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The Influence of Traffic Speed on Residents' Wellbeing

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Abstract

Past research showed that residents' wellbeing is closely related to levels of perceived traffic stressors such as noise, overcrowding, pollution, ultimately highlighting the importance of living in stress-free environments. In the Netherlands those environments are called 'Woonerven'. In those streets however, traffic speed is oftentimes exceeded. We hypothesized that traffic speed as well as wellbeing of residents differed between two 'Woonerven', with one street having a lower average speed of road users and higher wellbeing levels of residents. Further hypotheses were that the implementation of road markings lead to a decreased traffic speed which is followed by an increase in residents' wellbeing. To test the hypotheses, two 'Woonerven' in Groningen were used for this study in which traffic speed and wellbeing was assessed through a radar and a questionnaire respectively. Whereas sample sizes for the hypotheses regarding traffic speed were 32,778 and 50,131, sample sizes for the hypotheses testing wellbeing were 33 and 11. Only one hypothesis was supported by our results, namely that traffic speed differed significantly between the investigated 'Woonerven'. The other hypotheses addressing wellbeing levels and the hypothesized speed reduction following the implementation of road markings were not supported. Results of this study can be useful for city designers and policy makers that aim to tackle traffic related stressors in urban environments. Future studies can further research the influence of traffic speed on wellbeing and test the effectiveness of different road markings to reduce speed in other domains.

Keywords: Traffic Stress, Traffic Speed, Wellbeing, Road Markings

The Influence of Traffic Speed on Residents' Wellbeing

Environmental Stressors and Mental health

At the beginning of 2021 people in the North of the Netherlands ranked their mental wellbeing the lowest it has been in years irrespective of age, gender, level of education, and type of household. The average score given by participants regarding their life was a 6.9 whereas in the year before it was a 7.7 on a scale from zero to ten (University of Groningen, 2021). Currently between 12 and 15 percent of the Dutch population are suffering from mental health complaints, with this number being the highest in Europe. While this can be to a large degree attributed to the Coronavirus pandemic, this number has been relatively stable over the last four years, thus even be apparent before the pandemic (CBS, 2021; NL Times, 2021). As mental health and wellbeing are closely related to people's ability to function effectively in one's daily life, special focus should be given to this issue by states and cities respectively (Huppert, 2009). Multiple studies concluded that besides one's genes, the environment in which one spends time greatly influences one's mental health (e.g., Evans, 2003). When now looking at wellbeing and its links to urban environments historically by investigating the relationship between mental disorders and ecological design, it has been suggested that living in urban environments contributes to a higher chance of suffering from low mental health compared to not living in urban environments (Faris & Dunham, 1939). This is in line with other studies concluding that people living in urban environments are more exposed to different stressors than people living in rural areas. This in turn makes them more prone to suffer from psychiatric disorders, such as depression, anxiety disorders, and psychosis (McKenzie et al., 2013; Peen et al., 2010; Romans et al., 2011). New estimates show that by 2050 68% of citizens are going to be living in cities rather than in rural environments (United Nations, 2018). Keeping in mind the aforementioned link between urban environments and wellbeing, this might in turn result in more people suffering from

lower health when stressors are not targeted and therewith reduced. And even though the Netherlands are constantly ranked among the ten happiest Nations in the World, it is important to address stressors in an urban environment in order for the wellbeing of inhabitants not to decrease (World Happiness Report, 2018).

Most of the issues regarding wellbeing which stem from living in cities, are regarding noise, overcrowding and pollution (Peen et al., 2010; Van den Berg et al., 2007; Wallenius, 2004). With the term traffic stress referring to the stressors and perceived dangers that are the result of a close interaction with (motorized) traffic, many of those factors are encompassed in this definition (Crist et al., 2019). Consequently, traffic stress is to a large degree responsible for the associated lower wellbeing of residents living in urban environments rather than in rural areas (Gee & Takeuchi, 2004). In line with this, previous studies highlighted that perceptions of neighbourhood safety and wellbeing are related to several mental as well as physical health outcomes, like obesity and problems to effectively guide attention (Petrac et al., 2009; Tobin et al., 2016; Wang et al., 2019). Additionally, when investigating the direct effects of traffic stress, people who reported having higher levels of perceived traffic stress were subject to a lower health status and expressed more depressive symptoms in comparison to residents reporting lower levels of traffic stress. This effect was larger for people living in areas with higher vehicular burdens in which there was more vehicle use due to people driving or using public transportation (Gee & Takeuchi, 2004).

'Woonerf' as a Stress-Free Environment

The aforementioned studies highlight the importance of living in a perceived stress-free environment as they positively influence health and wellbeing of residents. In the Netherlands these environments are called "Woonerven". Other countries such as the United Kingdom started using the term "Home Zone" in the late nineties instead when referring to those environments (Collarte, 2012) In those streets, pedestrians, cyclists, as well as vehicles

co-exist with all of them having equal rights and having to adhere to a low speed limit (Voorhes & Bloustein, 2004). Green spaces, trees and plants are also often part of a Woonerf, adding to a perceived stress-free urban street/ environment as research has shown that green environments lower stress (van den Berg et al., 2010).

A problem that many 'Woonerven' encounter, however, is that traffic participants do not adhere to the rules, especially in regard to the speed limit. In fact, according to one study in all of the investigated 'Woonerven', traffic speed was exceeded, on average by more than 10 km/h (Sołowczuk & Gardas, 2020). Consequently, the positive influences of living in such a street are diminishing as a higher average speed is linked to an increased noise, higher emissions, and a decreased safety of other road users (Sołowczuk & Gardas, 2020). With about 26% of all journeys in the Netherlands made by bicycle, and even more in cities, it can be said that cycling is a very popular choice of transport (Hudde, 2022; Mobile, 2020; National Institute for Public Health and the Environment, 2018; van der Zee, 2015). Cycling itself has many positive effects not just for the people cycling but also for the environment as it does not cause any pollution and is a relatively quiet mode of transportation. For example, it is associated with many different positive factors, such as increased physical health and fitness, cardiorespiratory fitness, reduced risks of coronary heart disease morbidity, cancer risk, and obesity (Bourne et al., 2018; Oja et al., 2011; Rojas-Rueda et al., 2013). In addition to that people in the Netherlands are living on average half a year longer which is associated to their cycling habits (Fishman et al., 2015). While cycling has many positive effects which should not be disregarded, they can still significantly influence levels of traffic stress with traffic participants not adhering to the rules, increasing the perceived traffic stress for residents. Even though bicycle use in the Netherlands is already significantly higher compared to other industrialized nations, it is still on the rise (Harms et al., 2016). The rise of cycling does however not only come with benefits as past research showed other traffic participants

face stressful situations when encountering cyclists, often as a result of cycling speed or for being inconsiderate in busy traffic (Nixon, 2014; Parker et al., 2002). The average cycling speed varies between 12.5 and 26.5km/h depending on multiple factors such as road surfaces or weather (Eriksson et al., 2019). As electric bikes are increasing in usage in the Netherlands and they have a higher-than-average speed compared to normal bikes, average speed of cyclists might increase in the near future, possibly resulting in the neighbourhood to be perceived as more stressful (Nixon, 2014, van Cauwenberg et al., 2019; Vlakveld et al., 2015).

Nudging to Overcome Habits

Habits refer to habitual responses that are being carried out as a result of contextual cues. They are formed largely through instrumental learning with people repeating certain actions within a stable context. As a result, associations in one's procedural memory between the cue in the environment and the response behaviour are formed (Mazar & Wood, 2018; Wood et al., 2022). When successfully formed, the contextual cue elicits the response behaviour with little or no conscious intent.

However previous scholars outlined that habitual action following the contextual cue can be overridden when sufficient motivation and opportunities are present (Wood et al., 2022). Thus, when now altering the environment and thereby changing the contextual cues, it might be possible to overcome habitual behavioural responses. Past studies supported this notion. Participants changed their TV watching and exercise habits because of altered contextual cues that support engaging in this activity (Wood et al., 2005). Additionally, another study found similar results for the influential role of contextual cues with hungry participants eating carrots rather than chocolate (Lin et al., 2016). Consequently, a change in contextual cues might disrupt habit performance and thereby behavioural responses.

One form of changing the contextual cue and ultimately altering the habitual behaviour could be through what Thaler and Sunstein (2008) referred to as nudge. According to them a nudge is a psychological intervention in which subtle changes in the environment take place. Nudges are proposed to work through cognitive biases, which in turn lead to a behaviour change without forbidding alternative ways of behaving or drastically altering economic incentives (Weijers & de Koning, 2021). The theory underlying the nudging approach is the dual process theory, according to which there are two cognitive systems that process information, namely system one and system two (Kahneman, 2011). System one commonly referred to as 'automatic' contains uncontrolled, effortless, fast, and unconscious thinking. It uses cognitive boundaries, rules of thumb and biases when eliciting habitual behaviours. On the other hand, system two, also called 'reflective', refers to controlled, effortful, slow, deductive and self-aware thinking and behaviours. With system one requiring less effort than system two, it often governs our behaviour as this is more energy efficient and is therefore preferred. This can however lead to behaviours that are inconsistent with people's long-term goals (e.g., eating less and then snacking as a result of a contextual cue). Rather than now circumventing system 1, nudging aims to use the same rationale but in a way for the desired behaviour to be initiated (Weijers et al., 2021).

Previous studies highlighted that nudges can be effective in overcoming automatic or habitual behaviour. A widely known successful nudge is the image of a fly in urinals to avoid spillages (Lawton, 2013). Nudges have been proven to be useful in different domains, such as in safety, health, financial wellbeing, and climate. By providing health information or real-time feedback concerning the speed one drives, people used the stairs more frequently or car drivers reduced the speed at which they were travelling respectively (Weijers et al., 2020). Furthermore, through manipulating shared cars, past research showed that a nudge that reminds people of the desired behaviour, can be successful when wanting to overcome

habitual behaviour (Namazu et al., 2018). Those findings highlight the notion that through subtly changing the environment, habitual behaviour can be overcome.

Road Markings

In the past, road surfaces were frequently object for studies with road markings being investigated regarding their effect on speed, lateral position, and overtaking behaviour (Ariën et al., 2017; Godley et al., 2004; Hussain et al., 2021; Shackel & Parkin, 2018; Westerhuis et al., 2017). Further, previous research examined optical illusions as road markings, showing that they can be effective in significantly reducing speed of traffic participants when for instance peripheral lines are used as an optical illusion (Goodley et al., 2000). Other examples of optical illusions as road markings include 'image bumps'. Here instead of an actual physical speed bump, an 'image bump' is a painting or drawing that is perceived as a three-dimensional obstacle that is placed onto the road (CREST, 2013). These forms of road markings have been proven successful in the past to reduce traffic speed at least in the short run, as the example of the city of Philadelphia shows. However, long term effects of this intervention are not yet investigated (The New York Times, 2008).

Using a driving simulator Hussain et al., (2021) studied speed limit pavement markings that differed in regard to brightness and/ or size. Results showed that road markings that combined an increase in size and brightness were most effective in reducing speed, with travelling speed being significantly lower than for a control group. These findings indicate that road markings that are two dimensional in nature can also be effective in reducing traffic speed.

Present Study

The current study aims to contribute to the literature that investigated the effect traffic has on the wellbeing of residents. For this, two 'Woonerven' which are similar in design will be compared. In both streets the official speed limit is 15 km/h. Whereas one street is being

used frequently by commuting bicyclists, going above the speed limit (='Woonerf 1') the other street (='Woonerf 2') does not have a corridor function and is not as often used, with presumably lower cycling speed. As outlined before, fewer traffic violations might increase wellbeing through less perceived traffic stress. In line with this, the first hypotheses will be:

H1: *The speed of traffic participants is lower in Woonerf 2 than the speed of traffic participants in Woonerf 1.*

H2: *The wellbeing of residents is higher in Woonerf 2 than of residents living in Woonerf 1.*

In Groningen, the study location, 60% of daily trips are made by bicycle (van der Zee, 2015). Based on the aforementioned definition of a habit, the behaviour to cycle or drive through a Woonerf at speeds greater than the speed limit (i.e., 15km/h) is most likely to be habitual or automatic as it is a behaviour that is being carried out regularly, requiring little conscious control. Therefore, in the investigated Woonerf not only cars might be violating traffic rules, but especially bicyclists as well. This study further investigates a nudge that is aimed at reducing traffic speed. The nudge will take the form of yellow lines painted onto the road in regular intervals highlighting the speed limit and thus be the subtle change in the environment needed to alter automatic or habitual behaviour. As yellow has been proven most effective for traffic signs, this is the colour that will be used for the signs (Clark et al., 1996). With previous research highlighting that regular intervals of speed markings are effective, this study aims to expand those findings in another context (Hussain et al., 2021). This intervention might also indirectly effect residents' wellbeing through a lower average traffic speed which in turn may result in lower perceived traffic stress. Consequently, an intervention aimed to slow cyclists down might also lead to the neighbourhood to be perceived as less stressful. Keeping in mind the benefits that a perceived stress-free neighbourhood has on one's wellbeing, it is hypothesized that the intervention also increases the wellbeing of the

residents living in this street (Gee & Takeuchi, 2004). Based on the aforementioned argumentation, further hypotheses will be:

H3: *The implementation of the road markings results in a decreased average speed of traffic participants.*

H4: *The wellbeing of residents increases after the road markings have been implemented.*

Method

Participants

To check if residents' wellbeing significantly varies between two environments that differ regarding traffic, two streets that were similar in design were used for the purpose of this study, namely the Lodewijkstraat (=Woonerf 1) and the Zwarteweg (=Woonerf 2).

Figure 1

Picture of the Lodewijkstraat ('Woonerf 1')

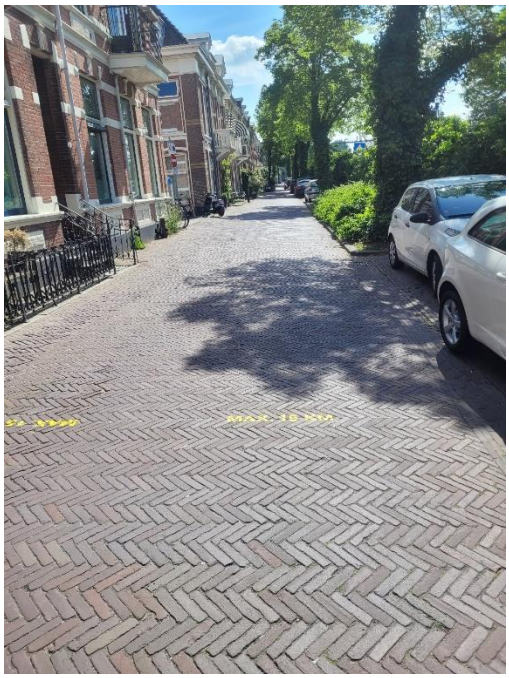
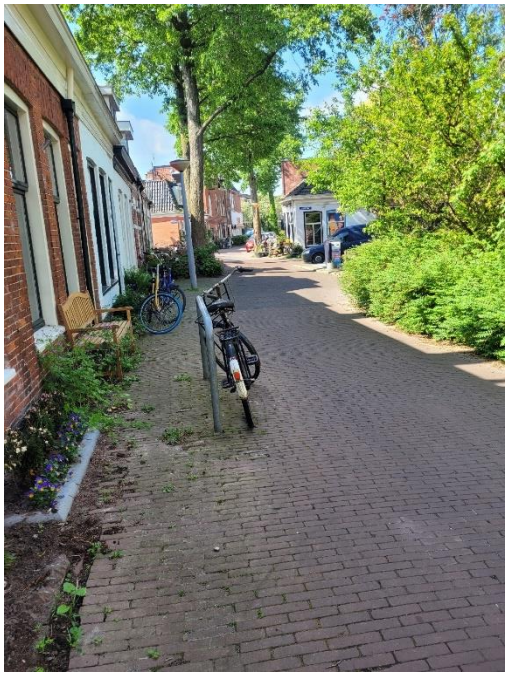


Figure 2

Picture of the Zwarteweg ('Woonerf 2')



Participants were recruited through letters in the mailbox, asking them to fill out a short online survey which assessed their level of wellbeing (see Appendix A & B). Thus, the sample that is used for this study represents a convenience sample. Participation for this study was voluntary. Only people who lived in the corresponding streets were included. Participants who did not fill out the exploratory questions and the demographics were still included if their wellbeing score was completely filled out.

The sub-sample that was used to compare the wellbeing in the two 'Woonerven' consisted of 33 participants, out of which 18 live in the 'Woonerf 1' and 15 in the 'Woonerf 2' respectively. Due to participants not filling out the survey or not giving their consent to participate, a total of eight responses were deleted with three in the 'Woonerf 2' and five in the 'Woonerf 1'. The majority of participants (i.e., nine) were aged between 26-40 and between 41-60, with three participants not indicating an age (see table below).

Table 1

Frequency Statistics of Participants Age

Woonerf	Age	Frequency	Percent
'Woonerf 1'	Between 18-25	1	5.6
	Between 26-40	4	22.2
	Between 41-60	6	33.3
	Older than 61	7	38.9
	Missing	0	0.0
	Total	18	100.0
'Woonerf 2'	Between 18-25	4	26.7
	Between 26-40	5	33.3
	Between 41-60	3	20.0
	Older than 61	0	0.0
	Missing	3	20.0
	Total	15	100.0

The second sub-sample compared the wellbeing of residents in the 'Woonerf 1' before and after the road markings have been implemented. Out of the 18 people that filled out the first survey, 14 also filled out the second survey. Due to not giving consent to participate or not filling out the second survey correctly, three responses were deleted. Ultimately, the final sub-sample consisted of eleven participants, with most of them (i.e., four) indicating that they are between 41 and 60 years of age. For a full description of the age distribution in this sample see the table below.

Table 2

Frequency Statistics of Participants Age

	Age	Frequency	Percent
'Woonerf 1'	Between 18-25	1	9.1
	Between 26-40	3	27.3
	Between 41-60	4	36.4
	Older than 61	3	27.3
	Missing	0	0.0
	Total	18	100.0

Participants for the testing of the hypotheses regarding the average traffic speed consisted of people going through the street. As this is a behaviour observable in public, no given consent was necessary. Three different sub-samples were used to test the hypotheses, namely the pre-and post-measurement in the 'Woonerf 1' and the one speed measurement in the 'Woonerf 2'. Whereas for the first speed measurement in the 'Woonerf 1' two existing measurements were averaged, yielding a total of 27.452 traffic participants, in the post-measurement 22,679 road users' speed was observed. Lastly, 5,326 participants made up the sub-sample in the 'Woonerf 2' regarding speed measurements.

Procedure and Design

The Ethics Committee of the Faculty of Behavioural and Social Sciences of the University of Groningen approved this study (PSY-2122-S-0233). Data was handled in accordance with the Data Management Plan and the Ethics Protocol of the University of Groningen. Before measuring wellbeing, all participants gave informed consent to participate. As this study was voluntary, participants could withdraw from filling out the survey at any point with no consequences. As there was no deception used in this study, participants were

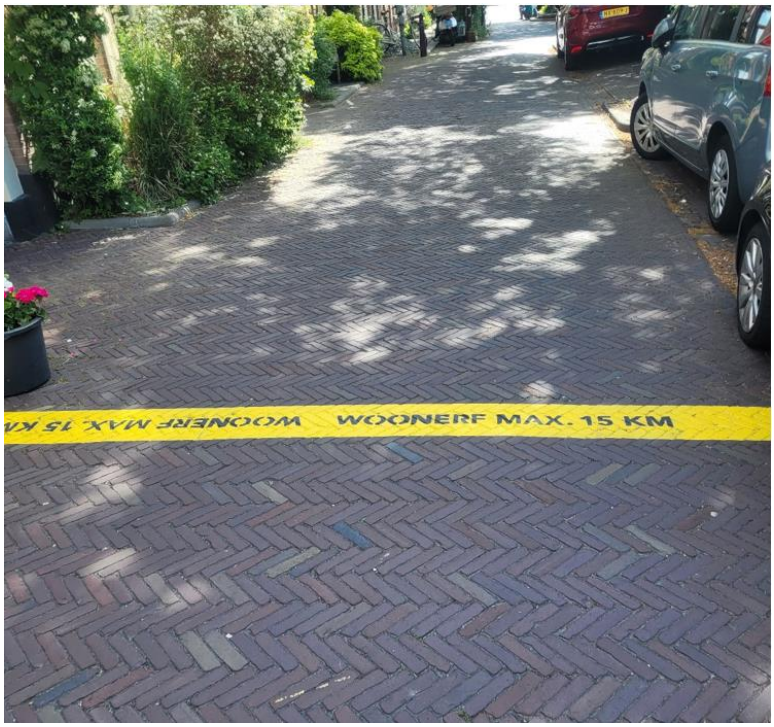
only informed about the purpose of the study before filling out the survey with no debriefing provided at the end of the survey.

Wellbeing was assessed through the World Health Organization- Five Well-Being Index (WHO-5), which has been used widely in past research, demonstrating good construct validity (Taylor et al., 2018; Topp et al., 2015). The measure includes five statements that all are being rated on a scale from 0 to 5 regarding how participants felt in the last two weeks. The five statements are as followed: "I have felt cheerful in good spirits.", "I have felt calm and relaxed.", "I have felt active and vigorous.", "I in general woke up feeling fresh and rested.", and "My daily life has been filled with things that interest me.". The possible answers were: at no time=0, some of the time=1, less than half of the time=2, More than half of the time=3; most of the time=4, and all of the time=5. The numbers are then interpreted according to the WHO standards, with the numbers being added up, making up a raw score that is then multiplied by 4 to give a final score (Child Outcomes Research Consortium, n.d.). A score of 100 represents the best possible result regarding wellbeing and 0 the worst. Participants were also asked to fill out three additional questions which were answered on a Likert scale from 0=not at all happy to 10=extremely happy. The first question was regarding how happy they are living in the corresponding street. Next, participants rated the statement "The speed of traffic participants going through the street heavily influences my well-being" with the same Likert scale. Lastly, participants were asked how large the influence of parked cars is on their wellbeing, which was also answered based on the Likert scale ranging from 0 to 10. This was done in order to avoid demand characteristics by making it less obvious that merely traffic speed was investigated. Additionally, this question was used for exploratory purposes to investigate if parked cars indeed have an influence on one's level of wellbeing. At the end of the survey, participants were given the chance to leave a comment. For exploratory and control purposes participants were asked to indicate their age based on four different

answer possibilities: between 18 and 25, between 26-40, between 41-60, and older than 61. For a detailed description of the survey see Appendix C. For the post-measurement regarding the wellbeing of participants in the 'Woonerf 1' participants filled in the same questionnaire as before. Every participant who filled out and the first survey and provided an email-address for the follow up assessment, received an invitation to fill out the post-measurement two weeks after the road markings had been implemented. However, participants were also asked to answer two open questions for exploratory purposes, namely "Do you think the yellow lines with woonerf/ speed reminder, which have been painted onto the road, had an effect on the speed of traffic participants going through the street?" and "what do you think of the design/ format of the speed limit reminder?". The road markings are placed in regular intervals in the 'Woonerf 1' and consist of a yellow line indicating the speed limit and that traffic users are going through a 'Woonerf' (see picture below).

Figure 3

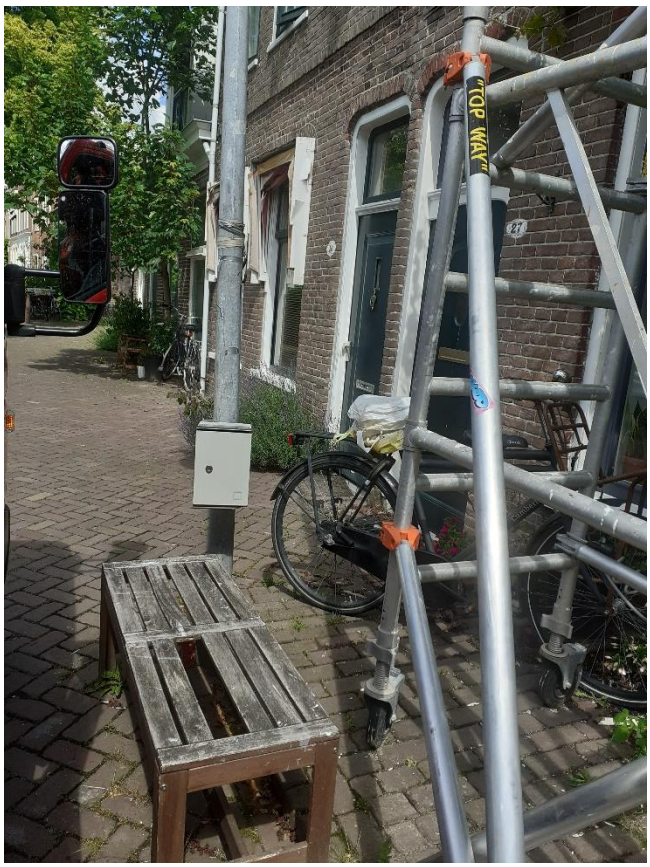
Road markings in the 'Woonerf 1'



Speed of road users was measured per transportation mode through a radar by the Municipality of Groningen which then provided these data for the purpose of this study. Speed was measured three times in the 'Woonerf 1'. Here two already existing measurements were used as a pre-measure after having been averaged. Those measurements were conducted from 01.02.2021 at 09:34 am until 05.02.202 11:07 am and from 06.12.2021 9:59 am until 13.12.2021 09:29 am respectively. After the road markings had been placed another speed measurement took place from the 01.06.2022 07:43am until 09.06.2022 11:08 am. In the 'Woonerf 2' speed was only measured once, from the 28.06.2022 11:01 am until 10.07.2022 04:32 am.

Figure 4

Picture of the radar that measures traffic speed



Scores of the speed measurements and the wellbeing assessment were then used to test the different hypotheses. For hypothesis 1, the average speed of the 'Woonerf 2' was

compared to the averaged pre-measurements of the 'Woonerf 1'. To test hypothesis 2, wellbeing stemming from residents living in the 'Woonerf 2' were compared to the pre-measurement of wellbeing of people residing in the 'Woonerf 1'. For the third hypothesis assessing the effectiveness of the road markings, the averaged pre-measurement speed scores were compared to the average speed of traffic participants going through the street after the road markings had been implemented. The last hypothesis assessing the hypothesized increase in wellbeing, compared the pre-measurement scores to the post-measurement wellbeing scores in the 'Woonerf 1'.

Data Analysis Plan

All statistical analyses were done with JASP (Version 0.16.2), a commonly used openly accessible statistics software platform. The first three hypotheses dealing with comparisons regarding traffic speed and residents' wellbeing in the two 'Woonerven', were all tested through an independent sample t-test. Lastly, to test hypothesis 4 if wellbeing increased after the implementation of the road markings, a repeated measures ANOVA was conducted.

Results

Hypotheses Testing

According to hypothesis 1, the average speed of traffic participants is lower in'Woonerf 1' than in 'Woonerf 2' for both two-wheelers (bikes and bicycles) as well as for cars. For both transportation modes the average speed was higher in 'Woonerf 1' than in 'Woonerf 2' (see table below). Due to the assumptions of normality and equality of variances being violated, the Mann-Whitney U test was used (for all preliminary analyses see Appendix E). According to the Mann-Whitney U test this difference was significant for bikes ($U(N=9{,}439, N=2{,}884)= 22{,}700{,}000$, $p=<.001$) as well as for cars ($U(N=18{,}013, N=2{,}442)=$

35,700,000, p=<.001). Therefore, the first hypothesis is fully supported as traffic speed is significantly lower in 'Woonerf 2' compared to 'Woonerf 1' for both transportation modes.

Table 3

Descriptive Statistics for hypothesis 1

	Car speed		Bike speed	
	'Woonerf 1'	'Woonerf 2'	'Woonerf 1'	'Woonerf 2'
Valid	18,013	2,442	9,439	2,884
Missing	0	0	0	0
Mean in km/h	20.1	14.8	19	13.4
Std. Deviation in km/h	5.3	4	5.1	3.4
Minimum in km/h	8	8	8	8
Maximum in km/h	56	38	57	31

The second hypothesis stated that the wellbeing of residents is higher in 'Woonerf 1' than of residents living in 'Woonerf 2'. This hypothesis was tested by comparing two different sub samples representing residents' wellbeing in 'Woonerf 1 and 2' respectively. Due to normality being violated the Mann-Whitney U test was used instead. Wellbeing scores were higher in 'Woonerf 2' (M=69.9, SD=15.4) than in 'Woonerf 1' (M=60.7, SD=19.9). In addition, the maximum and the minimum score were higher in 'Woonerf 2' than in 'Woonerf 1', yielding a smaller range of wellbeing scores in 'Woonerf 2' (see table below). However, the Mann-Whitney test yielded this difference as not significant at an alpha level of .05 (see table below). Thus, the second hypothesis is not statistically supported as the wellbeing is not significantly higher in 'Woonerf 2' than in 'Woonerf 1.

Table 4

Descriptive Statistics for hypothesis 2

	Wellbeing Score	
	'Woonerf 1'	'Woonerf 2'
Valid	18	15
Missing	0	0
Mean	60.7	69.9
Std. Deviation	19.9	15.4
Range	64	52
Minimum	20	48
Maximum	84	100

Table 5

Independent Samples T-Test

	W	p
Wellbeing Score	108.5	0.172

According to the third hypothesis the average speed of traffic participants reduced after the road markings had been implemented in the 'Woonerf 1'. Here, traffic speed was compared for each mode of transportation, namely for two-wheelers (so bikes and bicycles) and cars respectively. For both groups the mean of traffic speed was higher in the post-measurement than in the pre-measurement (see table below). For bikes, this difference is not significant at an alpha level of .05 ($U(N=12.120, N=9,439)= 59,620,000, p=1$) according to the Mann-Whitney U test. The Mann-Whitney U test also revealed the difference between pre- and post-measurement in terms of traffic speed for cars not to be significant

($U(N=10{,}559, N=18{,}013)= 101{,}700{,}000, p=1$). Consequently, the third hypothesis is not supported with the mean being even higher in post-measurement for both modes of transportation.

Table 6

Descriptive Statistics for hypothesis 3

	Car Speed		Bike Speed	
	Post-Measure	Pre-Measure	Post-Measure	Pre-Measure
Valid	10,559	18,013	12,120	9,439
Missing	0	0	0	0
Mean in km/h	20.6	20.1	19	18.6
Std. Deviation in km/h	5.4	5.3	5.1	4.9
Minimum in km/h	8	8	8	8
Maximum in km/h	68	56	57	49

Lastly, the fourth hypothesis stated that the wellbeing of residents living in the 'Woonerf 1' increased after the road markings had been implemented. Descriptive results show an increase in wellbeing for the post-measurement ($M=62.18, SD= 18.36$) when comparing it to the pre-measurement ($M=57.09, SD=24.53$). However, according to results of the repeated measures ANOVA this finding is not significant (see table below). Consequently, results do not find a significant effect on an increase in wellbeing following the implementation of the road markings.

Table 7

Descriptive Statistics for hypothesis 4

	Wellbeing Time 1	Wellbeing Time 2
Valid	11	11
Missing	0	0
Mean	57.1	62.2
Std. Deviation	24.5	18.4
Minimum	20	20
Maximum	84	84

Table 8

Within Subjects Effects for repeated measures ANOVA

Cases	Sum of Squares	df	Mean Square	F	p	η^2
Wellbeing	142.55	1	142.55	1.27	0.29	0.11
Residuals	1121.46	10	112.15			

Exploratory Analysis

The survey assessing the wellbeing of residents included three items for exploratory purposes. The first question asked how happy residents are living in that specific street. Whereas the second statement asked participants to indicate to what extent traffic participants going through the street heavily influence their wellbeing, the third statement asked how large the influence of parked cars is on their wellbeing. When now comparing scores of 'Woonerf 1' to scores of 'Woonerf 2', the means were for each question slightly higher in 'Woonerf 1'.

However, all differences were not statistically significant. For the full statistical analysis see Appendix F.

The same items were also used for the pre- and post-measurement in the 'Woonerf 1'. Here, means were slightly higher for two out of three questions for the pre-measurement. Only, the second question asking about the influences of traffic on residents' wellbeing was higher for the post-measurement. However, these differences were not statistically significant.

Lastly, participants in the post-measurement were asked open questions that are being analyzed on a qualitative level, namely if participants think the road markings had an effect on the speed of traffic participants going through the street, what residents think about the design of the road markings and if residents wish to share a comment with us. See Appendix D for all answers. Regarding the first question, ten participants indicated that they think the road markings did not have a satisfactory effect or that the effect was far from being satisfactory with one of them thinking that road markings in general are not an effective way of altering transportation behaviour. Additionally, the same participant indicated that the road markings might not have been readable for cyclists or scooters going through the street. One resident thought the road markings reduced traffic speed by a bit.

For the second question, participants were mostly happy with the design, with some indicating the road markings are quite clear and are something different to previous signs. One participant indicated that they perceive the road markings to be still overlooked with another one adding that the road markings do not look official even though they are neatly done. Lastly, when given the option to leave a comment, one participant expressed that they are dissatisfied with the amount of road markings that are implemented onto the road.

Discussion

Previous studies concluded that people who are living in a neighbourhood that is perceived as stressful are often subject to a lower wellbeing with residents being more prone

to suffer from psychiatric disorders (e.g., Gee & Takeuchi, 2004; McKenzie et al., 2013). There are different stressors in urban environments with noise, pollution, overcrowding being the most apparent ones, which are combined in the term traffic stress (Crist et al., 2019; Peen et al., 2010; Van den Berg et al., 2007). This study aimed to contribute to the knowledge in the domain of traffic stress and its link to wellbeing. More specifically, this study compared two 'Woonerven' in regard to the average speed of road users and residents' wellbeing. In addition, this research also tested a nudge in the form of road markings aiming to decrease average traffic speed.

The first hypothesis was that the speed of traffic participants is lower in the 'Woonerf 2' than the speed of traffic participants in the 'Woonerf 1'. Based on the results, this hypothesis was fully supported. According to the second hypothesis these two 'Woonerven' should also differ in regard to residents' wellbeing. Our results however did not find a significant difference between wellbeing levels between the 'Woonerven'.

Generally, these findings are not in line with past research. Numerous studies highlighted that the environment in which one lives greatly influences one's wellbeing (e.g., Evans, 2003). Additionally, urban environments in which people face higher levels of traffic stress were found to have a negative influence on one's health (Babisch et al., 2001; Crist et al., 2019; Evans et al., 1995; Gee & Takeuchi, 2004; Rylander, 2004). Keeping in mind that the 'Woonerf 1' has a corridor function for people going to the city and the train station and is thus used frequently, the results are rather unexpected as the 'Woonerf 2' is not used as often. According to studies high traffic speed and a high volume of traffic participants should increase one's perceived stress which then in turn negatively influences one's wellbeing (Anciaes et al., 2017; Kingham et al., 2020; Scholes et al., 2016). There are several potential alternative explanations that could explain why wellbeing did not significantly differ between the two streets. One of them highlights the low response rate, ultimately yielding small

sample sizes. As outlined by previous scholars, a small sample size results in low statistical power, which in turn negatively influences the likelihood of detecting a true effect (Button et al., 2013). Therefore, real differences in terms of wellbeing might have been apparent when comparing residents' wellbeing in 'Woonerf 1' to wellbeing in 'Woonerf 2'. However, with such small sample sizes, this effect might have been undetected.

Furthermore, past studies investigating stressors that affect wellbeing in urban environments, mainly tested noise, pollution, and overcrowding (Crist et al., 2019; Gee & Takeuchi, 2004; Peen et al., 2010, Van den Berg et al., 2007). All of these stressors are less apparent when taking a bicycle as a transportation mode rather than a car. (Li et al., 2002; Tara et al., 2015; UCLA Transportation, n.d.; University of Montana, n.d.). Consequently, based on the definition of traffic stress, residents might not have experienced high levels of traffic stress keeping in mind the relatively high amount of trips done on a bicycle in our sample as well in Groningen altogether (van der Zee, 2015). This in turn might have influenced residents' wellbeing not to differ significantly between the two streets, as levels of traffic stress might not have differed much in the first place.

Additionally, people's wellbeing depends on numerous factors, not just traffic speed, with wellbeing serving as an umbrella term summarizing subjective evaluations of one's life, including work life, relationships or health (Diener & Ryan, 2009). Further, weather seasons as well as weather in general heavily influence wellbeing (Fedderson et al., 2016). With the first measurements starting in late spring and the study ending in summer, people might have experienced higher levels of wellbeing, due to them possibly spending more time outdoors and the days getting longer. This idea has been supported by past research that showed that colder months can negatively affect people's mood (Beecher et al., 2016; Ergler et al., 2013; Rosenthal et al., 1984). Consequently, the date of the research and with it the positive effects on wellbeing of the summer season, might have negated the negative influences on wellbeing

of living in an environment with many traffic related stressors. Ultimately, this might have led to levels of wellbeing not to significantly differ.

Based on hypothesis 3 the average traffic speed should have decreased following the implementation of the road markings. With no significant effect being apparent and residents expressing that in their view traffic speed did not decrease substantially, this hypothesis is not supported on a statistical level as well as on an exploratory level. This is not in line with past research that indicated that road markings can be effective when wanting to reduce speed (e.g., Goodley et al., 2000; Hussain et al., 2021). However, road markings did not always yield the desired effect, with Westerhuis et al., (2017) suggesting that in their study road markings were not visible enough in order to significantly influence lateral positioning of bicyclists. As in our study the road markings were yellow, relatively large and placed in regular intervals, visibility was most likely not the issue. A past study showed that regular intervals of road markings can be effective in reducing traffic speed (Hussain et al., 2021). However, there are some differences between their study and our study. Firstly, speed limit was higher in their scenario (i.e., 100km/h) compared to our scenario (i.e., 15km/h). Thus, it could be the case that road markings are only effective to reduce speed up to a certain threshold. Additionally, Hussain and colleagues (2021) increased the road markings' size and brightness further down the road, giving drivers the feeling, they are driving faster than they are which in turn might make them slow down more. In our study, road markings did not increase in size or brightness, possibly explaining why our study design did not yield the desired effect on traffic speed.

Another alternative explanation for why traffic speed did not decrease for bicyclists is the possibility that traffic participants might have underestimated their traffic speed. As people in the Netherlands cycle mainly for the purpose of commuting, it seems reasonable to assume that many of them are not equipped with a speedometer (Ministry of Infrastructure

and Water Management, 2020). With now no real time feedback given to bicyclists regarding their speed, cyclists could underestimate the speed they travel at, ultimately yielding a higher average traffic speed for two-wheelers in our study. This idea has been supported by past studies showing that especially bicyclists with little experience substantially underestimate traffic speed (Wu et al., 2017).

Furthermore, social norms could explain why traffic speed did not significantly decrease. There are two different kind of social norms which are important to distinguish. Whereas injunctive norms refer to what behaviours are typically (dis) approved, descriptive norms refer to behaviours that are common within a certain setting (Pebley et al., 2020). Previous work highlighted that injunctive norms can be made salient through signs indicating norms (Keizer et al., 2008). For this study there were no signs but rather road markings indicating the speed limit and therewith the injunctive norm (i.e., speed limit) was made salient. However, people are more likely to violate injunctive norms when descriptive norms are in violation of social norms, implying a cross-norm inhibition effect (Keizer et al., 2008). For the context of this study this means that people are more likely to not obey to the speed limit and thus violate the injunctive norm when they see other people speeding (i.e., descriptive norm). Consequently, seeing other people going through the street at a greater speed than the speed limit might have decreased the effectiveness of the road markings to reduce average traffic speed.

In addition, the weather might have influenced the speed of traffic users. The pre-measurements were conducted in December and February whereas the post-measurement took place in June. In winter in the Netherlands the temperatures are on average significantly lower than in summer with the wind speed being higher as well (Weather Spark, n.d.). Past studies showed that weather parameters such as cold temperatures and strong winds can reduce average traffic speed (Chmielewski et al., 2019). Consequently, the road markings

might have been partly successful in reducing speed, as without the road markings traffic speed might have been even higher for the post-measurement which was conducted in summer.

Regarding hypothesis 4, results are not as surprising as the road markings have not reduced traffic speed significantly. Thus, it would be unanticipated if wellbeing significantly increased as the level of perceived traffic stress might not have decreased in the first place. However, even if the road markings would have had the desired effect, wellbeing might not have necessarily increased. Next to the aforementioned possibility of not finding a significant effect due to a small sample size, the post-measurement took place only after two weeks. Past studies that investigated interventions aimed to increase wellbeing used a longer time period in between measurements (e.g., Cunnife, 2020; Erraziriz et al., 2022; Giordano et al., 2020; Keeman et al., 2017; Poudel-Tandukar et al., 2021; Yaden et al., 2021). Consequently, the time frame might have been too short in order to detect an increase in wellbeing following the implementation of the road markings.

Practical Implications

This study has valuable insights for policy makers and city designers, but especially for municipalities. As aforementioned, there will be an increasing urbanization in the future and with it presumably a raise of traffic related stressors (United Nations, 2018). Consequently, it is of greatest interest to keep those stressors at a minimum, for example by reducing traffic speed. With this study investigating the effectiveness of an intervention to reduce speed in 'Woonerven', this study offered valuable insights into what municipalities or city designers can do to effectively reduce traffic related stressors. Even though the road markings did not prove to be effective, results can be used to design subsequent road markings differently and trying out further interventions (e.g., by varying the colour, design or shape respectively). Additionally, even if our study did not find effects of traffic speed on

residents' wellbeing, it highlights that municipalities as well as policy makers should target multiple traffic related stressors as only targeting speed might not yield the desired increase in wellbeing of residents. Consequently, when designing interventions aimed to increase wellbeing, a holistic approach should be used, targeting multiple traffic related stressors simultaneously.

Strengths and Limitations

There are several strengths regarding this study that are worthwhile elaborating on. Firstly, the sample sizes for the testing of the effectiveness of the road markings as well as the traffic speed differences between the two streets, were relatively large thus providing more exact mean values. This in turn allowed us to accurately compare pre- and post-measurement and the speed of the two 'Woonerven'. Additionally, data collection took place in a real life setting through radar, thus it is most likely that the sample was quite heterogenous in terms of certain demographics such as age or level of education. As the speed measurement was conducted through a radar which was hard to spot, road users might not have known that they were part of a study. This in turn might have positively influenced the chance for participants not to fall subject to demand characteristics by altering one's behaviour so it is line with the anticipated study outcome. Furthermore, data regarding residents' wellbeing were also collected in real life settings, i.e., in real streets in Groningen. Therefore, ecological validity for this study is high.

Choosing a real-life setting however also has some disadvantages. As this way the study setting is not experimental in nature, establishing a cause-and-effect relationship, like the effect of road markings on wellbeing, is hard to do due to outside influences not being controlled for. However, this is crucial when investigating the influences of traffic stress as that depends not only on speed but also on other factors that may influence wellbeing, such as traffic noise, pollution or even relationships or one's work life. Further, even though traffic

speed was differentiated between two modes of transportation, this study did not make a distinction between bicycles and scooters. However, keeping in mind the possible effect of (not) having a speedometer on one's traffic speed, differentiating between those two transportation modes might have proven to be worthwhile. By relying on small sample sizes for the wellbeing measurements, extreme and individual outside influences might have heavily altered the mean values for the whole sample. The small sample size is not only also problematic for the statistical power of the study and the chance to detect a true effect but also for the representativeness of the sample. As this way it is unlikely that every group of individuals living in the street is adequately represented and a high possibility that certain groups are either under- or overrepresented, ultimately not being representative for the population of interest.

Future Research

As only the first hypothesis regarding the difference in traffic speed between the two 'Woonerven' was supported future studies may investigate this further. With data collection regarding wellbeing in urban environments being most likely to continue in the future, future studies may use insights from this study. The road markings did not substantially reduce traffic speed. As outlined before this could be due to different alternative explanations which can be addressed by future research using an experimental design. This way other variables could be kept constant and thus controlled for. Keeping in mind that Dutch residents cycle more than any other European country, and might therefore have differing cycling routines, scholars may conduct similar studies in countries with different cultural backgrounds (Pucher & Buehler, 2008). Additionally, future work may explore the effect of traffic speed on residents' wellbeing in more detail by controlling for other influences such as traffic emissions, traffic noise and traffic volume. As traffic environments where lots of cyclists are apparent, might have different effects on traffic stress for people living in the street, this could

be further elaborated on. This could be done by comparing environments that are dominated by motorized vehicles to environments with many bicyclists. As our research failed to extent previous findings regarding regular intervals of road markings on traffic speed, future research may test if the same study design which was used by Hussain and colleagues (2021) is also effective for lower speed limits. Lastly, by using a large-scale comparison of different 'Woonerven', future work may overcome a shortcoming of this study, namely the relatively small sample size for the assessment of residents' wellbeing.

Conclusion

As aforementioned different traffic related stressors negatively impact the wellbeing of residents in urban environments. To mitigate these negative influences of traffic stress on wellbeing, it is important to target stressors that stem from traffic in cities. This study investigated the link between traffic speed and residents' wellbeing. Additionally, it tested the effectiveness of road markings to reduce the average speed of traffic participants. Even though traffic speed differed significantly between the two 'Woonerven', no effect was found for residents' wellbeing. Additionally, the road markings did not reduce average traffic speed and results did not show an increase in wellbeing following the implementation of the road markings. To conclude, we therefore recommend investigating the role of different traffic related stressors on wellbeing by using an experimental design and test the effectiveness of other road markings on reducing traffic speed.

References

Anciaes, P. R., Scholes, S., Stockton, J., & Ortegon, A. (2017). Living close to busy roads reduces wellbeing. https://discovery.ucl.ac.uk/id/eprint/1559484/1/Anciaes_et%20al%202017%20Living%20close%20to%20busy%20roads%20reduces%20wellbeing%20%28presentation%29.pdf

Ariën, C., Brijs, K., Vanroelen, G., Ceulemans, W., Jongen, E. M. M., Daniels, S., Brijs, T., & Wets, G. (2017). The effect of pavement markings on driving behaviour in curves: a simulator study. *Ergonomics*, *60*(5), 701–713.

Babisch, W., Fromme, H., Beyer, A., & Ising, H. (2001). Increased catecholamine levels in urine in subjects exposed to road traffic noise:the role of stress hormones in noise research. *Environment International*, *26*(7), 475–481. https://doi.org/10.1016/S0160-4120(01)00030-7

Beecher, M. E., Eggett, D., Erekson, D., Rees, L. B., Bingham, J., Klundt, J., Bailey, R. J., Ripplinger, C., Kirchhoefer, J., Gibson, R., Griner, D., Cox, J. C., & Boardman, R. D. (2016). Sunshine on my shoulders: weather, pollution, and emotional distress. *Journal of Affective Disorders*, *205*, 234–238. https://doi.org/10.1016/j.jad.2016.07.021

Bourne, J. E., Sauchelli, S., Perry, R., Page, A., Leary, S., England, C., & Cooper, A. R. (2018). Health benefits of electrically-assisted cycling: A systematic review. *The International Journal of Behavioural Nutrition and Physical Activity*, *15*. https://doi-org.proxy-ub.rug.nl/10.1186/s12966-018-0751-8

Button, K. S., Ioannidis, J. P., Mokrysz, C., Nosek, B. A., Flint, J., Robinson, E. S., & Munafó M. R. (2013). Power failure: why small sample size undermines the reliability of neuroscience. *Nature Reviews Neuroscience*, *14*(6), 442–442.

CBS. (2021). Perceived mental health: trend stable in 2020. https://www.cbs.nl/en-gb/news/2021/09/perceived-mental-health-trend-stable-in-2020

Child Outcomes Research Consortium. (n.d.). The World Health Organisation-Five Well-Being Index (WHO-5). https://www.corc.uk.net/outcome-experience-measures/the-world-health-organisation-five-well-being-index-who-5/

Chmielewski, J., Budzynski, M., & 4th World Multidisciplinary Civil Engineering-Architecture-Urban Planning Symposium, WMCAUS 2019 4 2019 06 17 - 2019 06 21. (2019). The impact of weather on traffic speed in urban area. *Iop Conference Series: Materials Science and Engineering*, *603*(2). https://doi.org/10.1088/1757-899X/603/2/022072

Clark, K. L., Hummer, J. E., & Dutt, N. (1996). Field evaluation of fluorescent strong yellow-green pedestrian warning signs. *Transportation Research Record: Journal of the Transportation Research Board*, *1538*(1), 39–46. https://doi.org/10.1177/0361198196153800105

Collarte, N. (2012). The Woonerf Concept "Rethinking a Residential Street in Somerville". https://nacto.org/docs/usdg/woonerf_concept_collarte.pdf

CREST. (2013). Optical Illusions on Roads and Measures for Their Reduction. http://compillusion.mims.meiji.ac.jp/pdf/roadillusions_eng.pdf

Crist, K., Schipperijn, J., Ryan, S., Appleyard, B., Godbole, S., & Kerr, J. (2019). Fear factor: level of traffic stress and gps assessed cycling routes. *Journal of Transportation Technologies*, *09*(01), 14–30. https://doi.org/10.4236/jtts.2019.91002

Cunniffe, J. R. (2020). Implementation of a family mindfulness based stress reduction program in the school setting and its effects on family functioning and wellbeing [ProQuest Information & Learning]. In *Dissertation Abstracts International Section A: Humanities and Social Sciences* (Vol. 81, Issue 8–A).

Diener, E., & Ryan, K. (2009). Subjective well-being: a general overview. *South African Journal of Psychology*, *39*(4), 391–406. https://doi.org/10.1177/008124630903900402

Ergler, C. R., Kearns, R. A., & Witten, K. (2013). Seasonal and locational variations in children's play: implications for wellbeing. *Social Science & Medicine*, *91*, 178–185. https://doi.org/10.1016/j.socscimed.2012.11.034

Eriksson, J., Forsman Åsa, Niska, A., Gustafsson, S., & Sörensen Gunilla. (2019). An analysis of cyclists' speed at combined pedestrian and cycle paths. *Traffic Injury Prevention*, *20*(Sup3), 56–61. https://doi.org/10.1080/15389588.2019.1658083

Errazuriz, A., Schmidt, K., Undurraga, E. A., Medeiros, S., Baudrand, R., Cussen, D., Henriquez, M., Celhay, P., & Figueroa, R. A. (2022). Effects of mindfulness-based stress reduction on psychological distress in health workers: A three-arm parallel randomized controlled trial. *Journal of Psychiatric Research*, *145*, 284–293. https://doi-org.proxy-ub.rug.nl/10.1016/j.jpsychires.2020.11.011

Evans, G. W. (2003). The built environment and mental health. *Journal of Urban Health: Bulletin of the New York Academy of Medicine*, *80*(4), 536–555. https://doi.org/10.1093/jurban/jtg063

Evans, G. W., Hygge, S., & Bullinger, M. (1995). Chronic noise and psychological stress. *Psychological Science*, *6*(6), 333–338.

Faris, R. E. L., & Dunham, H. W. (1939). *Mental disorders in urban areas: an ecological study of schizophrenia and other psychoses*. Univ. Chicago Press.

Feddersen, J., Metcalfe, R., & Wooden, M. (2016). Subjective wellbeing: Why weather matters. *Journal of the Royal Statistical Society: Series A (Statistics in Society)*, *179*(1), 203–228. https://doi-org.proxy-ub.rug.nl/10.1111/rssa.12118

Fishman, E., Schepers, P., & Kamphuis, C. B. M. (2015). Dutch cycling: Quantifying the health and related economic benefits. *American Journal of Public Health*, *105*(8), e13–e15. https://doi-org.proxy-ub.rug.nl/10.2105/AJPH.2015.302724

Gee, G. C., & Takeuchi, D. T. (2004). Traffic stress, vehicular burden and well-being: A multilevel analysis. *Social Science & Medicine*, *59*(2), 405–414. https://doi-org.proxy-ub.rug.nl/10.1016/j.socscimed.2003.10.027

Ghasemi, A., & Zahediasl, S. (2012). Normality tests for statistical analysis: a guide for non-statisticians. *International Journal of Endocrinology and Metabolism*, *10*(2), 486–9. https://doi.org/10.5812/ijem.3505

Giordano, F., Scarlata, E., Baroni, M., Gentile, E., Puntillo, F., Brienza, N., & Gesualdo, L. (2020). Receptive music therapy to reduce stress and improve wellbeing in Italian clinical staff involved in COVID-19 pandemic: A preliminary study. *The Arts in Psychotherapy*, *70*. https://doi-org.proxy-ub.rug.nl/10.1016/j.aip.2020.101688

Girden, E. R. (1992). *Anova : repeated measures* (Ser. Sage university papers. quantitative applications in the social sciences, no. 07-084). Sage Publications.

Godley, S. T., Triggs, T. J., & Fildes, B. N. (2000). Speed reduction mechanisms of transverse lines. *Transportation Human Factors*, *2*(4), 297–312. https://doi.org/10.1207/STHF2-4_1

Godley, S., Triggs, T., & Fildes, B. (2004). Perceptual lane width, wide perceptual road centre markings and driving speeds. *Ergonomics*, *47*(3), 237–256.

Harms, L., Bertolini, L., & Brömmelstroet, M. T. (2016). Performance of Municipal Cycling Policies in Medium-Sized Cities in the Netherlands since 2000. *Transport Reviews*, *36*(1), 134–162. https://doi-org.proxy-ub.rug.nl/10.1080/01441647.2015.1059380

Hudde, A. (2022). The unequal cycling boom in germany. *Journal of Transport Geography*, *98*, 103244–103244. https://doi.org/10.1016/j.jtrangeo.2021.103244

Huppert, F. A. (2009). Psychological well-being: Evidence regarding its causes and consequences. *Applied Psychology: Health and Well-Being*, *1*(2), 137–164. https://doi-org.proxy-ub.rug.nl/10.1111/j.1758-0854.2009.01008.x

Hussain, Q., Alhajyaseen, W. K. M., Reinolsmann, N., Brijs, K., Pirdavani, A., Wets, G., & Brijs, T. (2021). Optical pavement treatments and their impact on speed and lateral position at transition zones: a driving simulator study. *Accident Analysis and Prevention*, *150*.

Kahneman, D. (2011): Thinking, Fast and Slow. In *Statistical Papers* (Vol. 55, Issue 3, pp. 915–915). Springer Science and Business Media LLC. https://doi.org/10.1007/s00362-013-0533-y

Keeman, A., Näswall, K., Malinen, S., & Kuntz, J. (2017). Employee wellbeing: evaluating a wellbeing intervention in two settings. *Frontiers in Psychology*, *8*, 505–505. https://doi.org/10.3389/fpsyg.2017.00505

Keizer, K., Lindenberg, S., & Steg, L. (2008). The spreading of disorder. *Science*, *322*(5908), 1681–1685.

Kingham, S., Curl, A., & Banwell, K. (2020). Streets for transport and health: the opportunity of a temporary road closure for neighbourhood connection, activity and wellbeing. *Journal of Transport & Health*, *18*. https://doi.org/10.1016/j.jth.2020.100872

Laerd Statistics. (n.d.). Mann-Whitney U Test using SPSS Statistics. https://statistics.laerd.com/spss-tutorials/mann-whitney-u-test-using-spss-statistics.php

Lawton, G. (2013). Nudge in the right direction. (Cover story). *New Scientist*, *218*(2922), 32–36. https://doi-org.proxy-ub.rug.nl/10.1016/S0262-4079(13)61510-9

Li, B., Tao, S., & Dawson, R. W. (2002). Evaluation and analysis of traffic noise from the main urban roads in beijing. *Applied Acoustics*, *63*(10), 1137–1142. https://doi.org/10.1016/S0003-682X(02)00024-5

Lin, P.-Y., Wood, W., & Monterosso, J. (2016). Healthy eating habits protect against temptations. *Appetite*, *103*, 432–440. https://doi-org.proxy-ub.rug.nl/10.1016/j.appet.2015.11.011

Mazar, A., & Wood, W. (2018). Defining Habit in Psychology. Center for Open Science. https://doi.org/10.31234/osf.io/kbpmy

McKenzie, K., Murray, A., & Booth, T. (2013). Do urban environments increase the risk of anxiety, depression and psychosis? An epidemiological study. *Journal of Affective Disorders*, *150*(3), 1019–1024. https://doi-org.proxy-ub.rug.nl/10.1016/j.jad.2013.05.032

Ministry of Infrastructure and Water Management. (2020). Cycling facts: new insights. https://s23705.pcdn.co/wp-content/uploads/2021/03/Netherlands-Cycling-Facts-2020.pdf

Mobile. (2020). Cycling and urban qualities. https://mobile2020.eu/fileadmin/presentations/Bosch_mobile2020_2013_ljubljana.pdf

Namazu, M., Zhao, J., & Dowlatabadi, H. (2018). Nudging for responsible carsharing: using behavioural economics to change transportation behaviour. *Transportation : Planning - Policy - Research - Practice*, *45*(1), 105–119. https://doi.org/10.1007/s11116-016-9727-1

National Institute for Public Health and the Environment. (2018). Cycling in the Netherlands. https://www.sportenbewegenincijfers.nl/sites/default/files/2019-02/011047_Factsheet%20Fietsen_V3_TG.pdf

Nixon, D. V. (2014). Speeding capsules of alienation? social (dis)connections amongst drivers, cyclists and pedestrians in Vancouver, BC. *Geoforum*, *54*, 91–102. https://doi.org/10.1016/j.geoforum.2014.04.002

NL Times. (2021). Dutch young people have higher rates of mental illness than rest of Europe. https://nltimes.nl/2021/10/17/dutch-young-people-higher-rates-mental-illness-rest-europe

Oja, P., Titze, S., Bauman, A., de Geus, B., Krenn, P., Reger, N. B., & Kohlberger, T. (2011). Health benefits of cycling: A systematic review. *Scandinavian Journal of Medicine & Science in Sports*, *21*(4), 496–509. https://doi-org.proxy-ub.rug.nl/10.1111/j.1600-0838.2011.01299.x

Parker, D., Lajunen, T., & Summala, H. (2002). Anger and aggression among drivers in three european countries. *Accident Analysis and Prevention*, *34*(2), 229–235. https://doi.org/10.1016/S0001-4575(01)00018-5

Pebley, K., Krukowski, R. A., Porter, K., & Little, M. A. (2020). Descriptive and injunctive norms related toe-cigarettes. *Military Medicine*, *185*(11-12), 1922. https://doi.org/10.1093/milmed/usaa227

Peen, J., Schoevers, R. A., Beekman, A. T., & Dekker, J. (2010). The current status of Urban-rural differences in psychiatric disorders. *Acta Psychiatrica Scandinavica*, *121*(2), 84–93. https://doi-org.proxy-ub.rug.nl/10.1111/j.1600-0447.2009.01438.x

Petrac, D. C., Bedwell, J. S., Renk, K., Orem, D. M., & Sims, V. (2009). Differential relationship of recent self-reported stress and acute anxiety with divided attention performance. *Stress: The International Journal on the Biology of Stress*, *12*(4), 313–319. https://doi-org.proxy-ub.rug.nl/10.1080/10253890802380714

Poudel-Tandukar, K., Jacelon, C. S., Rai, S., Ramdam, P., Bertone-Johnson, E. R., & Hollon, S. D. (2021). Social and Emotional Wellbeing (SEW) intervention for mental health

promotion among resettled Bhutanese adults in Massachusetts. *Community Mental Health Journal*, *57*(7), 1318–1327. https://doi-org.proxy-ub.rug.nl/10.1007/s10597-020-00754-w

Pucher, J., & Buehler, R. (2008). Cycling for everyone: lessons from europe. *Transportation Research Record*, *2074*(1), 58–65. https://doi.org/10.3141/2074-08

Rojas-Rueda, D., de Nazelle, A., Teixido, O., & Nieuwenhuijsen, M. (2013). Health impact assessment of increasing public transport and cycling use in barcelona: a morbidity and burden of disease approach. *Preventive Medicine*, *57*(5), 573–579.

Romans, S., Cohen, M., & Forte, T. (2011). Rates of depression and anxiety in urban and rural Canada. *Social Psychiatry and Psychiatric Epidemiology: The International Journal for Research in Social and Genetic Epidemiology and Mental Health Services*, *46*(7), 567–575. https://doi-org.proxy-ub.rug.nl/10.1007/s00127-010-0222-2

Rosenthal, N. E., Sack, D. A., Gillin, J. C., Lewy, A. J., Goodwin, F. K., Davenport, Y., Mueller, P. S., Newsome, D. A., & Wehr, T. A. (1984). Seasonal affective disorder. a description of the syndrome and preliminary findings with light therapy. *Archives of General Psychiatry*, *41*(1), 72–80.

Rylander, R. (2004). Physiological aspects of noise-induced stress and annoyance. *Journal of Sound and Vibration*, *277*(3), 471–478. https://doi.org/10.1016/j.jsv.2004.03.008

Scale. (2022). Mann-Whitney U and Homogeneity of Variance. https://www.scalestatistics.com/mann-whitney-u-and-homogeneity-of-variance.html

Scholes, S., Boniface, S., Stockton, J., & Mindell, J. (2016). Developing a questionnaire to assess community severance, walkability, and wellbeing: results from the Street Mobility Project in London. https://discovery.ucl.ac.uk/id/eprint/1474883/1/Stockton__pdf__ucl_streetmobility_paper05.pdf

Shackel, S. C., & Parkin, J. (2018). Influence of road markings, lane widths and driver behaviouron proximity and speed of vehicles overtaking cyclists. *Accident Analysis and Prevention*, *73*(1), 100–108. https://doi.org/10.1016/j.aap.2017.08.004

Sołowczuk, A., & Gardas, P. (2020). Effect of the parking lane configuration on vehicle speeds in home zones in poland. *Sustainability*, *12*(2), 588–588. https://doi.org/10.3390/su12020588

Tara, P. M. A., Robyn, R. M. G., & Richard, L. N. (2015). Street-level noise in an urban setting: assessment and contribution to personal exposure. *Environmental Health*, *14*(1), 18–18. https://doi.org/10.1186/s12940-015-0006-y

Taylor, L., Hahs, A. K., & Hochuli, D. F. (2017). Wellbeing and urban living: nurtured by nature. *Urban Ecosystems*, *21*(1), 197–208.

Thaler, R. H., & Sunstein, C. R. (2008). *Nudge: Improving decisions about health, wealth, and happiness*. Yale University Press.

The New York Times. (2008). To Slow Speeders, Philadelphia Tries Make-Believe. https://www.nytimes.com/2008/07/12/us/12bump.html

Tobin, E. T., Zilioli, S., Imami, L., Saleh, D. J., Kane, H. S., & Slatcher, R. B. (2016). Neighbourhood stress, depressive symptoms, and asthma morbidity in youth. *Journal of Pediatric Psychology*, *41*(9), 952–60. https://doi.org/10.1093/jpepsy/jsw012

Topp, C. W., Østergaard, S. D., Søndergaard, S., & Bech, P. (2015). The who-5 well-being index: a systematic review of the literature. *Psychotherapy and Psychosomatics*, *84*(3), 167–76. https://doi.org/10.1159/000376585

UCLA Transportation. (n.d.). How Riding a Bike Benefits the Environment. https://transportation.ucla.edu/blog/how-riding-bike-benefits-environment

United Nations. (2018). World Urbanization Prospects: The 2018 Revision [key facts]. https://population.un.org/wup/publications/Files/WUP2018-KeyFacts.pdf

University of Groningen. (2021). Mental health at lowest ebb since the start of the coronavirus pandemic. https://www.rug.nl/news/2021/02/mentale-gezondheid-daalt-tot-dieptepunt-sinds-begin-coronacrisis?lang=en

University of Montana. (n.d.). Benefits Of Biking. https://www.umt.edu/transportation/bike/about/benefits/

Van Cauwenberg, J., De Bourdeaudhuij, I., Clarys, P., de Geus, B., & Deforche, B. (2019). E-bikes among older adults: benefits, disadvantages, usage and crash characteristics. *Transportation*, *46*(6), 2151–2172. https://doi.org/10.1007/s11116-018-9919-y

Van den Berg, A. E., Hartig, T., & Staats, H. (2007). Preference for Nature in Urbanized Societies: Stress, Restoration, and the Pursuit of Sustainability. *Journal of Social Issues*, *63*(1), 79–96. https://doi-org.proxy-ub.rug.nl/10.1111/j.1540-4560.2007.00497.x

Van der Zee, R. (2015). How Groningen invented a cycling template for cities all over the world. https://www.theguardian.com/cities/2015/jul/29/how-groningen-invented-a-cycling-template-for-cities-all-over-the-world

Vlakveld, W. P., Twisk, D., Christoph, M., Boele, M., Sikkema, R., Remy, R., & Schwab, A. L. (2015). Speed choice and mental workload of elderly cyclists on e-bikes in simple and complex traffic situations: a field experiment. *Accident Analysis and Prevention*, *74*, 97–106. https://doi.org/10.1016/j.aap.2014.10.018

Voorhes, A. M. & Bloustein, E. J. (2004). Home Zone Concepts and New Jersey. https://nacto.org/docs/usdg/home_zone_concepts_nj_alanvoorhees.pdf

Wallenius, M. A. (2004). The interaction of noise stress and personal project stress on subjective health. *Journal of Environmental Psychology*, *24*(2), 167–177. https://doi.org/10.1016/j.jenvp.2003.12.002

Wang, R., Yuan, Y., Liu, Y., Zhang, J., Liu, P., Lu, Y., & Yao, Y. (2019). Using street view data and machine learning to assess how perception of neighbourhood safety influences urban residents' mental health. *Health & Place*, *59*. https://doi-org.proxy-ub.rug.nl/10.1016/j.healthplace.2019.102186

Weather Spark. (n.d.). Climate and Average Weather Year Round in the Netherlands. https://weatherspark.com/countries/NL

Weijers, R. J., & de Koning B. B. (2020). Nudging to increase hand hygiene during the covid-19 pandemic: a field experiment. *Canadian Journal of Behavioural Science / Revue Canadienne Des Sciences Du Comportement*, *(20201105)*. https://doi.org/10.1037/cbs0000245

Weijers, R. J., de Koning, B. B., & Paas, F. (2020). Nudging in education: From theory towards guidelines for successful implementation. *European Journal of Psychology of Education*. https://doi-org.proxy-ub.rug.nl/10.1007/s10212-020-00495-0

Westerhuis, F. (Frank), Jelijs, L. H. (Bart), Fuermaier, A. B. M. (Anselm), & de Waard, D. (Dick). (2017). Using optical illusions in the shoulder of a cycle path to affect lateral position. *Transportation Research Part F: Traffic Psychology and Behaviour*, *48*, 38–51. https://doi-org.proxy-ub.rug.nl/10.1016/j.trf.2017.04.014

Wood, W., Mazar, A., & Neal, D. T. (2022). Habits and goals in human behaviour: Separate but interacting systems. *Perspectives on Psychological Science*, *17*(2), 590–605. https://doi-org.proxy-ub.rug.nl/10.1177/1745691621994226

Wood, W., Tam, L., & Witt, M. G. (2005). Changing circumstances, disrupting habits. *Journal of Personality and Social Psychology*, *88*(6), 918–933. https://doi-org.proxy-ub.rug.nl/10.1037/0022-3514.88.6.918

World Happiness Report. (2018). World Happiness Report. https://s3.amazonaws.com/happiness-report/2018/WHR_web.pdf

Wu, C., Yu, D., Doherty, A., Zhang, T., Kust, L., & Luo, G. (2017). An investigation of perceived vehicle speed from a driver's perspective. *Plos One*, *12*(10), 0185347. https://doi.org/10.1371/journal.pone.0185347

Yaden, D. B., Claydon, J., Bathgate, M., Platt, B., Santos, L. R., & Vigo, D. (2021). Teaching well-being at scale: an intervention study. *Plos One*, *16*(4), 0249193. https://doi.org/10.1371/journal.pone.0249193

Zach. (2021). The Three Assumptions of the Repeated Measures ANOVA. https://www.statology.org/repeated-measures-anova-assumptions/#:~:text=A%20repeated%20measures%20ANOVA%20assumes%20sphericity%20–%20that%20variances%20of%20the,repeated%20measures%20ANOVA%20become%20unreliable.

Appendix A

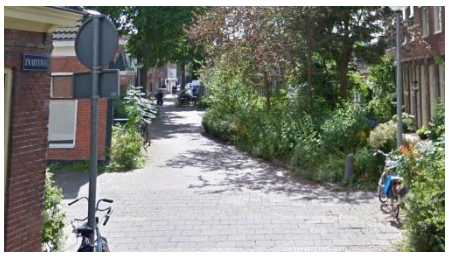
Is there a relationship between traffic and wellbeing?
For a master thesis research at the Department of Environmental Psychology at the University of Groningen we are interested in the relationship between traffic and wellbeing of people living in the **Zwarteweg**.

What is the research about?
What are aspects that have an influence on a person's wellbeing? Finding out if traffic influences wellbeing, can be a vital first step to designing better cities and neighbourhoods more resident friendly. Wellbeing covers a multitude of different factors including your happiness and how you are doing. Traffic stress might have an influence on the well-being of residents living in a stressful environment.

What do we ask of you?
You will be asked to answer questions in an online questionnaire concerning your wellbeing. Filling in the questionnaire will take less than 5 minutes.

If you would like to participate scan the QR code which will lead to the survey. Alternatively go to https://tinyurl.com/ye2xvc4n.

If you have any questions about the research feel free to contact Luca Roggenkamp via m.l.roggenkamp@studentrug.nl or Prof. Dr. Dick de Waard via d.de.waard@rug.nl.



Is er een verband tussen de verkeerssituatie en welzijn?
Voor een afstudeeronderzoek binnen de afdeling Omgevingspsychologie aan de Rijksuniversiteit Groningen zijn we geïnteresseerd in de relatie tussen hoe de verkeerssituatie beleefd wordt en welzijn van mensen die in de **Zwarteweg** wonen.

Waar gaat het onderzoek over?
Wat zijn aspecten die van invloed zijn op iemands welzijn? Het vaststellen of verkeer van invloed is op het welzijn, kan een essentiële eerste stap zijn om steden en buurten aantrekkelijker te maken voor bewoners. Welzijn omvat een groot aantal verschillende factoren, waaronder hoe gelukkig u zich voelt en hoe het met u gaat. Verkeersstress kan van invloed zijn op het welzijn van bewoners die in een stressvolle omgeving leven.

Wat vragen we van uw?
U wordt gevraagd om een online vragenlijst over uw welzijn in te vullen. Het invullen van de vragenlijst duurt ongeveer 5 minuten.

Als u wilt deelnemen, scan dan de QR-code hiernaast of ga naar https://tinyurl.com/ye2xvc4n die naar de enquête leidt.

Voor vragen over het onderzoek kunt u contact opnemen met Luca Roggenkamp (m.l.roggenkamp@studentrug.nl) of met Prof. Dr. Dick de Waard (d.de.waard@rug.nl).

Flyer handed out to residents living in the Zwarteweg. One side of the flyer advertised the study in English and one in Dutch respectively.

Appendix B

Is there a relationship between traffic and wellbeing?
For a master thesis research at the Department of Environmental Psychology at the University of Groningen we are interested in the relationship between traffic and wellbeing of people living in the **Lodewijkstraat**.

What is the research about?
What are aspects that have an influence on a person's wellbeing? Finding out if traffic influences wellbeing, can be a vital first step to designing better cities and neighbourhoods more resident friendly. Wellbeing covers a multitude of different factors including your happiness and how you are doing. Traffic stress might have an influence on the well-being of residents living in a stressful environment.

What do we ask of you?
You will be asked to answer questions in an online questionnaire concerning your wellbeing. Filling in the questionnaire will take less than 5 minutes.

If you would like to participate scan the QR code which will lead to the survey. Alternatively go to https://tinyurl.com/yxyz6ar6.

If you have any questions about the research feel free to contact Luca Roggenkamp via m.l.roggenkamp@studentrug.nl or Prof. Dr. Dick de Waard via d.de.waard@rug.nl.

Is er een verband tussen de verkeerssituatie en welzijn?
Voor een afstudeeronderzoek binnen de afdeling Omgevingspsychologie aan de Rijksuniversiteit Groningen zijn we geïnteresseerd in de relatie tussen hoe de verkeerssituatie beleefd wordt en welzijn van mensen die in de **Lodewijkstraat** wonen.

Waar gaat het onderzoek over?
Wat zijn aspecten die van invloed zijn op iemands welzijn? Het vaststellen of verkeer van invloed is op het welzijn, kan een essentiële eerste stap zijn om steden en buurten aantrekkelijker te maken voor bewoners. Welzijn omvat een groot aantal verschillende factoren, waaronder hoe gelukkig u zich voelt en hoe het met u gaat. Verkeersstress kan van invloed zijn op het welzijn van bewoners die in een stressvolle omgeving leven.

Wat vragen we van uw?
U wordt gevraagd om een online vragenlijst over uw welzijn in te vullen. Het invullen van de vragenlijst duurt ongeveer 5 minuten.

Als u wilt deelnemen, scan dan de QR-code hiernaast of ga naar https://tinyurl.com/yxyz6ar6 die naar de enquête leidt.

Voor vragen over het onderzoek kunt u contact opnemen met Luca Roggenkamp (m.l.roggenkamp@studentrug.nl) of met Prof. Dr. Dick de Waard (d.de.waard@rug.nl).

Flyer handed out to residents living in the Lodewijkstraat. One side of the flyer advertised the study in English and one in Dutch respectively.

Appendix C

Please respond to each item by marking one box per row, regarding how you felt in the **last two weeks**.

I have felt cheerful in good spirits.

All of the time	Most of the time	More than half of the time	Less than half of the time	Some of the time	At no time
○	○	○	○	○	○

I have felt calm and relaxed.

All of the time	Most of the time	More than half of the time	Less than half of the time	Some of the time	At no time
○	○	○	○	○	○

I have felt active and vigorous.

All of the time	Most of the time	More than half of the time	Less than half of the time	Some of the time	At no time
○	○	○	○	○	○

I in general woke up feeling fresh and rested.

All of the time	Most of the time	More than half of the time	Less than half of the time	Some of the time	At no time
○	○	○	○	○	○

My daily life has been filled with things that interest me.

All of the time	Most of the time	More than half of the time	Less than half of the time	Some of the time	At no time
○	○	○	○	○	○

How happy are you living in the Lodewijkstraat? Please indicate from 0=not at all happy, to 10=extremely happy.

The speed of traffic participants going through the Lodewijkstraat heavily influences my well-being. Please indicate from 0= not at all true, to 10= absolutely agree.

How large is the influence of parked cars in the Lodewijkstraat on your wellbeing? Please indicate from 0=not at all, to 10=very large.

How old are you? Please tick the corresponding box.

- ○ between 18 and 25
- ○ between 26-40
- ○ between 41-60
- ○ older than 61

If you have further comments you would like to share with us, please leave them here.

Survey that was used to assess wellbeing of residents in the Lodewijkstraat or Zwarteweg, with the street name being changed respectively.

Appendix D

	Do you think the yellow lines with woonerf/ speed reminder, which have been painted onto the road, had an effect on the speed of traffic participants going through the street?	What do you think of the design/ format of the speed limit reminder?	If you have further comments you would like to share with us, please leave them here.
	Nee, totaal niet. Gedrag is niet af te dwingen met bordjes, strepen of teksten. Dat is een utopie.Ik zie geen enkel effect. De tekst is ook niet te lezen als je eroverheen fietst/scootert. En wat afschuwelijk lelijk in zo'n pittoresk straatje.	-	-
	Helaas niet voldoende	Duidelijk	Waarom worden er geen snelheids boetees uitgedeeld?
	Nee, geen verschil	-	-
	Not sure but probably not. The neighbors probably did like the signs since they mind the traffic more	Doesn't look very official, though it was neatly done	-
	Neen	-	-
	nee	-	-
	nee	Leuk dat het een keer wat anders is	-

	Nog niet echt. Maar wel minder moppers als je mensen aanspreekt op de snelheid	Ik ben er blij mee	-
	nee	Ontsierend	Drempels zijn nodig
	Beetje	Good	-
	nee	Duidelijk, maar wordt toch ‘over het hoofd gezien’	Ben zeer ontstemd over de vele snelheids duivels

Appendix E

Preliminary analysis

For testing the hypotheses, certain assumptions needed to be established. Hypothesis 1 was tested with an independent sample t-test. Independence of observations is met as speed was measured in two streets and thus groups are different in nature. However, it might have been the case that some participants might have cycled through both streets in the time of the speed measurements. As data collection was anonymous, this could not be checked for. For the comparison of the speed of bikes, Levene's test indicated that equality of variances is violated (F=190.885; p=<.001). As the sub-sample for bikes speed in the 'Woonerf 1' is greater than 9,000, the assumption of normality holds (Ghasemi & Zahediasl, 2012). The Shapiro-Wilk test revealed that normality is violated for the sub-sample of bikes speed for 'Woonerf 2' (W=.946; p=<.001). In the other condition, namely bikes speed, according to Levene's test, equality of variances was violated (F=121.598; p=<.001). With the sample size being greater than 9,000 for 'Woonerf 1', the assumption of normality holds (Ghasemi & Zahediasl, 2012). The Shapiro-Wilk test indicated that the assumption of normality is violated for the speed scores for bikes in 'Woonerf 1' (W=.949; p=<.001). Due to this the Mann-Whitney U test was used for both comparisons, as this test is robust against violations of normality and equality of variances (Laerd Statistics, n.d.; Scale, 2022).

For the independent sample t-test that was used for the testing of hypothesis 2, independence of observations is met as participants belong only to either the 'Woonerf 1' or 'Woonerf 2' group. The other two assumptions, namely normality and homogeneity of variance were statistically tested. Levene's Test of Equality of Variances indicated that the assumption of homogeneity was not violated (F= .33, p= .57). Based on the Shapiro-Wilk test, the assumption of normality was violated for scores in the 'Woonerf 1' (W=.85, p=.01). Scores in the 'Woonerf 2' did not violate the assumption of normality (W=.95, p= .5). Due to

the violation of normality, the Mann-Whitney U test was used instead, as this test makes no assumptions about normality (Laerd Statistics, n.d.).

For hypothesis 3, which was tested with an independent sample t-test, the assumption of independence of observations is met, as the groups are different in nature and not per se the same people. However, some participants might have appeared multiple times for the speed measurements. As data was collected anonymously and on an observational level, this could not be checked for. As each sub-sample consists of at least 9,000 participants, the assumption of normality holds (Ghasemi & Zahediasl, 2012). According to Levene's test the assumption of equality of variances was violated for cars (F=17.093; p=<.001) as well as for bikes (F=6.945; p=0.008). Due to this, the Mann-Whitney U test was used for the testing for this hypothesis, as this test is robust against violations of equality of variances (Scale, 2022).

Hypothesis 4 was tested with a repeated measures ANOVA. Here, several assumptions need to be checked for as well. The assumption of normality holds, with the Shapiro-Wilk test not yielding a significant deviation for the pre-test (W=.93, p=.38) and the post-test respectively (W=.94, p=.52). As for this study, there are only two factors for the repeated measures ANOVA, sphericity cannot be violated (Girden, 1992).

Appendix F

The first question was regarding how happy participants are living in the corresponding street. Here, the mean was higher for people living in the 'Woonerf 1' (M=8) compared to residents of the 'Woonerf 2' (M=8.1). With Levene's test of equality of variances not yielding a significant result (F=1.27; p=.27), the assumption of homogeneity of variances is not violated. Shapiro-Wilk's test indicated that normality is violated for scores of 'Woonerf 1' (W=.82; p=.003) but not 'Woonerf 2' (W=.92; p=.25). Consequently, the Mann-Whitney U test was used to compare scores of the two streets, yielding a non-significant result (U(N=18, N=15)= 121, p=.88).

Next, the statement 'the speed of traffic participants going through the street heavily influences my wellbeing' is analyzed. The mean was higher for residents of the 'Woonerf 1' (M=5.1) than for residents living in the 'Woonerf 2' (M=2.3). Here, the assumption of normality was violated for both the 'Woonerf 1' (W=.89; p=.04) and the 'Woonerf 2' (W=.85; p=.04) as indicated by the Shapiro-Wilk test. Additionally, Levene's test (F=6.99; p=.01) indicated that the assumption of homogeneity of variances was violated. As the Mann-Whitney U test is robust to both violations, it was used for the analysis ultimately showing results do not significantly differ (U(N=18, N=15)= 151, p=.07; Scalë, 2022; Laerd Statistics, n.d.).

Lastly, answers regarding the question 'how large is the influence of parked cars in the street on your wellbeing' are investigated. The means of both groups differ slightly, with scores from the 'Woonerf 1' being slightly higher (M=2.6) than in the 'Woonerf 2' (M=2.3). The assumption of homogeneity of variance was not violated with Levene's test not yielding a significant result (F=.03; p=.86). The assumption of normality however is violated for both the 'Woonerf 1' (W=.85 p=0.01) and the 'Woonerf 2' (F=.73; p=.001) respectively, ergo the

Mann-Whitney U test was used. Results showed that scores between the two groups do not significantly differ ($U(N=18, N=15)= 94.5$, $p=.76$).

The same questions and statements are also investigated for the pre- and post-measurement in the 'Woonerf 1'. Sphericity cannot be violated as there are only tow factors that are being tested (Girden, 1992). The assumption of normality is tested each time. Firstly, it was tested if answers to the question 'how happy are you living in the 'Woonerf 1'? differed significantly between pre- and post-measurement. As normality was violated for the pre-measure ($W=.83$; $p=.02$) but not for the post-measure ($W=.94$; $p=.55$) based on the Shapiro-Wilk test, the Friedman test was used for the repeated measures ANOVA as it robust to assumption violations regarding normality (Zach, 2021). Scores were on average slightly lower in the pre-measurement ($M=7.9$) than in the post-measurement ($M=8$). However, this difference was not significantly different ($W=.03$; $p=.56$).

Next, the statement 'The speed of traffic participants going through the street heavily influences my wellbeing' was investigated. Normality was not violated for both the pre-measure ($W=.93$; $p=.38$) and the post-measure ($W=.94$; $p=.52$). Scores were higher on average in the pre-measurement ($M=5.4$) compared to the post-measurement ($M=4.6$). Based on the results of the repeated measures ANOVA this difference is not significant ($F(1, 10) =1.83$, $p=.21$).

Furthermore, the exploratory and control question 'how large is the influence of parked cars in the street on your wellbeing?' was tested. The normality assumption based on the Shapiro-Wilk test holds for the pre-measurement ($W=.91$; $p=.26$) as well as for the post-measurement ($W=.91$; $p=.31$). The mean is slightly higher in the first measurement ($M=3.4$) than in comparison to the second measurement ($M=2.4$). Results of the repeated measures ANOVA deemed this difference not to be significant ($F(1, 10) =1.42$, $p=.27$).