 2013. Noise policy: sound policy? A meta level analysis and evaluation of noise policy in the Netherlands. Dissertation, University of Utrecht.
- Woltjer, J., 2000. Consensus Planning: the relevance of communicative planning theory in Dutch infrastructure development. Aldershot, Ashgate.
- Yang, J., Aloe, A.M., Feeley, T.H., 2014. Risk Information Seeking and Processing Model: A Meta-Analysis. Journal of Communication 64, 20–41.