

## **Perceived highway nuisance in a residents' context**

*Experiences of residents along the Southern Ring Road in Groningen*

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## **Samenvatting**

Ondanks dat snelweginfrastructuur vaak wordt geassocieerd met overlast zoals geluid, luchtverontreiniging en barrière-effecten, is er slechts weinig bekend over de beleving van deze effecten in de bredere wooncontext. Dit paper beoogt een dieper inzicht te verschaffen in (het ontstaan van) snelweg overlast in de woonbeleving. Dit doen we op basis van interviews met bewoners in 32 huishoudens nabij de Zuidelijke ringweg in Groningen. De Zuidelijke ringweg is onderdeel van de snelweg A7 en loopt door verschillende buurten in de stad.

Tijdens de interviews kwamen verschillende thema's naar boven die relevant bleken in het begrijpen van snelweg overlast. Één hiervan was de mate waarin bewoners bewust kozen voor een woning nabij de Zuidelijke ring. Sommige bewoners gaven aan dat zij van te voren de voor- dan wel de nadelen van een dergelijke locatie hadden afgewogen, terwijl anderen de Zuidelijke ring eigenlijk pas opmerkten toen de woonkeuze was gemaakt. Vooral deze laatste groep gaf vaker aan overlast te ervaren. Een andere factor van belang bleek informatie. Een groep gesproken bewoners gaf aan dat recent ontvangen informatie over mogelijk schadelijke effecten van luchtverontreiniging de zorgen rond het wonen nabij de Zuidelijke ring hadden versterkt. Ook beleefde veranderingen in de woonomgeving, vaak veroorzaakt door overheidsacties, bleken een rol te spelen in het ontstaan van overlast. Voorbeelden hiervan waren ervaringen met eerdere projecten aan de Zuidelijke ring, de komst van geluidsschermen, het verwijderen van bomen of het plaatsen van gebouwen die reflectie veroorzaken. Daaraan gerelateerd bespraken bewoners dat hun huidige perceptie van overlast mede beïnvloed is door de verwachtingen over toekomstige ontwikkelingen van de Zuidelijke ring. Een laatste veel besproken thema was de persoonlijke omgang met de effecten van de Zuidelijke Ring. Sommige bewoners beschreven cognitief beter om te kunnen gaan met de effecten van de Zuidelijke ring, of beschreven meer mogelijkheden te hebben om er afstand van te doen, bijvoorbeeld door positie of isolatie van de woning, een uitvalsbasis zoals bezoek aan vrienden, of meer mogelijkheden om eventueel te verhuizen. Dergelijke aspecten bleken mee te spelen in hoeveel nadruk mensen gaven aan de overlast van de Zuidelijke Ring.

De ervaringen van de bewoners benadrukken het belang van aandacht voor de interacties tussen infrastructuur(ontwikkeling) en de bredere woonbeleving voor (snelweg) infrastructuur planning. De interviews geven ook inzicht in de variatie in bewonersperspectieven; het open staan voor kenmerken en ervaringen van bewoners kan van toegevoegde waarde zijn in het verbeteren van de woonkwaliteit nabij (snelweg) infrastructuur.

## **Introduction:**

With the growth of highway infrastructure, there is nowadays an increasing concern for its negative externalities. Noise and air pollution nuisances – caused by among other things highway traffic – are related to serious health effects (e.g. Stansfeld et al., 2000; Shepard et al., 2010; RIVM, 2014). For this reason, there has been an increasing attention for mitigating the negative impacts of highways. Examples of these measures are noise barriers, isolation of houses or more silent asphalt (I&M, 2015; RWS, 2014).

Dealing with highway nuisance however appears to be a complex task (e.g. Weber, 2013), among other things because there appears to be no one to one relationship between (mostly via model calculated) highway exposure and the perception of highway nuisance (e.g. Hamersma et al., 2015; Miedema and Vos, 1999). Many (other) physical and personal factors are found to be associated to nuisance perception, such as: perceived environmental quality; socio-demographics; psychological aspects such as anxiety for the source and feeling of control over the source; governmental perception; information and expectations about future developments of the polluting source (e.g. Guski, 1999; Hamersma et al., 2015; Fields, 1993; Miedema and Vos, 1999).

Despite the large number of studies into factors influencing nuisance perception, there seems to be only limited literature providing deeper insight into how highway nuisance perception actually evolves in relation with and through residents' living experience. Following Gifford et al (2007), perceptions of the environment are formed in transactions between individuals and their physical settings. In these transactions, individuals influence their environments, and their behaviour and experiences are influenced by their environments (Gifford et al., 2011). Being more aware of the interaction between residents' nuisance perception and their living context can be of added value in understanding why highway nuisance perception does (or does not) occur in certain cases.

This paper aims to study highway nuisance perception in a residents' context. More precisely we pay particular attention to reasons behind residents' perception and evolvement of this perception throughout their residential experience. To this aim, we choose for a qualitative 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 (Wakefield et al., 2001; Eyles, 1998; Elliott, 1999). All interviewees we spoke to live along the Southern Ring Road, serving as a connection between two highways and passing through the city of Groningen, the Netherlands. At the moment of interview, the residents in the neighbourhoods along the Southern Ring Road are facing a big highway adjustment project in the near future. The chosen research context makes it interesting to not only study highway nuisance perception throughout residents living experience in a highly densely populated area, but to also reflect on its relation with future changes.

The insights of this study are relevant for highway infrastructure planning. Although working towards a more integrated view between infrastructure and the environment, current infrastructure planning policy seems to be still quite fragmented and sectoral, focusing on the highway and related accessibility and on mitigating arising negative consequences (e.g. Heeres et al., 2012; Arts, 2007; Tillema et al., 2012; Elverding, 2008; I&M, 2014; Rebelgroup Advisory, 2015). In a study on Dutch noise policy, Weber (2013) indicates that narratives of residents about the effects of (noise) pollution on health and quality of life could be of added value to traffic policy and planning practice in optimizing spatial and environmental quality. By taking notice of (the broad range of) residents' experiences close to highways, the insights of this paper could help to foster a more integral way in thinking about strategies for highway infrastructure planning by using an outside-in perspective. In this way, the insights of this paper could contribute to higher residential satisfaction close to highways.

## Theory

The presence of a highway could foster different negative externalities influencing the residential context. Tillema et al (2012) summarize these effects in three types of highway nuisances: noise, air pollution and barrier-effects, the latter caused by traffic intensity or visual aspects of the highway. However, literature suggests that the extent to which those externalities are perceived differs for the various residents. There is widespread agreement that there is not an one-to-one relationship between true exposure and perception of nuisances and that perceptions are for at least a part determined by non-acoustical factors (e.g. Hamersma et al., 2015; Miedema and Vos, 1999; Weber, 2013; Van Kamp et al., 2004; Fields, 1993). When nuisances are perceived, this could result in annoyance towards the source, which is defined by Stallen (1999) in the context of noise as a form of psychological stress.

Highway nuisances may impact on residents' living experience. In the study of Hamersma et al (2014) different types of highway nuisances were compared and related to residential satisfaction in the broader residential environment. Based on questionnaire data among residents in seven locations close to highways in the Netherlands, they found that actually only a relatively small percentage of residents perceived severe nuisance of the highway. People were on average comparably annoyed by noise, air pollution and barrier-effects. Studies looking into the relationship between perception of noise and air pollution tend to indicate that people who are negative about noise are also more likely to be negative about air pollution – also called the halo effect (Bickerstaff and Waker, 2001). Hamersma et al (2014) found that the perception of especially highway noise and to a lesser extent air pollution and barrier-effect nuisance influence people's residential satisfaction. However, perceived advantages of the location such as good access lane proximity and an attractive neighbourhood at least partly compensate for these effects. As such, the perception of highway nuisances seems to be traded off with other aspects in the residential context.

Grifford et al (2011) argue that both physical aspects of the location (stressors and amenities) and personal factors are presumed to influence the way residents think about their cities and neighbourhoods. With respect to physical factors, rather obviously, most studies find a relationship between (calculated) exposure and nuisance perception (e.g. Schreckenberg, 2010; Hamersma et al., 2015; Miedema and Vos, 1999), with variation in the strength of this effect. Also other physical factors are found to be associated with the perception of (traffic) nuisance. For example, the study of Hamersma et al (2015) shows associations between the perceived attractiveness of the environment, perceived greenery and residents' highway nuisance perception. Also other studies indicate that greenery seems to relax the perceiving of noise nuisances (e.g. Gidlöf-Gunnarsson and Öhrström, 2007). The relationship between noise perception and noise barriers has also been studied. In general, nuisance perception seems to decrease when view on the road is reduced (e.g. Banjung et al., 2003). However, the study of Aylor and Marks (1975) showed that judgment of noise is stronger when the barrier totally obscures sight compared to when the source can be partly seen. As well, type of barrier and residents' engagement in the design of barriers has found to be relevant in this matter (Nederveen 2007). Joint and Kahn (2010) argue that transparent and vegetative barriers are seen as more pleasant, however are not to be reflected in lower nuisance perception. With respect to physical house characteristics, studies found that nuisance perception is lower for residents living in isolated houses (e.g. Fields, 1993).

Also personal factors are widely studied in relation to nuisance perception. Hamersma et al (2015) found that factors such as socio-demographic and attitudinal factors were relevant in the perception of highway nuisances. For example, they found that people with a negative attitude about cars, non-highway users, house owners and older people had a higher nuisance perception

of the highway. In general, studies on the explanation of traffic nuisance perception argue that nuisance perception has much more to do with personal attitudinal than with socio demographic factors (e.g. Miedema and Vos, 1999; Fields, 1993). For example, Fields (1993) concluded that noise annoyance was related to attitudinal factors such as fear of danger, noise sensitivity, noise prevention beliefs, whereas it was much less related to aspects such as income, age, home ownership and education.

The role of awareness is also reflected upon in theory in understanding nuisance perception. For example, the study of Hamersma et al (2015) showed that people, who indicated to have a preference for a highway location when making their location choice, had a lower perception of highway nuisances. This finding points at the (potential) relevance of residential self-selection in understanding nuisance perception, i.e. the tendency of people to make residential choices based on travel behaviour, abilities, needs and preferences (e.g. Van Wee, 2009; Mokhtarian and Cao, 2008). Nevertheless, the study of Nijland et al (2007) couldn't find proof that the number of noise sensitive people was lower in high- compared to low noise exposure areas. One of their explanations for their findings was, that people were maybe 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 and related action (Saksena, 2007; Bickerstaff, 2004). Studies indicate that the amount of perceived air pollution nuisance is related to experiences with air pollution or knowledge about its potential negative effects (e.g. Saksena, 2007). Related to this, several studies indicate a role of the media in raising the awareness of air pollution (e.g. Saksena, 2007; Bickerstaff and Walker, 2001). This suggests that information could play a role in the perception of nuisances.

Another aspect found by studies to be relevant in understanding nuisance perception is the residents' ability to cope with the situation. Stallen et al (1999) constructed a model when asking the question why noise nuisance perception occurs. In this model, noise annoyance is determined by the extent to which a person perceives a threat – i.e. perceived disturbance, and the possibilities – or resources that a person has to face this threat – i.e. perceived control or coping capacity. Coping tactics are seen here as ways of dealing with negative externalities in the residential environment in a situation when residents are not able to or do not want to move out of the neighbourhood. Being able to cope with daily background stressors is important for human well-being and health (Miedema, 2007). According to Lazarus (1991) the coping concept relates to the belief and confidence of a person affected by a source to somehow manage the problem. He defines two categories of coping strategies; problem focused strategies, which focus on influencing the source itself, or emotional focused strategies which focus on the way we think about the source.

Also people's perception of the government and related actions is mentioned by researchers as playing a role in the perception of noise and air pollution nuisance (Guski, 1999; Kroesen et al., 2008; Saksena, 2007). If people fear the source, they usually hope that the government will protect them against it. If they have the feeling that actions of authorities are not sufficient, this may increase the amount of nuisance perceived (e.g. Guski, 1999). Other studies refer to the potential relationship between perception of nuisances and expectations about future government-led developments, so called anticipation effects. In other words, studies found evidence 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 (Hatfield et al., 2001; Job et al., 1996; Brown and Van Kamp, 2008).

To conclude, many studies point to physical and personal factors which may play a role and interact in people's perception and experience of nuisances. In the remainder of the article we try

to gain deeper insight into these factors being of relevance in understanding the experience of highway nuisance perception in a residents' context.

**Method:**

The study area we selected consisted of residents living in close proximity of the Southern Ring Road in Groningen, a city of approximately 200.000 citizens in the North of the Netherlands. The Southern Ring Road serves as a part of the A7 highway, by connecting the highway to and from Drachten (to/from the West of the Netherlands) and the highway to and from Nieuweschans (to/from the border between Germany and the Netherlands). The ring road was constructed between 1965 and 1970. As a consequence of the construction, a part of the Oosterpoort neighbourhood and a big part of a forest in the city were fragmented. The Southern Ring Road passes through several neighbourhoods in the city, as can be seen in Figure 2. The various neighbourhoods surrounding the ring road inhabit people with varying age categories and household types. Housing types range from old houses to modern housing. Most neighbourhoods surrounding the Southern ring have a high population density and a considerable part of the houses consists of apartment blocks. Nevertheless, there are also some areas along the southern ring with a lower density and more (semi) detached houses, for example in the Rivierenbuurt, Buitenhof and Hoogkerk area (see also Figure 2).

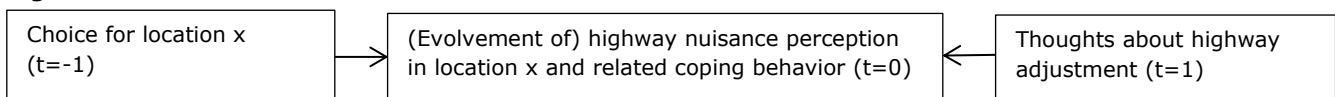
Currently there are plans for a large adjustment of the Southern Ring and its surroundings (I&M, 2015). These plans aim to improve 1) accessibility, by including extra lanes and connections, 2) liveability of the city, by including a deepening of the Southern Ring Road in the landscape and more greenery, and 3) traffic safety, by including grade separated crossings and less on-ramps (ZRG, 2015). The adjustment project is controversial, with some protest groups currently fighting the project in court. Depending on the decision of the lawyer, the execution of the project is planned to start in the end of 2016 (ZRG, 2015).

*Operationalisation*

To gain insight into experiences with highway nuisance, we interviewed residents from 32 houses in close proximity of the highway (see Appendix 1). Some interviews were with a couple living in the same house; in total 36 people participated. The residents we spoke to all lived within 300 meters from the highway. Residents were randomly invited to participate in the interview or were approached via snowballing. In this way, we tried to reach as much as possible variation in residents with respect to highway nuisance perception and to assure for variation in neighbourhoods, length of residence, house owners and renters, age, and household type.

The interviews were conducted in the period April - June 2015. To induce spontaneous answers, the topic "Southern Ring Road" was not explicitly mentioned in the invitation. Semi-structured interviews were held that focused on the perception of highway nuisance in the broader residential experience. Interviews started broad by asking about location choices and residential satisfaction, after which people's relationship with the highway was further discussed. Consequently we discussed residents' current perception of highway nuisance in relation to 1) their location choices, 2) its evolvment through their residential experience, 3) coping behaviour and 4) their thoughts about future highway adjustment. Figure 1 gives a general overview of the structure of the interviews.

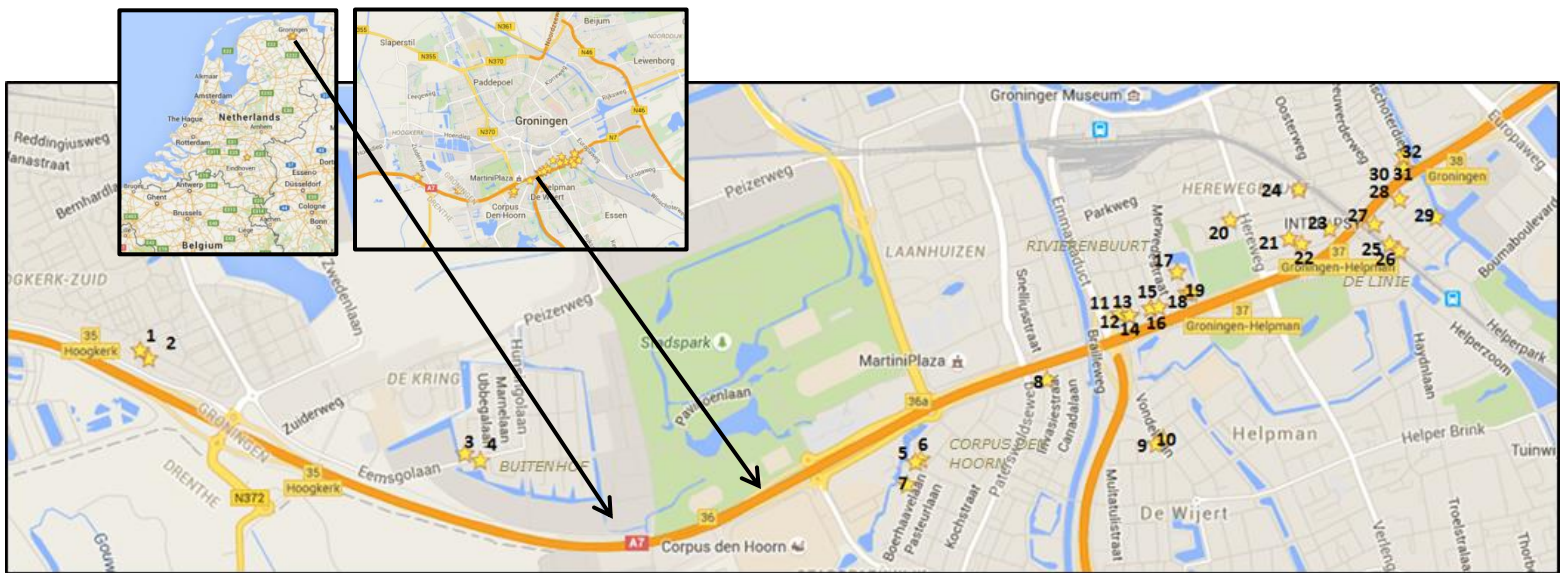
**Figure 1: Structure of the interview**



The interviews were tape-recorded, transcribed and coded afterwards. Key themes were then identified based on the relevance to the research objectives, the frequency it was mentioned, and the extent to which it resulted in differences between groups of residents (e.g. Wakefield and Elliot, 2000; Wakefield et al., 2001).

Following ethical considerations, interviewees' informed consent to participate should be contained (e.g. Ritchie and Lewis, 2003). All residents were informed about the purpose of the study, the research team, the handling of data and the duration of the interview. As well, we acknowledged that participation was voluntary and gave people the possibility to withdraw from the interview at any moment and to check the transcripts afterwards, complemented by signing a letter of consent.

**Figure 2: Map of research area (Numbers refer to the houses of the various respondents, see Appendix 1)**



## Results analysis

Below we discuss the main outcomes of our analysis with regard to (the evolution of) nuisance perception of the Southern Ring Road in residents during their residential experience. We refer to themes that rose from the interviews, respectively: the level of awareness with the ring road when making the location choice, the role of information, the role of a changing environment, future ring road plans, and personal ability to cope.

In general, we found that the Southern Ring Road appeared of different importance to our interviewees. In some interviews, the ring road was spontaneously mentioned. When asking about people's residential location choices or residential satisfaction. For others, it was discussed only when specifically asking about the residents' relationship with the Southern Ring Road. These residents were much less aware of the presence of the highway in their residential context.

Most residents referred first to noises when we asked them about potential nuisance perception of the Southern Ring Road. Later during the interview other types of nuisances i.e. air pollution and barrier effects such as a view on the Southern Ring Road were sometimes mentioned. Residents referred to the "perceptibility" of air pollution as a reason for not noticing air pollution. Barrier effects of the ring road were mainly discussed when their house had a direct view on the highway. As was stated by one of the interviewees:

*"There might be air pollution, but it is not really perceptible, you don't notice it. And, although I live very close to the highway, when I am sitting outside, there is always a row of houses between me and the highway." (Respondent#28)*

During our interviews we found out that opinions of residents about the amount of nuisance perceived by the Southern Ring Road were mixed and not specifically related to the actual distance between the residents' house and the Southern Ring Road. A majority of the residents we randomly approached by invitation letter and talked to indicated not to perceive any noticeable nuisance of the Southern Ring Road. This group did not notice the highway as a source of annoyance in their neighbourhood. As one couple, living very close to the Southern Ring Road mentioned:

*"We do not perceive it as nuisance, but others do." (Respondent#24)*

Others, however, did report a negative influence of the highway. For them the presence of the Southern Ring Road causes negative effects at least during some moments in time, which make that they cannot enjoy their residence as much as they wanted to.

*"Yes, I perceive nuisance. It is not always there, but when the wind is coming from southwest...And that is often the case. Especially now it is summertime and you are more outside, you hear it" (Respondent#3)*

#### Awareness when making location choice

The interview results indicated that although all residents moved into the area after the Southern Ring Road was constructed, there were differences in the extent to which people actually consciously made this choice. The extent to which residents currently perceive nuisances of the ring road is related to the extent to which they made an informed choice to live close to the Southern ring.

Most residents were aware of the presence of the highway while choosing for their residential location. Some people explicitly evaluated positive aspects of the Southern Ring Road highway in their location choice. For example, a group of residents mentioned that they explicitly preferred a location close to a highway from accessibility reasons, to reach activities such as the work location and family and friends. Several residents even mentioned that their view on the highway made it easier to plan their trip. As one man mentioned:

*"Strategically it is an ideal location towards the south. I watch whether there are traffic jams. If I notice in the morning when I have to go that there is a traffic jam on the viaduct, I take an alternative route. That takes a little bit more time, but you avoid the traffic jam." (Respondent #1)*

In addition to accessibility also some other advantages of the presence of the Southern Ring Road were positively evaluated by residents in their location choice. For example, three residents mentioned that having the Southern Ring Road in front of their house instead of another house creates a larger feeling of privacy. Noticeable is that the respondents referring to privacy were women. As one woman said:



*"It could also have been that we lived in front of another flat. That I would have disliked more, because you feel that others can watch you. So from that perspective, I thought living next to a highway is an advantage." (Respondent#16)*

Three older interviewees who lived all three directly in front of the Southern Ring Road explicitly notified the positive aspects of liveability created by a view on the highway, which they highly like in their residential location choice. For them, living along the Southern Ring Road gives them some activity to look at, which is appreciated.

*"At a certain moment, they wanted to construct a noise barrier which would reduce our sight on the highway. We did a questionnaire in the neighbourhood, and 90% appeared to be against it. Older people like to watch trucks and cars, where does it come from, it creates some distraction." (Respondent#13a)*

However, other residents did not specifically see advantages of the Southern Ring Road when they chose for their current residence. Some interviewees did notice the potential negative effects of the highway when making their location choice and traded it off with the perceived positive aspects of the location. Some mentioned that they based their evaluation of potential nuisances of the Southern Ring Road on previous experiences with living close to roads and highways. For example, a woman indicated that their previous house was also close to a ring road and at that moment she didn't perceive severe nuisance and got used to it. Based on this, she was not really concerned about the proximity of the Southern Ring Road when choosing for the current residential location.

*"The house we lived before was also close to the highway, and a lot of traffic passed, so we were used to it. I have the feeling that the location we have now is even more quiet, maybe that is because of the noise wall." (Respondent #16)*

Other residents indicated that they explicitly evaluated the potential nuisances of the Southern Ring Road before they chose for their current residence. They listened to the sounds and observed the presence of the ring road by visiting the place several times before they chose to take the house. Based on their evaluation, they judged the situation to be bearable. As one man mentioned:

*"Well, I have checked whether I would be annoyed by it indeed. Nuisances, cars passing by. I visited the house several times, at several moments of the day, peak and off-peak hours, but I did not feel annoyed by it." (Respondent#8)*

However, another group of interviewees indicated that they made a less-informed choice to live close to the Southern Ring. They indicated to be much less or only partly aware of the potential negative effects of the ring road when choosing for the location as they were focusing on other aspects being at that moment of more relevance, such as the positive characteristics of the house or the neighbourhood. For some of these residents, the awareness of the negative effects of the Southern Ring Road grew during the time they lived in the neighborhood by experiencing its effects. Especially this group of interviewees more often indicated to currently perceive nuisance of the ring road. As one man indicated:

*"At that time, the highway was not really a factor in our considerations compared to other things. But during the time of residence, you get a better picture of this." (Respondent #20)*

Finally, in this group of "uninformed" people, we observed a differences in how people evaluated their own choice to live close to the Southern Ring Road. Some interviewees thought that they were not well enough informed by the real estate agent beforehand and thought they should have been guided more in their decision for the location. As one man indicated:

*"I didn't think about potential negative effects of the highway when choosing for the location. At a certain moment you become aware that during southwestern wind there is always noise. It depends a little bit on the intensity of the traffic, but there is a lot of noise from the highway. I would like to have been informed by the real estate agent on this. They did indicate that there were a lot of busses passing, but they didn't tell me anything about the effects of the highway." (Respondent#3)*

Other residents however explicitly mentioned that although they actually perceive nuisance from the Southern Ring Road, they thought they should not complain because it was actually their own responsibility as they in the end chose themselves to live here. As one man mentioned:

*"Well, I choose to buy this house, so I could say I could better have not bought the house. However, this would be a little bit pitiful towards myself, so.."(Respondent#22a)*

#### Role of changing environment

Some residents indicate that they were aware of the Southern Ring Road when making their residential choice, however that changes have occurred in their direct environment, which made their nuisance perception to change. As such, the situation changed compared to the situation where they once chose for. This indicates the interaction that exists between negative effects of the highway and its broader environment.

For example, several residents who lived in the area already for a longer time indicated that the amount of traffic on the ring road has increased over time and by that their perception of nuisance increased. As on woman mentioned:

*"When we chose to live here, it was a nice location and it was 1986. It was the first of September, and on the 15<sup>th</sup> of September the Eastern Ring Road opened. Because of this the traffic intensity close to my house also increased." (Respondent#17)*

Others indicated that their perception of nuisance has changed in either positive or negative sense by changes in physical elements of the Southern Ring Road infrastructure. For example, during our interviews, several residents referred to the previous ring road adjustment in 2008. Some indicated that because of the adjustment project their situation improved as the nuisances decreased by an improvement of the traffic situation and by the construction of noise barriers. However, the effects of the adjustment project were not evaluated as positive by all interviewees. For example, some residents mentioned that the amount of noise changed because of the placement of a noise barrier.

*"The noise of the highway has increased since they built the screens there. Maybe they are too low and maybe they increase the noise at higher floors of the building, like on the third floor where I live." (Respondent #11).*

Others indicated that changes in the broader environment impacted on their perception of nuisance. A typical example mentioned by several interviewees was the construction of buildings in the surroundings, causing reflection and a perceived increase in nuisance perception. As one interviewee mentioned:

*"I cannot remember that we were so annoyed by the highway in the beginning. At the moment we chose for the location, the noise screens were one meter higher, and those buildings (points to some buildings) were not there yet. To my opinion the arrival of those buildings also influenced on the noise reflection. It feels like the noise is pumped through the openings between the buildings."* (Respondent #4)

Also the presence of trees was several times referred to in relation to interviewees' awareness of the Southern Ring Road. It is noticeable that all residents referring to trees indicated that they felt trees to have a relaxing effect on their perceiving of nuisances. Some residents indicated that their awareness of the southern ring was raised after the removing of trees in the surrounding area. As one older woman mentioned:

*"At a certain moment they decided to construct a field over there, for which they had to remove the trees. These trees reduced the amount of noise and dust coming from the highway. So, every tree they removed means a difference. Instead of minimizing nuisance, they maximized nuisance by doing that."* (Respondent#7)

Residents talking about an increase in nuisance perception because of environmental changes, also often refer to governmental policy and action. The Dutch government bases their mitigation actions mainly on exposure calculations (RWS, 2014). Calculations are based on models including several factors to estimate the amount of exposure on a specific location. Several interviewees report that they feel that calculations are not coherent with what they actually perceive. The group of residents perceiving nuisance also shows a kind of disappointment with respect to governmental actions and the way they perceive they have a say in this. As one respondent indicates:

*"We did measure the exposure level ourselves, however...it was always higher than the calculations of the government. However, they insisted not 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)

#### Anticipation on future plans

A further theme we would like to address as it appeared relevant in understanding residents' current level of nuisance perception is the Southern Ring Road adjustment project that is planned. During the interviews we found that the information residents received and the experiences they have had with involvement in the planning process of the planned Southern Ring Road adjustment were taken into account in the way they talked about their nuisance perception of the ring road. Residents indicated that the way they currently looked at the negative effects of the highway was influenced by what they heard about the future adjustment plans. Some residents, being actively against the new highway plans, indicated that they became frustrated and stressed by the presence of the highway because of the plans they heard about future highway adjustment plans.

This was especially the case for residents in the Rivierenbuurt area and the Helpman area (see also Figure 2), where residents expect that the situation will get worse than it is now. The stress caused by thinking about the plans made them focusing more on the negative effects. As one interviewee mentioned:

*"The whole way we were involved I dislike. They do not take us seriously. Maybe it is also that I am more annoyed by the presence of the highway because I am so concerned with the new plans." (Respondent#10)*

The other way around, some residents expect an improvement of the current situation based on the information they have received. These interviewees mainly live in the Oosterpoort and the Linie, where the plans are to deepen the Southern Ring Road and cover it by a green area. Some interviewees in these areas indicated that the information they received about the future highway plans relaxed the way they think about the Southern Ring Road. Knowing that the future situation is likely to be better than the current one made it easier to deal with the current situation. As one woman mentioned:

*"My perception of highway nuisance first increased when I heard about plans for adjustment. The first ideas I heard I was really negative about. At that moment I heard every car passing by and was really annoyed. Now, I am more calm about it, also because the current plans sound more positive to me." (Respondent #32)*

#### Role of increased knowledge

Another aspect mentioned by interviewees as having an influence on their nuisance perception appears to be increased information about the potential harmful effects of especially air pollution. Several residents indicated that their concerns about the effects of living close to the highway grew by the extra information they recently read or heard about potential negative effects of air pollution. Residents indicate that they are not sure about the effects of air pollution for their health and that their awareness of this potential danger grew by the information they heard about the topic while living in the area. Some residents especially related their concerns to the health of their children. For example, one woman indicates that her concerns about the potential danger of air pollution especially increased after her first child was born.

*"Some time ago I spoke with a doctor of the National Institute for Public Health and the Environment (RIVM). The directives they have, legally accepted norms, that is..., they still know very little about it. 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)*

Some interviewees also indicated that the extent to which they got influenced by information about the potential impact of air pollution was related to their own health status. Some residents referred to the fact that they do not really feel that air pollution is currently affecting their health, as they do not currently perceive any related health effects. One resident, however, indicated that his awareness of the potential consequences of air pollution increased by personal health problems. At a certain moment he was 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 because of that I became more aware of the potential danger of air pollution." (Respondent#21)*

Finally, what was also noticeable is that especially interviewees who were against the plans for the future adjustment raised the point of air pollution. The protest groups against the project recently spread information about the potential negative effects of the adjustment project with respect to the city's air quality. Especially the residents who indicated to be against the project referred to the negative effects as these were also presented by the protest group. The other way around, residents who were more in favour of the plans indicated that they thought the information spread by the protest groups about the potential danger of air pollution was overemphasized. One resident indicates that he thinks that our current legislation is that strict that he believes that the air pollution problem as proposed by the protest groups is not really of his concern:

*"Our environmental legislation is nowadays that strict that I believe that the problem should not be overemphasized." (Respondent #26)*

#### (Personal) ability to cope

A final theme we would like to address as it appeared relevant in how residents talk about their experiences with Southern Ring Road nuisances is their personal ability to cope with its externalities. Whereas some residents found ways to deal with the negative effects of highway proximity, others have more difficulties to cope with the situation and describe a higher perception of nuisances in their residential context.

Some interviews referred to more emotional focused coping (e.g. Lazarus, 1991) and indicated that they tried not to focus on the negative effects of the Southern Ring Road. Several residents mentioned that they (try to) see the ring road as a part of the city life in which they live. They indicated that every residential location has its positive and negative effects where 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 #4a)*

As well, several interviewees indicated that their perception of noise nuisance of the highway has decreased during the period they live in the neighbourhood, because they got used to it. They do not explicitly notice it any more. Some residents referred to a situation they had in which they had visitors asking about their problems with highway noises. As one man indicates:

*"Sometimes if I have visitors they make notice of the noises of the highway and ask me if I am not disturbed by it. But I got used to its noises." (Respondent#5)*

Others however indicate to have more problems to emotionally cope with the presence of the highway, as it is a constantly recurring thing. These residents indicated to feel more sensitive to it and they couldn't find a way to not (yet) focus on it. One man indicated that he especially gets focused on the noises of the highway while being in bed, which sometimes causes sleeping problems.

*"My wife goes to bed and sleeps in 15 minutes. I go to bed and don't sleep that fast...And when I have bad luck I am awake for 3 hours and then I notice how noisy it is." (Respondent#4b)*

Another man also indicates that he feels his ability to cope with nuisances of the Southern Ring Road decreased by age. There are different studies arguing that noise sensitivity increases with age (van Kamp et al., 2004). In the beginning he was much more relaxed, whereas the stress about the presence of the highway has grown in time.

*"When I was younger I had no problems with the noises from the highway. But since I grew older it is getting worse. It is a continuous nerve impulse which doesn't make me calm."*  
(Respondent#10)

We also observed differences between interviewees with respect to their feeling of having options to escape from and as such control the negative effects of the Southern Ring Road i.e. problem-focused coping strategy (Lazarus, 1991). For example, some residents indicated that the position of the house or the features of the house made it easier to deal with highway nuisances. For example, because their balcony or garden was positioned on the "good side" of the house, or they had the possibility to close windows or were of the opinion that they have a well-isolated house, Also going to a friend, or going to the camping site were mentioned as escape options. These possibilities made living close to the ring road for them more bearable. As one man indicated:

*"In the backside of the house there is more noise than on the frontside. But anyway, we have" a mobile home outside the side, and we go there every summer.."* (Respondent#12)

Some people however indicated that they had more difficulties to escape from the nuisance – and problems to relieve stress – due to their inability to easily leave. As an example, we observed differences between residents with rental and owned houses in their perceived possibilities to move due to Southern Ring Road nuisance. Several residents with a rental house indicated that they were less concerned about the highway and related future developments because they could easily leave, as they wanted to. The other way around, house owners with nuisance perception sometimes mentioned potential concerns they had about selling their house to future buyers. We also observed a difference between residents we spoke to with different age. Most residents with younger age we interviewed appeared to be more relaxed in the way they talk about coping with highway nuisance. They often indicate that they will just move at the moment they are not anymore satisfied with the situation. Some of the older residents however indicated that they would not easily move as things get worse. As one older resident, living in front of the southern ring argues:

*"Well, look, I am almost 80 and he is 84, then you are not thinking about moving anymore."*  
(Respondent#13)

### **Discussion of research findings**

The stories of interviewees revealed different aspects being relevant in understanding the experience and involvement of highway nuisance perception in a residents' context. Below we further discuss our findings according to the themes brought up by the interviewees and relate them to factors discussed in literature.

One of the observations from our interviews was that the way people talk about and perceive nuisances of the Southern Ring Road in proximity of their home was related to the extent to which they were aware of the presence of the ring road when making their location choice. The fact that all residents we interviewed moved into the area after the Southern Ring Road was constructed

could have caused a process of residential self-selection in which people select themselves into the area based on accessibility preferences or lower sensitivity to nuisances (e.g. Van Wee, 2009; Nijland et al., 2007). Indeed, a part of the residents indicated that they were aware of the ring road and evaluated it in their location choice. Some evaluated the proximity to the highway from a positive side by referring to accessibility gains, privacy reasons and accessibility aspects caused by the highway. The study of Hamersma et al (2015) did show that people who indicated to have a preference for a highway location had a lower perception of nuisances. Others evaluated its negative aspects compared to other positive aspects in their location search process and judged it to be bearable. Nevertheless, based on the stories of our interviewees we found that there were also people who made a less informed choice, which refers to a bounded choice based on "distorted" information (Simon, 1957). People who didn't realize the ring road was there were often negatively surprised by the presence of the ring road later on. This may explain why self-selection into these areas sometimes does not occur.

Furthermore, the interviewees provided us different examples of the interaction between the broader residential environment and their perception of highway nuisances. Interviewees mentioned changes in the design of the Southern Ring Road, but also changes in other aspects of their direct living environment such as the removing of trees which influenced their evaluation of the ring road. These findings may explain why studies find relationships between environmental aspects and nuisance perception, such as the study of Hamersma et al (2015) in which a relation was observed between the attractiveness of buildings in the residential area and residents' perceiving of highway nuisances. Changes in the environment were often caused by governmental actions and several interviewees referred to the consequences of those actions. This corresponds to literature referring to the relationship between nuisance perception and the perception of governmental actions (e.g. Guski, 1999). The examples of interviewees refer to limitations of current (calculation) methods in infrastructure planning policy, not being fully aware of the interaction between (changes in) the environmental landscape and highway externalities. As well, several interviewees indicated that they felt to have only little influence on the actions of governments with regard to highway planning, which increased a feeling of governmental distrust among certain interviewees. This corresponds to the relevance of creating sufficient possibilities for citizen involvement in (infrastructure) planning (e.g. Healey, 1997; Arnstein, 1969).

A further relevant theme were the plans to adjust the highway; The interviews show an influence of the adjustment project on residents' current perception of nuisances. Whereas some residents indicated that they were more stressed about the Southern Ring Road because of the information they received about the plans, others indicated that knowing that the situation is likely to be improved relaxed their perception of nuisances. As such, the way people talked about the presence of the Southern Ring Road had partly to do with their expectations about the future. This is in line with research indicating that annoyance levels could already change before the actual change in levels, so called anticipation effects (e.g. Henneberry, 1998; Chernobai et al., 2011; Guski, 2004). As well, this may also explain why the study of Hamersma et al (2014) indicated that a higher highway nuisance perception is associated with an expected decrease in residential satisfaction due to highway adjustment plans.

Another point discussed in the interviews was increased awareness by information. Residents indicated that information they received during their residential experience sometimes influenced their awareness of the potential negative effects of air pollution as a consequence of living close to the Southern Ring Road. This indicates the role of media and publicity in creating this awareness, as was also indicated by other studies (e.g. Bickerstraf and Waker, 2001; Saksena, 2007). Residents also provided aspects influencing the way they were affected by information about air pollution, such as having children, their own health status and trust in governmental actions. This

indicates that residents absorb information differently (e.g. Dunwoody and Griffin, 2015; Yang et al., 2014).

A last theme, which appeared relevant in our interviewees understanding of nuisance perception was their ability to cope. Both more emotionally and more problem-focused strategies (Lazarus, 1991) were discussed by residents. Whereas some residents indicated that they had found ways to not (emotionally) focus on the presence of negative effects, others indicated to have difficulties doing so. As well, we observed differences in how residents described their possibilities to have control over the nuisances of the Southern Ring Road, so called problem-focused strategies (Lazarus, 1991). Some residents referred to escape options such as visiting friends, going to a camping site, but also closing windows. Differences were observed in residents with respect to their flexibility to move in case they would think that the negative effects of the ring road would outweigh the positive effects of the residential location. Especially housing type and age were expressed in people thoughts about coping strategies, which is in line with other studies finding differences in these groups with respect to moving intentions and consequent behaviour (e.g. Hamersma et al., 2015; Speare, 1974, Lu, 1999).

Overall, the stories of interviewees revealed some insights into the (complex) interaction between people and their environment (e.g. Gifford et al., 2011) in understanding nuisance perception of the Southern Ring Road. It underlines that taking a broader perspective on nuisance perception, accounting for the variety of residents' views (e.g. Miedema and Vos, 1999; Fields, 1993; Hamersma et al., 2015) and characteristics of the area such as environmental and historical aspects (e.g. Hamersma et al., 2014; Nijland et al., 2007) is of added value in understanding reactions of residents to (highway) infrastructure.

## **Conclusions and recommendations**

In this research we aimed to get a deeper insight into highway perception in residents' context. More precisely we have paid particular attention to reasons behind residents' perception and evolvement of this perception throughout their residential experience. To this aim we interviewed several residents living in close proximity of the Southern Ring Road, functioning as part of a highway and passing through several neighborhoods in Groningen, a city in the north of the Netherlands. In the interviews we referred to people's broader residential experience in relation to the ring road and its nuisances, such as noises, air pollution and barrier-effects (e.g. Tillema et al., 2012).

We conclude that perceptions of highway nuisance in a residents' context broadly vary among residents. Different themes were discussed which appeared relevant in understanding these differences: the extent to which they consciously chose for a location in proximity of the Southern Ring Road, (perceived) changes in their environment influencing the perceptions of nuisance, their expectations regarding future highway adjustment, their increased level of information, and their personal capacity to cope with the situation. As well, we found some specific differences in views and the relevance of themes with regard to people socio-demographics such as age and household composition and neighborhood characteristics. By randomly inviting residents for participation in the study, this paper discussed the perceptions of an a-select group of residents with various backgrounds and perspectives. In this way we also gave voice to the more 'silent majority', which is often not heard in situations of public meetings, participation and protest (e.g. Woltjer, 2000).

The results of this paper were based on one case. Further research could study different cases to compare different (highway) settings with different physical situations, population demographics, historical background etc. As well, a follow up research for the Southern Ring Road Groningen might be interesting to see to what extent the coming highway adjustment project will be



reflected in a different nuisance perception. Furthermore, our interviews revealed relationships between people's current perception of nuisances and respectively their experiences with previous infrastructure projects and expectations about the future adjustment project. Additional research could further investigate to what extent people are involved in projects and experience this involvement, and how this relates to their perceptions of the highway. A mixture of both more quantitative and more qualitative research methods may create a more elaborated insight into the impact of highways and related governmental actions from the perspective of residents and its implications for future planning policy.

The interview results provide several insights relevant for (highway) infrastructure planning policy. For example, our research once again underlines that there appears to be a large variety in residents' perception of nuisances, which is not one-to-one related to the exposure calculations as currently used as directions for mitigation policy. Many interviewees mentioned environmental aspects influencing their level of nuisance perception, which are in their view currently not taken into account in calculations such as the influence of wind, trees, reflecting buildings. As (the perception) of residential environments varies, it is difficult to adjust calculations to every specific situation and individual resident. However, to avoid governmental mistakes to occur, it is important to accommodate for specific environmental aspects, for example by area specific measurements. Related to this, taking account of residents' knowledge of the environment and letting them participate in plans regarding highways and related adjustments in their neighbourhoods may help to relax the perception of its nuisances as it may create a feeling of having more control over it (e.g. Lazarus, 1991; Guski, 2004; Nederveen, 2007). Having more trust in future developments through being involved could in that way relax stress caused by the proximity of the highway.

Furthermore, it seems valuable to take account of residents' characteristics in highway planning policy. We for example encountered differences in views between older and younger residents with respect to their associations with the Southern Ring Road. Some residents emphasized the advantages of a location close to the Southern Ring in terms of accessibility. Many of the older residents we interviewed indicated that they enjoyed viewing the traffic on the ring road, whereas most younger residents indicated that no view on the ring road was preferred. At the same time, older residents perceived themselves to be less flexible when it comes to moving elsewhere when they are dissatisfied with (future) developments. Taking account of such characteristics in the design of (highway) infrastructure and residential areas could increase residential satisfaction.

Also, our results show that despite residents all moved into the neighbourhood after the Southern ring road was constructed, not all residents consciously made the choice to live there. Being aware of the potential effects and being able to evaluate this before actually making the residential location choice could relax future stress about nuisances. It is worth thinking about the information, which could be provided by real estate agents and housing associations in order to make people aware of the consequences of their choices. As well, it does indicate that the voluntariness of choosing for a residential location is important in understanding how nuisance perception is formed. This also indicates that differences in policy might be relevant between highway development and adjustment projects.

To summarize, our interviews showed examples of the interrelationships between the residents' living experience and their level of nuisance perception, which underlines the relevance of heading towards a more integrated policy and planning connecting highway infrastructure and its environment (Heeres et al, 2012; Elverding, 2008; I&M, 2014; Rebelgroup Advisory, 2015). It is important to evaluate the consequences of changes in the environment for highway planning, and the other way around. Taking a broader perspective while taking account for characteristics of the residential context could relieve stress and future protest against highway development.

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### Appendix 1: Characteristics of respondents

Nr	Gender	Age	Perceived nuisance	Within 50m of highway	Neighborhood	Car	Type of house	Household type
1	Male	60+	No	Yes	Hoogkerk	Yes	Detached house	Two person household
2	Male	60+	No	Yes	Hoogkerk-Zuid	Yes	Detached house	Two person household
3	Male	40-60	Yes	Yes	Buitenhof	Yes	Terraced house	Family
4a*	Male	40-60	Yes	Yes	Buitenhof	No	Terraced house	Family
4b*	Female	40-60	No					
5	Male	20-40	No	Yes	Corpus	Yes	Appartment (7th floor)	Two person household
6	Male	20-40	No	Yes	Corpus	Yes	Appartment (6th floor)	Two person household (now one child)
7	Female	40-60	Yes/No	No	Corpus	No	Appartment (5th floor)	One person household
8	Male	20-40	No	Yes	Wijert	No	Appartment (3th floor)	One person household
9	Female	20-40	No	Yes	Wijert	Yes	Appartment (3th floor)	One person household
10	Male	60+	Yes	Yes	Wijert	Yes	Appartment (3th floor)	One person household
11	Female	20-40	No	Yes	Rivierenbuurt	No	Appartment (5th floor)	One person household
12	Male	60+	Yes	Yes	Rivierenbuurt	Yes	Appartment (6th floor)	Two person household
13a*	Male	60+	No	Yes	Rivierenbuurt	No	Appartment (3th floor)	Two person household
13b*	Female	60+	No					
14	Female	40-60	No	Yes	Rivierenbuurt	No	Appartment (3th floor)	One person household
15	Female	60+	No	Yes	Rivierenbuurt	No	Appartment (3th floor)	One person household
16	Female	20-40	Yes/No	Yes	Rivierenbuurt	Yes	Appartment (ground floor)	Two person household
17	Female	60+	Yes	Yes	Rivierenbuurt	Yes	Semi-detached house	One person household
18a*	Male	40-60	No	Yes	Rivierenbuurt	Yes	Semi-detached house	Family
18b*	Female	40-60	Yes					
19a*	Male	60+	No	Yes	Rivierenbuurt	Yes	Semi-detached house	Two person household
19b*	Female	40-60	Yes					
20	Male	40-60	Yes	No	Rivierenbuurt	Yes	Appartment (ground floor)	Two person household
21	Male	40-60	No	Yes	Herewegbuurt	Yes	Terraced house	Family
22a*	Male	60+	Yes	Yes	Herewegbuurt	Yes	Detached house	Two person household
22b*	Female	60+	Yes					
23	Female	40-60	No	No	Herewegbuurt	yes	Terraced house	One person household
24a*	Male	60+	No	Yes	Herewegbuurt	Yes	Detached house	Two person household
24b*	Female	40-60	No					
25	Male	40-60	No	Yes	Linie	No	Appartment (2nd floor)	Family
26	Male	20-40	Yes/No	No	Linie	Yes	Appartment (3nd floor)	Two person household
27	Male	20-40	No	Yes	Linie	Yes	Appartment (ground floor)	Family
28	Female	60+	No	Yes	Helpman-Oost	Yes	Terraced house	One person household
29	Male	60+	No	No	Linie	Yes	Detached house	Two person household
30	Female	20-40	No	Yes	Oosterpoortbuurt	Yes	Appartment (1st floor)	Family
31	Female	20-40	No	Yes	Oosterpoortbuurt	Yes	Appartment (1st floor)	One person household
32	Female	40-60	Yes	Yes	Oosterpoortbuurt	Yes	Detached house	One person household

\*Interviews took place with two persons in the household