THE LUISENPLATZ STUDY

The relationship between visual fields and perceived stress in a public transport hub

ABSTRACT

This paper investigates the relationship between visual fields and subjective ratings of perceived stress in an open public space (OPS) and transport hub. The aim is to investigate possible influences these characteristics have on the recorded ratings. To do so, the sample is described with a visibility graph analysis and isovist properties and the constructed data is paired with participants' ratings of perceived stress.

This article uses data from surveys conducted in Darmstadt, a town of 120,00 in Germany, in summer 2015. Subject is the Luisenplatz, the city's main public square and a central transport hub. It houses various amenities, services and residency, and is a junction where the majority of the tram and bus lines meet. Previous research suggested that the Luisenplatz in its current state is perceived as one of the most stressful OPS in Darmstadt. Correlation between visual fields and statements about perceived stress show that users are more likely to feel stressed when in areas with high visibility, while visual complexity may contribute to less stressful scenarios. The method presented in this article is been shown to be promising in analysing how variables of the built environment may contribute to perceived stress in public transport hubs. It will be useful to further interdisciplinary research that sets out to better understand the role of the built environment as integral contributors to stress in urban mobility.

KEYWORDS

visual fields, public transport hub, perceived stress, spatial perception, configuration

1. INTRODUCTION

Emerging research spurs the discussion how visual field characteristics relate to emotions and behaviour in the built environment (Knöll, 2016, Knöll et al., 2014, Kuliga et al., 2013, Bielik et al., 2015). In this article, researchers investigate how visual field characteristics – commonly used in space syntax research to describe places – relate to users perception of an open public space (OPS) and major public transport hub as being stressful, and how they interact with further environmental stressors such as noise and high traffic.

In spite of the many positive aspects of life in cities, several others may harm health and wellbeing of its residents, the so-called environmental stressors (Evans and Cohen, 1987). Especially in the city, some of these stressors – such as noise, pollution, crowding and high traffic – are often intense and take a notable toll on the people who work and live in them.

The article uses data from surveys and observations conducted in Darmstadt, a town of 120,00 inhabitants in Germany, in summer 2015. Subject is the Luisenplatz, which was renovated in 1980 and was then praised for its value as a "framework to balance potentially conflicting functions – a large public transport terminal versus a recreational square for pedestrians" (Gehl and Gemzøe, 2008). Previous research assessing the spatial perception of its users, suggested that the square in its current state is perceived as one of the most stressful OPS in Darmstadt (Knöll et al., 2014).

Currently the space is subject to various redevelopment plans as part of the town's master plan 2030. Identifying the parameters that spike stress and compromise users' behaviour and wellbeing, could deliver relevant understanding for future planning.

This paper seeks to contribute a set of subjective spatial experience data (which has been gathered as part of a larger, extensive spatial perception and psychophysiological effects study) to the on-going discussion between the space syntax community and spatial, environmental researchers and planners.

2. BACKGROUND

Stressful OPS

In an online survey among students in 2014, the Luisenplatz was rated as the most stressful place in the city (Knöll et al., 2014). From the study, loudness, heavy traffic and poor vegetation where identified as determinant environmental factors for "stressful" OPS. In a later study, Knöll and colleagues found relations between street network characteristics and the users' ratings of stress and spatial qualities in OPS (Knöll et al., 2015). Building on these studies, Knöll et al. (2017) presented a set of environmental factors related to perceived stress in open public spaces including building coverage, street network and isovist characteristics and open space typologies (see table 1). In the regression analysis, if was found that isovist characteristics have an absolute sum of the standardized beta coefficients of 36.99%, pointing out to greater effects on urban stress levels than the other factors.

	Dependent Variable: Urban Stress Level[a)]		
	Standardized Beta Coefficient (SBC)	Percent of the absolute sum of all SBC	Sum
Building Density			**17.17%**
• Building Coverage Ratio	0.514**	17.17%	
Street Network			**20.18%**
• Ln Citywide Integration	0.210**	7.02%	
• Ln Local Integration	-0.394**	13.16%	
Isovist			**36.99%**
• Visibility	0.321**	10.73%	
• Ln Perimeter	0.417**	13.93%	
• Square Vertices Number	-0.369**	12.33%	
Open Space Typology			**25.66%**
• Park (park=1)	-0.140*	4.68%	
• Heavy traffic streets	0.100	3.34%	
• Courtyard	-0.223**	7.45%	
• Medium traffic street	-0.124*	4.14%	
• Pedestrian street	-0.181**	6.05%	

Notes: a) Random-effects GLS regression [[corr(u_i, X) = 0 (assumed)] ** and * indicate significance at the 1% and 5% level.

Table 1. Taken from Knöll et. al (2017).

The Luisenplatz

The OPS was selected for a more detailed analysis because of its importance to the everyday urban life and manifold surrounding land uses. In spite of being free of car-traffic, movement in this central transport hub adds to a total of about 2100 buses and trains running daily through it. In a recent counting, the Luisenplatz recorded the highest frequency for bus lines as well as trams in comparison to the service stations within the 500 m range, positioning itself as a dense transport service station with the highest number of diverse pedestrians utilizing the service.

Measures

A key aspect for analysing the built environment seems to be users' perception of an OPS's amenity quality, which expresses how attractive a space in particular can be for its users. In order to obtain spatially detailed data about the amenity quality of the Luisenplatz, participants were encouraged to use the context-sensitive mobile application MoMe that allowed them to rate spatial qualities and stress perception through eight core aspects of environmental and behavioural properties using a ten-step scale. The application records quantitative and qualitative data, such as of GPS tracks and waypoints with time-stamp (for navigation), and photographs and ratings (for users' perception), by making use of the context-awareness of mobile devices. (Halblaub Miranda et al., 2015). The set of bipolar adjectives used (table 2) was the basis for qualitative data on perception of public spaces and was first presented by Knöll et al. (2014).

English		German	
Low extreme (1)	High Extreme (10)	Minimum (1)	Maximum (10)
not stressfull	maximum stressfull	überhaupt nicht stressig	maximal stressig
not relaxing	maximum relaxing	überhaupt nicht entspannend	maximal entspannend
poor vegetation	much vegetation	viel Vegetation	wenig Vegetation
poorly maintained	well maintained	schlecht Instand gehalten	gut Instand gehalten
low traffic	high traffic	wenig verkehr	viel Verkehr
quiet	loud	leise	laut
no seating available	seating available	keine Sitzgelegenheit	viele Sitzgelegenheiten
unsafe	safe	unsicher	sicher

Table 2. Adjectives used by participants to rate perception of OPS on a 10-point interval. Original adjectives-scales and their translation to English.

Research Questions

The previous findings revealed many open questions, in particular with respect to visual fields and stress perception. How do the chosen environmental and spatial parameters influence the perception of the built environment and its users' behaviour?

Hypothesis 1: Visibility correlates positively to perceived stress

The authors assume that high visibility, defined as the relative rate of the area that can be overseen from a given location in OPS, has a positive correlation to perceived stress.

Hypothesis 2: Vertices number is negatively related to perceived stress.

In this study, the authors propose that low and high rates of visual complexity mediate perceived stress, while medium rates of visual complexity are negatively related to stress ratings in sub areas that are loud and highly exposed to tram and bus traffic.

3. DATA SETS AND METHODS

A combination of Visibility Graph Analysis (VGA) and point isovist analysis was constructed; the latter was based on participants' ratings of perceived stress. Both VGA and isovist measures have been limited to a 250-meter radius from the square centre. Environmental properties such as loudness and exposure to traffic were controlled with structured observations as well as assessed through users' statements.

Users' ratings

The assessment was done on-site by a group of visiting international students (n=17). Participants were asked to walk freely within the OPS and mark distinctively stressful and relaxing areas, and rate environmental and behavioural properties using the smartphone application MoMe. This paper presents the areas identified as stressful and their specific ratings along spatial quality and emotional perception.

Visibility Graph Analysis (VGA)

VGA has been used to calculate the visual integration of the space itself (Turner, 2001). The urban space has been reduced to a grid system of a 1-meter mesh in order to construct the visual relations and the OPS's relation to its surroundings. This dense mesh allows sufficient representation of every urban element and narrow street in the vicinity, as presented by Cutini (2003).

Isovists

The photographed motifs were clustered by themes and spatial proximity in areas of 10-metre radius, delivering vantage points, which are chosen according to how often the areas – and not phenomena such as crowding or litter – were rated as stressful.

4. RESULTS

From users' photographs, four main stressful areas could be identified (Figure 1). Ratings where analysed for each area separately (table 3).

Area 3, rated as most stressful (M= 7,60) has the lowest visibility and lowest vertices number (341). It is followed by area 4 with a rating of M= 7,17 and 388 isovist vertices. Both areas are on the east side of the OPS, where the majority of buses stop.

On the west side, area 1 follows the ranking with a rating of M= 6,43 on perceived stress and a total of 406 vertices, ending with area 2 and a perceived stress of M= 4,75 and the highest number of vertices (451).

Rating (1-min, 10-max.)	Area 1	Area 2	Area 3	Area 4
Perceived stress	6,43	4,75	7,60	7,17
Perceived relaxation	3,57	5,50	3,60	4,00
Vegetation	2,43	4,50	2,00	3,33
Maintenance	4,71	5,25	5,20	5,67
Traffic	6,14	5,50	8,40	6,83
Noise	6,57	6,25	8,20	7,50
Seating	3,43	4,00	3,60	4,17
Safety	4,14	4,75	3,20	4,83

Table 3. Mean values for the rated and clustered areas

Isovist properties	Area 1	Area 2	Area 3	Area 4
total area	22.679.988	20.364.674	12.095.074	17.951.496
Vertices	406	451	341	388

Table 4. Isovist properties

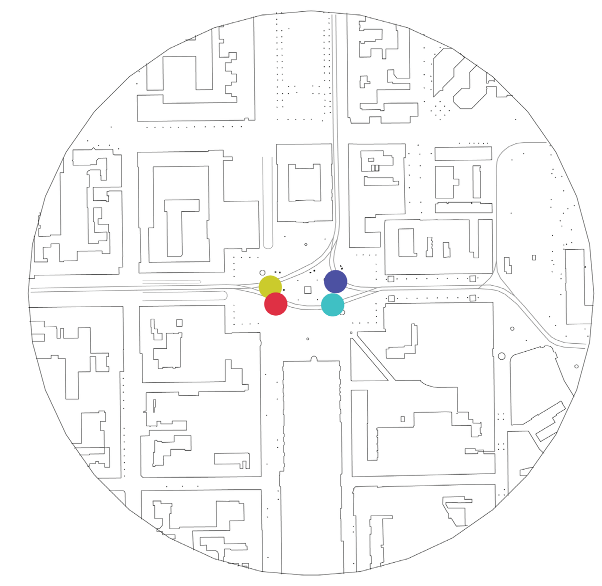

Figure 1. Areas rated as most stressful. Green: area 1, red: area 2, blue: area 3, and turquoise: area 4.

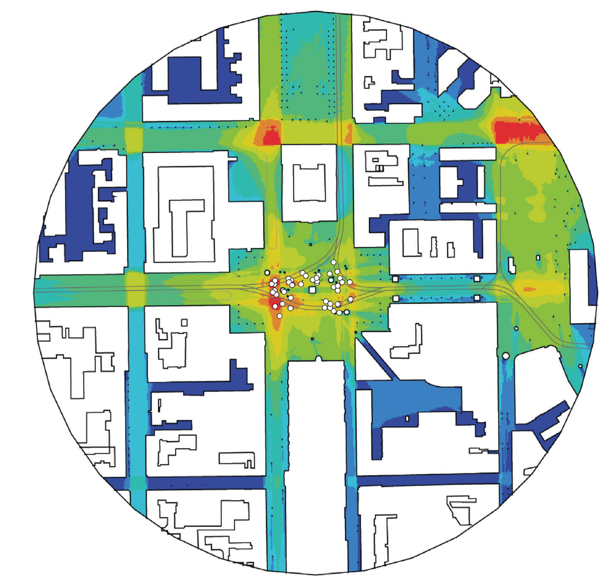

Figure 2. Visibility Graph Analysis (VGA) for the Luisenplatz and its surroundings in a 250 meter radius, coloured by Isovist Integration (high=red, low=blue). White spots represent the photographed areas.

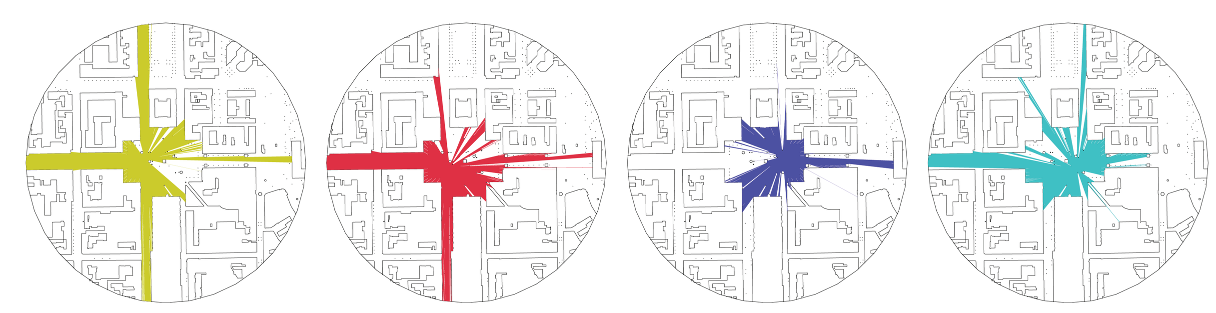

Figure 3. Isovists from different vantage points – from left to right: area 1, 2, 3, and 4.

5. DISCUSSION

The data shows that visibility has a weak negative relation to perceived stress, contrary to the assumption in hypothesis 1. The data endorses the statement in Knöll et al. (2017) regarding the ambiguity of visibility depending on the size of an area. The authors suggest that enclosure can be a further influencing factor to be taken into account when comparing different typologies of OPS.

On the other hand, the complexity of the isovist shape has a strong relation to perceived stress: high number of vertices indicates a place that has lower rating as stressful (Hypothesis 2).

Visibility and perimeter –which describe the shape of the OPS–, and vertices number – which indicate the complexity of the shape– are important characteristics to explain perceived stress.

These findings have potential implications in the redevelopment including location and shape of street furniture, such as roofing and seating along the waiting areas near high-motorized traffic.

6. CONLUSIONS

The current study has provided user ratings about the Luisenplatz in order to explore how OPS users describe emotional appraisal of OPS, the areas users identify as maximum stressful, and to what extent space syntax measures correspond to user statements.

This line of thought will have to be validated with bigger samples of OPS and in further cities of different size and cultural context.

A further aim is to deliver "high definition" measurement of psychophysiological effects on site to expand emerging theoretical frameworks to explain built environment factors on pedestrians' wellbeing. While the focus was on spatial perception and stress perception, other behavioural data, such as participants' heart rate, has to be the focus of further research.

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