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Urban Stress and Bicycle Infrastructure in the City of Osnabrück – Analysing Well-Being and Infrastructure Relationships in Streetscapes through a Triangulation Approach

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1 ABSTRACT

Active mobility is a key factor in the mobility revolution and is thus elementary in combating the climate crisis. At the same time, however, much research is still needed to improve the situation of active mobility, especially regarding inhibiting factors in the choice of active modes of transport. Essential here is road users' positive and negative emotional experiences in different infrastructure settings.

Due to high volumes and speeds of motorised traffic, high noise and pollution levels and a lack of greenery urban space, today is often associated with increased stress and an excess of stress-related diseases such as cardiovascular diseases, depression, or schizophrenia (Adli, 2017). Providing data and objectifying much-discussed issues such as perceived safety in transport infrastructure is essential for decision-making at the community level (Sørensen, 2009). Such data can provide evidence to refine traffic planning guidelines and improve public space for pedestrians and cyclists. It is therefore necessary to get a differentiated picture of social and ecological considerations in the mobility sector.

The BMDV project “Emotion Sensing for (E-)Bicycle Safety and Mobility Comfort ESSEM” investigates the subjective perception of cyclists’ safety in urban traffic. With the help of iterative environmental and body-related data collection, stress points in the municipal cycling network are identified and analysed in the two model cities of Ludwigsburg and Osnabrück .

The framework given in this study applies a triangulating approach that allows statements on individual “stress” utilising biological markers (skin conductivity, skin temperature) via a sensor wristband and through standardised questionnaires. In this way, vulnerable groups can be identified, which can be better taken into account in project development and planning. This study focuses on three “stress hotspots” in Osnabrück, considering different forms of bicycle infrastructure.

Keywords: Transportation Planning, Streetscapes, Bicycle Infrastructure, Well-being, Urban Stress

2 INTRODUCTION

To plan ecologically, spatially and socially sustainable and equitable cities of the future, one starting point is to move human perception to the centre. Especially in the field of active mobility, such as cycling, people are directly exposed to their environment. Projects such as the "Emotion Sensing for (E-)Bicycle Safety and Mobility Comfort ESSEM", funded by the German Ministry of Digital Affairs and Transport, focus on researching stress in cycling. On the one hand, body-related data are collected that can indicate a stress reaction in the body. These are geo-referenced and subjective data can thus be made objectively comprehensible in the form of heat maps in QGIS. The results represent an indicator of the subjective perception of safety. Spatial specifics, such as guidance forms and street intersections, have a significant role to play here. On the other hand, different people have different perceptions due to their different characteristics, which also shape the perception of stress. These can be collected through e.g. standardised questionnaires. The ESSEM project takes place in the model cities of Osnabrück and Ludwigsburg. The present study focuses on the results of the research in Osnabrück. The following research questions are guiding:

(1) Where do cyclists in Osnabrück feel stressed?

(2) To what extent do personal dispositions, such as gender, age or personality play a role in this?

(3) To what extent can statements be made about the connection between different designs of bicycle infrastructure and stress?

3 STATE OF RESEARCH

The state of research focuses on the perception of safety, measuring stress and influencing factors.

3.1 Perception of safety

One pillar of the mobility transition in Germany is to increase the share of cycling (BMDV, 2022). Obstacles to changing the mode of transport are manifold. An essential part of this is the perception of safety. On the one hand, there is objective safety. This can be quantified in the form of police accident statistics. At the same time, subjective safety must be taken into account (Johannsen, 2013). This is of great importance when choosing a means of transport. This subjective perception is determined by various factors. On the one hand, there are "exogenous" factors, i.e. external structural factors. These can lead to critical situations, near-accidents, a feeling of being squeezed or a noise-induced stress reaction. The resulting stress in cycling can therefore negatively influence the choice in favour of cycling and is, therefore, an important starting point for research (Graf, 2016). Various personal dispositions "endogenous factors" diversify the picture. For example, there are differences in people who generally use bicycles little, in gender, the purpose of travel, age and the psychological constitution of people when assessing stressors (Schmidt-Hamburger, 2022). When researching stress phenomena and their harmful effects on the human body, it is above all relevant how strongly the respective person evaluates and thus also feels the experienced stress. This subjective stress evaluation can be further specified by adding information about the mobility profile, socio-demographic and socio-psychological assumptions. The endogenous influencing factors refer to individual demographic, socio-economic and sociocultural attributes of individuals and their social environment, which significantly influence perception (Wermuth, 2005). Examples of relevant factors are gender, age, physical constitution, local knowledge or familiarity with the means of transport. Furthermore, from a biopsychological point of view, there are indications that genetic or psychological predispositions can strengthen or mitigate stress reactions. In this context, personality, control beliefs and risk tolerance are particularly important (Schandry, 2016; Kovaleva, 2012). These data are collected utilizing standardized questionnaires before the sensor measurements and included in the evaluation. It is hoped that this will identify particularly vulnerable groups in terms of stress to gain knowledge about barriers to equality for cyclists. Further insights can be gained from the increase in cycling behaviour. According to Geller (2009), cyclists can be divided into four groups: "the strong and fearless", "the enthusiastic and confident", "the interested but concerned" and "no chance, no matter what" (Geller, 2009). An overview of the characteristics is given in Table 1. The transitions between the groups should be viewed dynamically.

Group	Fearless cyclists	The enthusiastic and confident (Everyday cyclists)	The interested but concerned (Interested cyclists)	No chance, no matter what
Characteristics	• cycles always • safely, confident	• Drives daily routes, • confident, medium safety needs	• No everyday cycling • Safety concerns • open-minded towards bicycles	• No cycling in general
Riding skills	Excellent control of the bicycle	Confident, partly defensive because of security	Less sovereign	Poor control of the bicycle, lack of riding experience
Stress tolerance	high	medium	low	very low

Table 1: Types of cyclists (Geller 2009), own presentation.

In terms of cycling promotion, it is interesting in projects such as ESSEM to focus especially on the stress-ful experience of the "interested but concerned".

3.2 The construct of stress

Stress theories differ in terms of adaptability and operationalizability. Stress always arises when, depending on the theoretical underpinning, the physique (stress-as-a-reaction) or psyche (stress-as-a-stimulus or stress-as-a-transaction) has to muster resources to process environmental stimuli. The most prominent is the transactional stress model according to Lazarus (1999), but at the same time, it is also the most com-plex, since stress always arises situationally in the interaction of people and the environment. On the other hand, there are stress-as-a-reaction models (Selye, 1956; Cannon, 1932), which examine the physical reac-tions to an external stimulus (Bercht, 2013). Critical here is the assumption that a stimulus "stresses" all people equally (Lyon, 2005). The third group of theories, which understands stress as a stimulus, focuses on the psychological effects. Here, it is assumed that there are "critical life events" (Holmes, Rahe, 1967) that are objectively trigger stress to some extent. Due to developments in emotion research in this field, the stress-theoretical basis of this paper is more in line with models from the stress-as-a-reaction perspec-tive. However, subjective components are included in the data collection and analysis.

3.3 Influence of street space on the subjective perception

Safe infrastructure can be named as one key contributor to the promotion of bike traffic in cities (Reyn-olds, 2009; Di Gioia, 2017). Here different design solutions are discussed controversially in the light of conflicts in the use of street space, and space restrictions but also about safe and qualitative bike infra-structure (Hull, 2014; Autelitano, 2021; Van Petegem, 2021). Traffic engineering, therefore, was mostly focused on objective traffic safety, focusing solution finding for certain street designs on the analysis of accident statistics and fluidity of motorized traffic. A more comprehensive evaluation of safe mobility in-frastructure and in particular bike infrastructure today discusses the aspect of subjective safety in addition to quantifiable objective traffic data (Götschi, 2018). Subjective safety among other aspects takes a look at how street users feel in certain contexts, or if they are overwhelmed by other road users, like cars. Multiple studies show the extent of research and debate on the topic (Von Stülpnagel, 2022; Aldred, 2018; Beck, 2021; Nilsen, 2004). All in all the subject takes into account the sense of security and besides positive per-ceptions like comfort, or well-being, the feeling of aforementioned stress.

Today the aspect of subjective safety, or rather safe and comfortable design solutions finds recognition in more and more design manuals of bike infrastructure like the Dutch “Crow Manual”, especially consider-ing more vulnerable groups of cyclists like children or elderly people (De Groot, 2016). In Germany, the FGSV (Forschungsgesellschaft für Strassen- und Verkehrswege) addresses the topic of subjective safety, though it can be argued that it’s still not implemented in the design solutions of its manual for bike infra-structure the ERA (Empfehlung für Radverkehrsanlagen) or it’s manual for city streets, the RAST (in German: Richtlinien für die Anlage von Stadtstraßen/ “Guidelines for the construction of urban roads”). This shows that data and an extensive analysis of the stress experienced on certain cycleways, or rather certain street design solutions are still missing. This data and the aspect of subjective safety have to be evenly balanced with other data like accident statistics, or the capacity of street design and intersections for all street users, e.g. Here the concerns of pedestrians and other social uses of urban streets besides mo-bility have to be highlighted (Gehl, 2015).

4 DETAILS ON ESSEM

The “Emotion Sensing for (E-)Bicycle Safety and Mobility Comfort, ESSEM” project, the subjective safety perception of cyclists in urban traffic. The project aims to increase the comfort and safety of cyclists and thus contribute to sustainable and climate-neutral mobility. In a triangulation process consisting of iterative and sensor-based surveys of environmental and bio-physiological data and standardized questionnaires, stress points in the local bicycle infrastructure are being identified, analyzed and evaluated. The two model cities are Ludwigsburg and Osnabrück, in each around 350 test persons participate during the three-year project period (2022-2025).

The project data collected will be used to develop mechanisms for measuring safety, the perception of safety and mobility comfort in cycling, based on the underlying infrastructure, environmental influences, the cycling equipment used as well as the cycling accessories. The insights gained will help to identify optimization needs for (e-)bicycle infrastructures and components. This will promote modern, user-centred and data-based cycling planning and further advance environmentally sensitive traffic management (UVM) in Osnabrück. In the long term, the project aims to develop an innovative, and above all, practical tool that can be used to review and optimize urban cycling infrastructures.

5 METHODOLOGY

A triangulating procedure between methods (Flick, 2008) is used to research the stress experience of cyclists. With this method, the disadvantages of one method can be compensated for by the addition of another during data collection, analysis and interpretation. The subjectivity and complexity of the research object require a methodological procedure that reflects these circumstances (cf. Chapter 3.2).

The following Figure 1 provides an overview of the methodological approach. Triangulation was used in the study for data collection (standardized as well as open, sensor data), analysis (spatial and statistical) and interpretation.

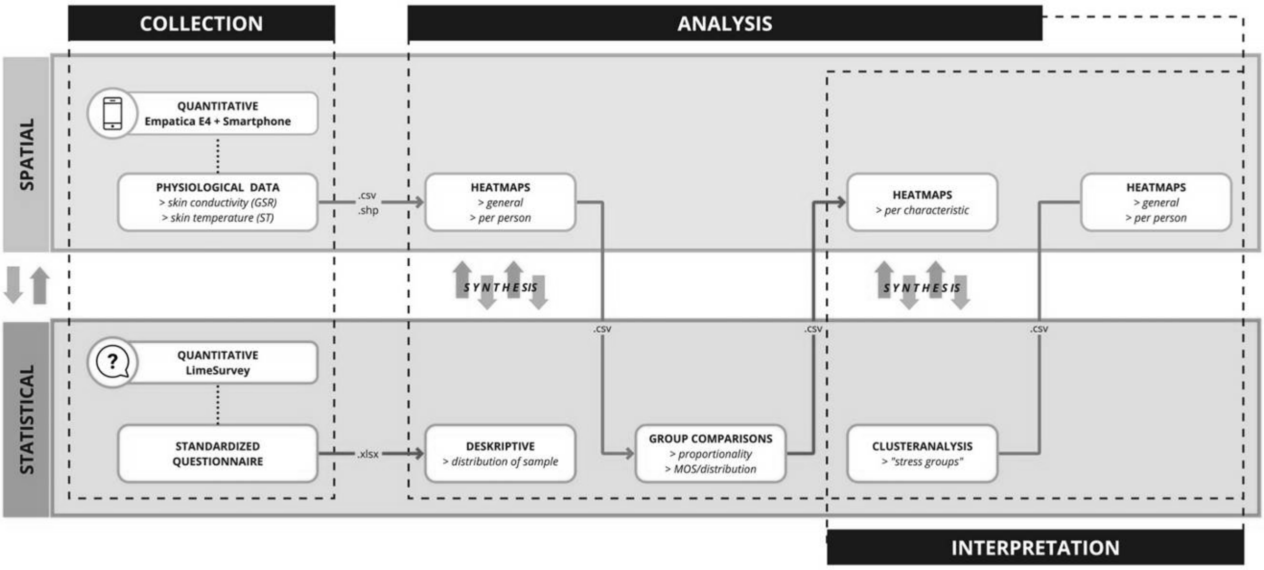

Figure 1: Scheme triangulating process, own presentation

5.1 EmoCycling

Measuring stress in terms of response is feasible, although theoretical limitations must be accepted. Biological indicators are used to identify moments of stress (MOS). When confronted with a stressor, the human organism regulates endogenous stress responses to establish homeostasis. These responses are detectable through a variety of body-related parameters and are recognized as a proven method for measuring stress from external stressors. These include an increase in electrodermal activity (EDA) and a decrease in skin temperature (Kyriakou, 2019; Schandry, 2016). Based on the functioning of these biosignals, Kyria-kou et al. (2019) developed an algorithm that can detect people's MOS using wearable biosensors. The biosensor wristband "E4" from the company Empatica was used to measure the biosignals. The data is collected in an app (e-diary) on a smartphone. The result is a database in which one line corresponds to one sec-ond of the measurement period and provides information about a MOS (yes/no) and its geographic coordi-nates, which can thus be read and visualized in a geographic information system (GIS).

The procedure of recording biostatistical data in a georeferenced manner and following the visualization in maps goes back to Christian Nold (2009). The "emotional cartography" (Nold, 2009) allowed humans and their physiological responses to serve as a kind of sensor for the first time, recording the state of stress or arousal in an urban context. Different developments in the technology itself (e.g. storing of measured EDA and ST in smartphone application) and the methodology (e.g. including ego-perspective cameras) hap-pened since then accumulate under the term "EmoCycling" (Zeile, 2016).

5.2 Standardized questionnaire

Additionally, "EmoCycling" a standardized questionnaire based on validated scales of mobility in Germany (2019) from the BMDV (Nobis, Kuhnimhof, 2018), Leibniz Institute for Social Sciences (GESIS) and Geller's (2009) types of cyclists was developed to record endogenous factors. The questionnaire was used to collect information about the person and his or her sociodemographic background as well as psychological characteristics in addition to traffic behaviours. The personality of individuals is traditionally determined based on the so-called Big Five, which consists of the characteristics of extraversion, neuroticism, openness, conscientiousness and agreeableness. The Big Five are considered to have good predictive power for certain aspects of life. The level of control beliefs describes a person's belief that he or she has control over various situations and that these are the result of his or her actions (internal) or that fate, coincidences, or powerful others are responsible for the occurrence of certain events (external) (Rammstedt, 2012; Ko-valeva, 2012; Beierlein, 2014). The degree of control belief is a relevant factor in the evaluation of a stress reaction (Brosschot, 1994).

5.3 Implementation and analysis

The data collection of ESSEM is divided into different phases in each city. This paper presents results from the first period in Osnabrück which took place in September 2022. 30 Participants were to fill in the standardized questionnaire and then were equipped with the sensor wristband and the smartphone which collected the measured EDA and ST. In the following, they collected their data on bike rides in their day-to-day life within two weeks. More detailed information on the former phases of the project can be found in Zeile et al. (2023).

For the data analysis, so-called heat maps were created based on the MOS and endogenous factors. This makes it possible to gain insight into the locations where a large number of MOSs of different individuals occurred. Further analyses focusing on the endogenous factors of the participants were performed by appropriate statistical analyses. In the first step, an overview of the distribution of the expressions was obtained. For this purpose, the distributions of the expressions and the MOS were examined (cf. Table 1).

In this paper cycleways on major streets in cities with a higher amount of motorized traffic are examined and correlations between stress levels and certain design solutions like advisory bike lanes, or "sharrows", separated and protected bike lanes are further examined. To further examine the underlying hypothesis that protected bike lanes and distance to other road users (e.g. cars and pedestrians), different designs of bike infrastructure in Osnabrück are superimposed with the data of the stress levels through the EmoCycling-methodology. Major urban roads are selected because here design solutions differ the most. On minor side streets designs mostly call for mixed traffic and generally speaking can only differ in ordinances like the Bicycle Streets, or more precisely the German "Fahrradstraße ". Major arteries in cities on the other hand are characterized by high traffic volumes, and high speeds and are oftentimes the most direct connection from A to B. Therefore, the analysis of subjective safety concerns concerning design solutions for this kind of infrastructure is of great interest. The analysis focuses on the areas in Osnabrück (cf. Figure 2). Those areas show different streetscapes which made it suitable for our analysis.

(1) Berliner Platz is located at the eastern end of the inner-city ring road "Am Wall". It is characterised by an extremely high vehicle load (evening peak with 3.633 vehicles/h and 345 bicycles/h). The bike lanes mostly show widths below standard, partly < 1.5m. In addition, bus lanes and high pedestrian volumes exacerbate the use of space (Heinke, 2022).

(2) Katharinenstraße is one of Osnabrück's "Bicycle Streets" with mixed traffic. It originates in the west outside the inner-city ring and ends at the inner-city ring. To reach the city center waiting at traffic lights is necessary. Katharinenstraße is highly frequented, but narrow for cycling volumes (pulks), overtaking is not possible. Left turners have no striping/space around to avoid possible oncoming traffic (Heinke, 2022).

(3) Lotterstraße/Am Wall: This intersection is located in the northwest of the city center. Very high traffic volume and the lack of objective safety already resulted in a temporary reconstruction (From the north). The bike lane was moved to the edge of the roadway and is now protected. Currently still under construction, which narrows the space. From the other directions the cyclists either ride on the bike lane in the middle of the road (from the west) or on the bus lane (from the south) (Heinke, 2022).

6 RESULTS, PRESENTATION AND DISCUSSION

30 persons were registered for the data collection. Three were prevented from attending at short notice and one person had not completed the questionnaire. In this context, a pseudonym to anonymously match the MOS and the information from the questionnaire was created. Table 1 provides an overview of the composition of the sample.

In the selection of participants, care was taken to ensure gender parity. This is reflected in the sample. The average age was 45 years. Of the participants, 42% had a university degree, and the educational level can be classified as fairly balanced. In terms of cycling types, there is a preponderance of everyday cyclists (70%), followed by interested cyclists. Most bicycles are powered by muscle power (60%). Overall, transportation infrastructure is rated as poor (46% find this at least poor). On average, participants were more likely to be extraverted, neurotic, and open-minded. The characteristics of conscientiousness and agreeableness were rather low. The level of internal locus of control was more pronounced than the external locus of control. People tended to be viewed as more likely to believe that they are causally responsible for their actions rather than external forces. In addition, people are more likely to be risk averse (62%).

The 26 participants had a total of 11,996 MOS after adjustment. Average 461 MOS. The median is 443. The range is from 108 to 1205.

Variable	Description	$N_{participants}$=26 (in %)	N_{MOS}= 11996 (in %)
F1a	Age (>45)	54	61
F1b	Gender (female)	46	46
F1c	Education, high	42	
Cyclist	Cycling types		
	No chance no matter what	0	0
	Interested cyclists	27	22
	Everyday cyclists	70	68
	Fearless cyclists	3	10
Drive Type	Type of drive of the bike		
	Conventional	60	
	electronic	40	
Bike Type	Most commonly used		
	Trekking bike	42	
	City bike	31	
Situation	Evaluation of the situation for cyclists in Osnabrück		
	very good, good		
	satisfactory	0	
	sufficient	12	
	poor	42	
	insufficient	31	
		15	
F4a	Big Five personality traits		
	Extraversion (above average)	54	52
	Neuroticism (above average)	69	75
	Openness (above average)	65	68
	Conscientiousness (below average)	73	77
	Agreeableness (below average)	58	59
F4b	Conviction of Control		
	Internal (below average)	62	54
	External (below average)	81	54
F4c	Risk affine	62	59

Statistical key figures

$\bar{x}$ = 461 MOS; $\tilde{x}$ = 443 MOS; $\{min; max\}\{108; 1205\}$

Table 2: Descriptive Analysis of the sample, own calculations

Figure 2 shows the heatmap of the MOS in downtown Osnabrück. After evaluating the interconnections of the volume and the bicycle infrastructure at the hotspots, no significant difference could be found. The underlying hypothesis that protected bike lanes have a positive impact on cyclist exposure could not be confirmed in this case. Here further research is needed as analysis of a short strip of around 150 meters at Heger-Tor-Wall did not show any MOS. Another crucial finding is the occurrence of hotspots especially at intersections, where different vehicles cross, noise is generated, and the situation is confusing. Situations like this a further examined in the following.

In further examination, the situation and potential stressors at those spots have to be observed with camera systems. Surely factors such as time of day and quantity of vehicles must be considered to obtain are more differentiated picture, especially on the effect of streetscapes, especially the design of bicycle infrastructure. Therefore, a comparison of morning or evening peaks at different cycling infrastructures would be favourable.

The analysis of the three study areas showed the following results, underlying some early findings of the research conducted concentrating on two major intersections and Katharinenstrasse a main bicycle route converted to a “Fahrradstraße” in 2011 (Martens, 2011).

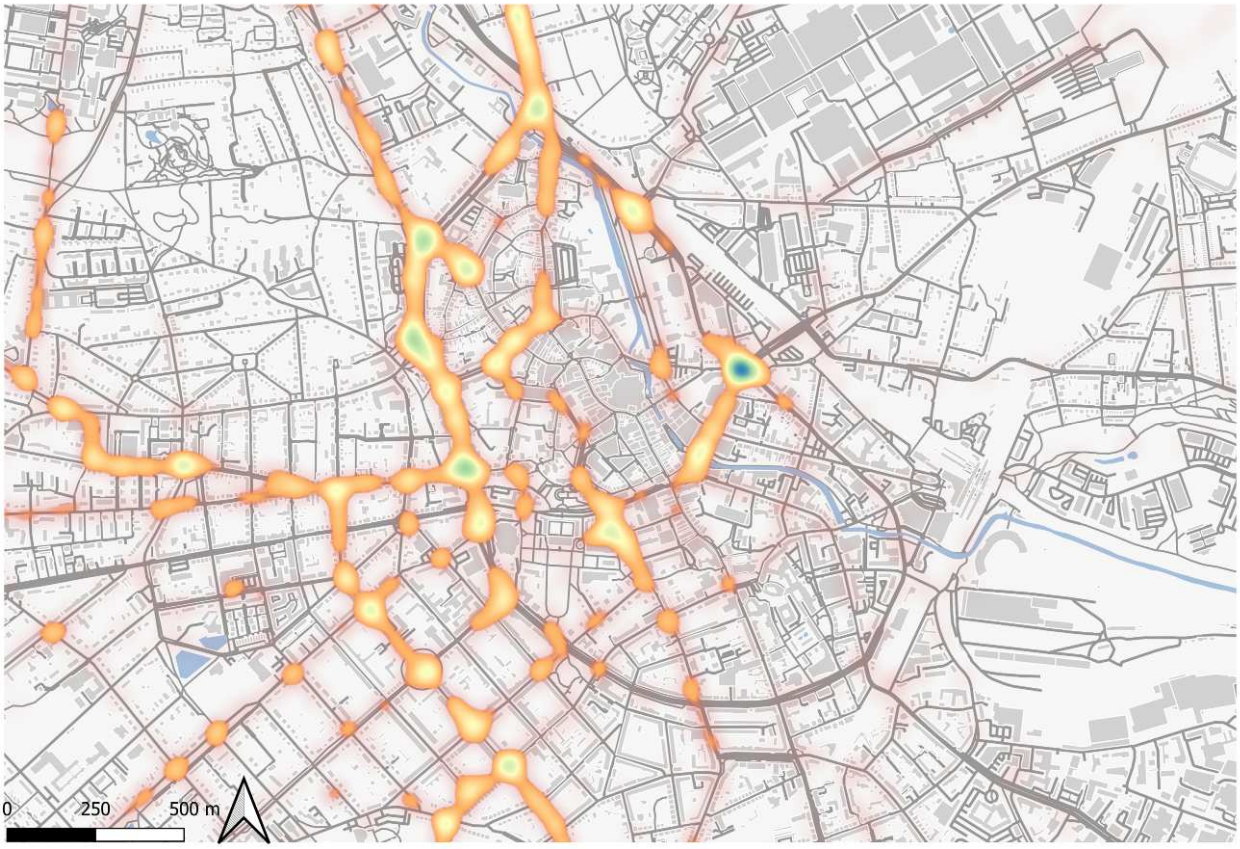

Figure 2: Heatmap of the MOS in Osnabrück with focus areas (1:20,000). Own figure based on OSM contributors. 21.06.2023

As Figure 2 shows, the Berliner Platz (1) shows the highest accumulations of MOS in the research area. This main intersection is characterized by high amounts of motorized traffic connecting the ring around the city center with one main artery leading out of the city to the east, the Wittekindstraße. Including the main bus routes the intersection also handles high amounts of bike traffic, as the data shows. Besides dedicated bus lanes, the distribution of street space is mostly dominated by 4-6 lanes, including turning lanes, for motorized individual traffic. The bike infrastructure here is characterized by painted bike lanes and no separation in construction by bollards, curbs or other measures. At the same time turning lanes for car traffic are crossing the bike lanes and cyclist turning left are expected to wait in the middle of the intersection waiting for their signal.

"Berliner Platz" (cf. Figure 3) can be named as a standard example for the design of many major intersections in German cities, including design choices standardized by main guidelines like the RAST, that are discussed in the section above (FGSV, 2006). The amount of MOS in this area shows the need to rethink design choices in the light of subjective safety and the general quality of bike traffic especially in intersections. Further analysis aims to prove the hypothesis mentioned above, questioning intersection designs mainly focused on red paint with no real protective measures, besides aspects like traffic speed and street width.

Another main intersection in Osnabrück that show similar characteristics as Berliner Platz in its spatial relationships within the city, the inner-city ring and outgoing main streets, here the Lotter Strasse. The intersection Lotter Strasse, Natruper-Tor-Wall (2) (s. figure 4) was redesigned converting one turning lane into a designated and protected lane for bike traffic.

On the other hand, the number of turning lanes and the general design of the intersection is very comparable with the situation at Berliner Platz. The research does not provide data before the redesign, but the MOS analysis shows some evidence towards improving stress levels in comparison to "Berliner Platz", which can be related to the redesign of the northern leg of the intersection. To confirm those findings further analysis is needed evaluating the questionnaires and other data comparing the findings at both intersections.

Figure 3: Photos of Berliner Platz (Maximilian Heinke)

Figure 4: Photos of Lotter Strasse – Natruper-Tor-Wall (left) and Bicycle Road Katharinenstraße (right) (Maximilian Heinke)

All in all, the data shows high amounts of stress levels or rather high accumulations of MOS. Relating problems in the design of those major intersections like this are discussed in literature and mobility panels under the aspect of subjective safety. Here protected intersections and roundabouts standardized in Dutch traffic guidelines (Rik de Groot, 2016) can be named as a possible design solution, that needs to be further examined using the methodology detailed in Chapter 5, adding quantifiable data to the discussion of road distribution objective and subjective safety of different street users, especially considering the needs of pedestrians.

Katharinenstraße (3) shows rather interesting findings. The street was redesigned as a bike street still allowing motorized traffic, but giving cyclist priority. The data shows high amounts of trips using Katharinenstrasse on different routes leading from east to west. At the same time, MOS data shows rather high amounts of stress. A closer examination of the street shows a high number of cars parking at a 45-degree angle with the street switching sides from north to south in between parking cars. In general, the street isn't characterized by high amounts of motorized traffic, so other possible stressors need to be further examined through questionnaires and further data analysis. At the same time the legal set-up of the "Bicycle Street" can be questioned concerning qualitative bike infrastructure not accompanied by real design changes including the reduction of street-side parking.

7 CONCLUSION

Contributing information to inhibiting factors of cycling was the main aim of this study. Embedded in the project "ESSEM", funded by BMDV 26 cyclists were equipped with sensor wristbands which measured their stress level whilst cycling in Osnabrück. In general, almost 12.000 so-called moments of stress (MOS) could be identified, geolocalized and visualized. The further analysis emphasized three "stress hotspots" where the cycling infrastructure differs. In doing so no mentionable results concerning the streetscape could be pointed out. Meaning MOS showed up on protected bike lines, in mixed traffic and so on. Most of the hotspots are located at intersections, where different modes of transport meet and the situation is unclear.

8 OUTLOOK ESSEM

Data analysis at this point in the project shows several limitations to significance. The study design required participants to ride bicycles in everyday life to rule out MOS associated with study participation ("study effects"). The marked variation in routes and travel times severely limits the comparability of participants' MOS patterns. Further research should focus on comparing street patterns at peak times to provide more detailed information and opportunities to restructure intersections, e.g., to make traffic signal timing more bicycle friendly. Further, after analyzing the routes taken, it seems obvious that some streets or even areas were avoided completely because participants knew in advance that it was not convenient to ride a bicycle there. An important example is “Am Wall”. This assumption was substantiated by responses from participants at a workshop in July 2023. Additionally, patterns of MOS by various personal dispositions such as gender, age or bicyclist type could not be considered for the time being. In addition to the small number of participants, the ratio of MOS to the number of bicycle trips made by bicyclists must also be integrated into the evaluation in order to conduct a meaningful statistical analysis. It is worth mentioning that this study and the other studies conducted by ESSEM focus mainly on the cycling domain at this point. In future studies, it is important to consider the entire transportation system when considering emotional responses.

These limitations will now be addressed in the upcoming project phases starting in September 2023. First, more test rides will be conducted, increasing the number of participants from 26 to about 120. In addition, a study design with pedestrians is being considered. To account for the non-comparability of the results provided and to allow studies to examine the role of personal dispositions, an additional study will be designed for spring 2024 to provide reference values. This study will be conducted during rush hour, will follow a pre-designed route that includes bypassed streets such as the inner ring road, and will be representative of all participants who participated in the prior studies. In a complementary way to spatial analysis, the data analysis is carried out by means of statistical group comparisons and cluster analysis (Schmidt-Hamburger, 2022). The aim here is to conduct an in-depth analysis focusing on the quality of the perception of negative emotions as inhibiting factors for cycling in Osnabrück.

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