COST 358 Pedestrians' Quality Needs

Measuring Walking

PQN Final Report - Part B4: Documentation

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Pedestrians' Quality Needs

Part B4
Documentation – Measuring walking

PQN project – Measuring Walking collective

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PEDESTRIAN QUALITY NEEDS
www.walkeurope.org

Colophon:

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Introduction

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*'Count what is countable, measure what is measurable,
and what is not measurable, make measurable.'*
Galileo Galilei

Walking is an inherent characteristic of being human. It is such a ubiquitous activity that it is often not regarded as a transport mode at all. However, even in highly motorised societies, it is an important component of almost all trips and in most places it still remains an important mode in its own right.

Walking is also very complex. Anyone who has observed pedestrian movements, interviewed people about their motivations and perceptions as pedestrians and tried to plan according to their needs knows the intricacies associated with walking. It is these elements which make walking and the research about it so fascinating.

Creating good urban spaces requires the knowledge of the characteristics of walking and the needs, abilities and wishes of pedestrians. Only if we understand these 'system properties' are we able to create appropriate institutional frameworks, devise good policies and design, build and maintain adequate facilities for pedestrians and sojourners. Only based on the characteristics can we communicate and promote walking in successful ways and measure walking adequately.

Measuring walking also serves as a crucial ingredient to inform policies, planning and promotion and to assess their impact. Good decisions are based on reliable information which in turn is gathered with adequate measuring tools. Measuring is one of the hinges to success.

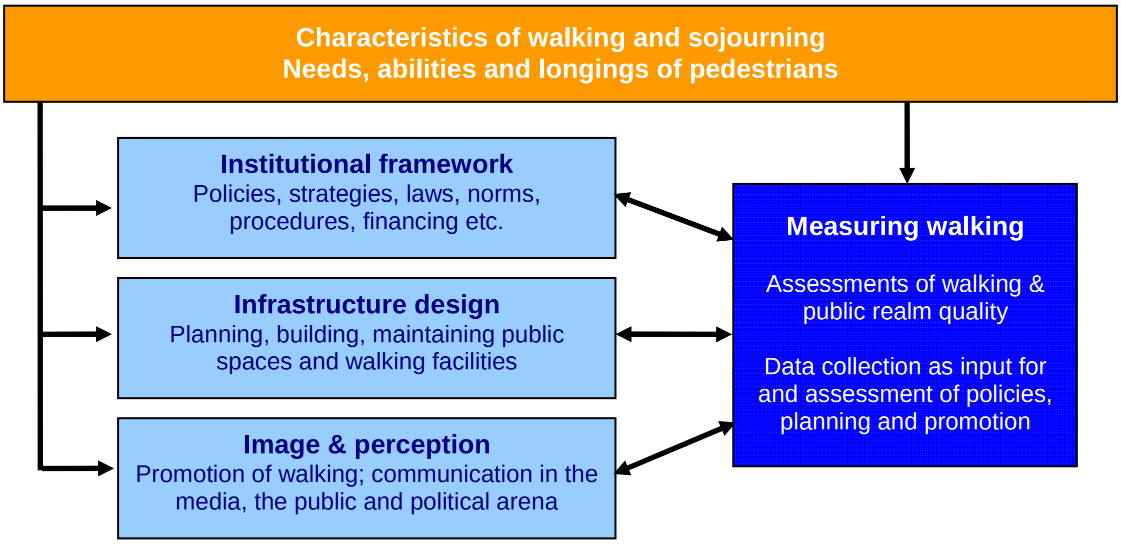

Figure 1 The role of Measuring Walking in the context of policies, infrastructure design and image and perception; all based on the characteristics of walking

If we want to enhance the role of walking, we need to improve the data situation. This means we need to develop good indicators and adequate data collection methods for measuring walking and public space qualities. Until now hardly any data on walking and public space qualities has been collected. Many of the contributions presented in the final reports of the Pedestrian Quality Needs project illustrate this. They also point to the short-comings of the existing methods. These methods are often so diverse and the data collection of such uncertain validity that it is almost impossible to compare data from different sources. We need not only to develop adequate and innovative methods but also to reach some common standards. Two steps are required to achieve innovation and standardisation: First, data collection methods have to be based on the awareness of the characteristics of walking as well as the needs, abilities and wishes of pedestrians and sojourners. Secondly, a minimal standardisation and harmonisation of indicators and data collection procedures is necessary, so that results are comparable.

The papers in this publication deal with both issues. In the opening contribution the process towards internationally standardised monitoring methods is presented followed by three papers which introduce innovative methodologies. The first of these papers deals with measuring emotional responses evoked in pedestrians by different urban spaces (chapter 2). The subsequent contribution explores new ways of assessing the influence of architectural and urban atmospheres on the way we walk in town (chapter 3). The fourth paper describes a newly developed tool for counting children on the street to assess their risk exposure (chapter 4).

The Pedestrian Quality Needs project (PQN) is part of a long-term endeavour to improve measuring walking. A lot remains to be done. Two main conclusions for the future can be drawn:

- The standardisation and harmonisation process started in PQN ought to continue. This requires an appropriate international forum for exchange and discussion. A new COST Action specifically focused on this topic may be the right format, but conferences and workshops would also help. It is important to involve the broad field of experts and practitioners associated with walking, broad both in terms of their professional and their geographical backgrounds. The collaboration with cities is crucial. The planned PAICE project (Pedestrian Appraisal, Investment, Coordination and Evaluation) by Walk21 as one follow-up of PQN will be an opportunity in this regard.
- New innovative methods have to be developed that build on the characteristics of walking and, thus, secure accurate measurements. Establishing national and international research programmes to allow a systematic and coordinated effort are also needed. The gaps in walking research are still huge, particularly compared to other transport modes. Special efforts are, thus, warranted and the benefits are obvious when we look at the challenges our societies face: climate change, peak oil, health crisis, etc.

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Measuring walking: Towards internationally standardised monitoring methods

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'Only what's being counted, counts.'
Common experience

Summary

This paper focuses on the information needed to create more walkable cities, particularly in terms of developing and implementing successful walking and public realm strategies. The specific focus is guided by the observation that until now hardly any data on walking and public space qualities has been collected by cities or urban areas, particularly not on the strategic level. Yet the walking environment and public realm for people to enjoy are at the core of any successful, liveable and healthy city. This is increasingly being recognised by many communities but, at the same time, they do not know what and how they should assess and measure the mentioned qualities.

There are many ways how this difficulty can be overcome. We suggest two main approaches: First, specific data collection methods need to be developed that are adequate for walking and sojourning. This requires awareness of the characteristics of walking and sojourning. Secondly, data should be collected in a way that at least some results are comparable. This requires some standardisation and harmonisation of indicators and data collection procedures.

After establishing what we know and identifying the problems many cities face in terms of data collection; and after analysing the methodological concepts, it is possible to outline a comprehensive Assessment Model which includes all relevant aspects of walking and sojourning. Based on this Assessment Model a path can be sketched out to create key performance indicators and methodologies to measure walking. These could help cities to improve their understanding how much walking there is and what needs to be changed in the future to create even healthier cities and more attractive public spaces.

1. Introduction

Walking is such a ubiquitous activity that it is often not regarded as a transport mode at all. However, even in highly motorised societies, it is an important component of almost all trips and in most places it still remains an important mode in its own right.

If we want to enhance the role of walking, we need to improve the data situation. This means we need to develop good indicators and adequate data collection methods for measuring walking and public space qualities. While we are currently witnessing an encouraging increase of surveys, counts and audits being performed to assess walking we are also faced with the problem that the methods used in different places are so diverse that the data are incompatible with often uncertain validity making it impossible to compare. So we not only need to develop adequate methods but also try to reach some common standards.

In the framework of this European COST Action 358 on ‘Pedestrian Quality Needs’ and the WALK21 international conference series (see www.walk21.com) we started such a discussion and international harmonisation process which aims to establish international guidelines for the collection, analysis and dissemination of qualitative and quantitative techniques for measuring walking. This paper discusses some of the results achieved from this activity.

The project started in 2006 after the adoption of the International Charter for Walking in Melbourne. Every year one day workshops attached to WALK21 conferences were held to find some common ground in terms of indicators and methods. The broad discussion process involving experts from many different professional and geographical backgrounds is by its nature very slow but gains the legitimacy necessary for globally shared standards[1].

Section 2 of this paper comprises a general assessment about what kind of information is currently available and what the problems are in terms of data collection. These general thoughts are illustrated with examples from the UK on data collected as part of mobility surveys and public realm assessments.

One of the basic problems is that the methods used are not adequate for walking. By analysing the characteristics of walking – in technical terms, the system’s properties – we can make sure that the developed measuring techniques are adequate. Some examples will be given in this regard in the first part of section 3, while in the second part three issues are discussed that are relevant when devising new measuring concepts.

In section 4 an assessment model is presented as a suggested basis for a comprehensive approach to measuring walking. Building on this model, a possible way forward is outlined in section 5 to create several sets of key performance indicators to enable cities and interested parties to assess successful walking and public realm strategies.

2. The problem

2.1 Current data collection situation in Europe: survey results

There is much evidence to suggest that reliable, rigorously collected and spatially compatible data about walking and about the quality of public space for walking is still widely missing. This section considers the problems of the data collection situation in Europe with a particular focus on the United Kingdom.

[1] The first workshop in Toronto (2007) focused on the relevant dimensions of walking that should be measured. The Barcelona workshop (2008) brought together users and producers of automatic counting equipment to advance the issue of pedestrian counts. The third workshop in New York (2009) centred on performance indicators resulting in a list of such indicators that participants found most relevant and important. During the workshop in The Hague (2010) data collection methods are being discussed. The process will extend over the end of the Pedestrian Quality needs project and is open to any interested person. All workshops are documented online at the website www.measuring-walking.org where also more information about the project is available.

Within our Pedestrian Quality Needs (PQN) project we started with a survey aiming to find out what type of data were available in each country and how they were collected. The survey was a result of the first attempts within the project to collect and compare data about walking. It quickly showed that not only was there very little information but also that the data were collected in so many different ways that the results could not be compared. A similar approach had already been taken in COST Action C6 “Town and infrastructure planning for safety and urban quality for pedestrian” (see Monheim und Frankenreiter 2000). This allowed for some comparisons between the two surveys – with the result that not much has changed despite some improvements.

No specific figures or results were sought in the survey. We were rather interested in the means and ideas behind the data collection. We asked the participants to provide information on all levels (national, regional, municipal and project-related) as far as this was possible[2]. The number and type of data that can be collected is almost limitless. The questionnaire contained, therefore, those items which were considered to be most important and relevant including the following dimensions:

- Transport behaviour (mobility statistics);
- Pedestrian volume (counts);
- Activity and time spent in public spaces (sojourn without mobility, stationary activity);
- Road danger (accidents, safety);
- Security: threats, attacks, harassments;
- Health: physical activities, competences (disabilities);
- Walking environment: quality accessibility, etc.;
- Ecological footprint;
- Perceptions, attitudes and images: ‘measuring the smiles’ and expectations of pedestrians;
- Investments, personnel, research: institutional aspects.

10 countries took part in the survey and provided results: Belgium, Finland, France, Germany, Greece, Italy, Netherlands, Norway, Spain and Switzerland. The information was mainly collected in 2007 and reflects the situation at that point in time.

The results not only confirm how little data are actually collected but also show the wide range of methodological approaches. Except for data on traffic accidents and on walking trips there is hardly any systematic collection of data undertaken. If there is any information it usually stems from single projects or case-studies. Even in the areas where there are some statistics available, walking is often not properly accounted for. An example of this is the lack of recording short trips (e.g. below 1 km or 1 mile) or the problem that only main modes are recorded which neglects stages to and from other transport modes. Generally, the recording procedures are not adequate to measure walking and can lead to a significant underestimation of walking trips and, therefore, to biased results.

Pedestrian counts are not conducted regularly in European cities with a few exceptions of a number of shopping streets in some countries. There is also very little knowledge and data about the activities and time people spend in public spaces. Information about pedestrian security is scarce as well. Available data on criminal acts usually suffers from severe reliability and validity problems as they are usually based only on reported offences to the police.

[2] The idea of the survey was to conduct a fairly quick scan of the main items of data collected within each country and it may well be that some data collection activity on the more local and project-related level has been overlooked. This, however, does not change the broad outcome from the survey.

Although most countries have some information about physical activities and obesity in their country (Body Mass Index based), the link to walking (transport surveys) is usually not made and the methodologies differ. The same is true for the assessment of people with disabilities. According to the survey there are also no systematic assessments of walkability (quality of the walking environment) performed by the cities although some single research projects are undertaken. Often GIS data on the municipal level is there but hardly ever used, except maybe for tourist guidance systems.

Data on CO_2 emissions, air quality, noise and energy consumption are collected in several countries but are not linked to walking levels. It is also interesting that cities and countries do not seem to be interested how their people feel as pedestrians as the data available on perceptions, attitudes and expectations of pedestrians is very scarce. Finally, very little is known about institutional aspects, e.g. investments into walking provision, economic benefits, marketing efforts and research, education and other resources provided to support walking.

We have to conclude from the survey results that the available data does neither give a comprehensive nor adequate picture of today's pedestrian situation. The detailed results of the survey can be found in the annex of the publication (available as separate pdf).

2.2 Problems of cities with data collection: views from city representatives

Based on in-depth discussions with representatives from a range of cities the main obstacles and problems were identified that contribute to today's paucity of data. The following points can be drawn as a result from these discussions:

- Lack of sensitivity and political will to collect data on walking: This is still a key reason why data on walking are not being adequately collected. As long as walking has little political representation the chances are slim that the needs of pedestrians will move up the transport agenda. What doesn't count isn't counted and what isn't counted doesn't count.
- Data are collected in a fragmented and inconsistent way: The lack of common standards contributes to this problem. In some cases the purpose of data collection is not clear.
- Indicators and/or methods are not appropriate for walking: Often indicators and data collection methods were developed for other purposes, but applied to walking. For example the collection of information only on main modes in travel surveys and their focus on distance, which neglects walking and distorts the picture of mode share.
- Restricted funding for studies and data collection on walking: The image of walking as being 'cheap' is also applied to money invested for the research. It is worth noting that often the funds for research are there but they are not allocated to walking and public realm research but to other transport modes.
- Staff lack knowledge and time to analyse and make use of data: Practitioners are often so absorbed in their everyday business that it is not possible for them to commission studies, analyse the results and translate them into policy or employ them to improve planning and design. This is true even if there is a political will and money available. The problem can develop as a vicious circle with lack of data weakening the position of dedicated staff, leading to even less time for their work.
- Information is there, but not edited to be used: The prime example is GIS information which often contains data on the walking network, distances, accessibility, connectivity and environmental quality, but the data are not edited into a format that can be accessed by the walking staff in the administration.
- Existence of data is not known or hard to access: Generally there seems to be very little co-operation between the different fields with a link to walking. For example the school board or health department may collect some information on children's trips to school or physical activity but this is not known in the transport department.

From the survey results, our own research and the discussions with city representatives we conclude that the available data gives neither a comprehensive nor adequate picture of today's pedestrian situation. The reasons for this situation are distorted definitions and terminology, inadequate methodologies, biased perceptions and structural obstacles (see also Sauter 2002).

2.3 What information is readily available on walking?

Clearly the answer to this question will vary somewhat according to location, scale of information and time period. However, this section seeks to examine what information is readily available to allow us to understand basic questions such as how much walking takes place (in a given location/time period) and how walking can be characterised. By necessity it is not possible to answer these questions in terms of every possible location, rather we focus on the UK as a case study and make comparisons where possible with other circumstance. In many other papers of the final COST action report, more data and methodological considerations can be found which cover not only a wide range of issues but also comprise data from other countries.

Sources of information about number of walking trips

At a national level in the UK there are two main sources of information about levels of walking – the National Travel Survey (NTS) and the Census of Population. The NTS is based on travel diaries collected from a large national sample in Britain and is undertaken on an annual basis, going back as far as 1988, with more ad hoc and less regular surveys since the mid-1960s. Its use is intended as a means to establish longer term trends and thus is less useful as a means of understanding more immediate changes. While an immensely useful source of information on travel and having some advantages for the study of walking (for example there is some information on trip stages i.e. walking as part of a longer trip), there are also weaknesses. There is probably some degree of underreporting of very short trips, particularly for walking. There is no information on routes. Perhaps most importantly it is not possible to break the locational information down beyond the level of Government Office Regions (currently England is split up into 9 such regions), partly due to the small sample size, but also as the data on origin and destination of trips is recorded at this level (and hence for walk trips most will start and end in the same GOR).

The Census in the UK is undertaken nationally every 10 years and involves all households, though the focus of the survey covers all aspects of life, not just transport. From a sample perspective it far exceeds the NTS, though there are other key limitations. Principally, it does not cover walking in any great detail and the main focus is on travel to work. It is, however, possible to get some idea of more local variations in walking from this source, which given the sampling issues, is not really possible from NTS. No information is available on changes which occur in the intervening 10 years between surveys.

Some urban areas undertake their own diary based travel surveys as a matter of course. For example, the London Area Transportation Survey (LATS) is a household based travel survey using a sample of households resident in the London area. This provides useful data on the amount of walking done by Londoners, but does not provide information on the amount of walking done in London as no information is collected on the walking done by those who do not live in the area, but who use it (for example the large number of people who commute into the city every day and tourists).

Importantly, none of these sources of information give any hint about suppressed demand for walking, simply they provide a record of some aspects of what actually happens. Nor do these sources provide information on the quality of the environments or the response of those who are doing the walking in those environments.

More ad hoc surveys of walking are undertaken, particularly by highway and city authorities, often providing a lot of detail, often based on observation and often linked to potential or ongoing work on aspects of the urban environment. Whilst useful and providing a lot of understanding for the specific locations involved there is rarely any systematic organisation of such surveys, nor consistency of application across different locations. Again, it is not possible from these to get a feel for how much walking or what type of walking happens in a given city or urban area.

Methodologies to assess the quality of the pedestrian environment

A range of methodologies (qualitative and quantitative) are evident in the literature that can be used to assess the pedestrian environment. These include the use of tools or checklists to assess the "walkability" of a particular route, stated preference techniques to determine pedestrian's value of specific aspects of their walking environments and more recently mobile methods which have been used to understand the pedestrian environment directly through the experiences of pedestrians (Kelly et al, 2007).

The needs of pedestrians can be elicited through the use of tools to assess the environment or the "walkability" of a particular route using some kind of scoring or checklist approach. These approaches usually use best practice for determining what pedestrian factors to include and the tools are often used by transport authorities and consultants. For example the Pedestrian Environment Review System (PERS) (TRL, 2004), permits users to rate a range of factors (including directness and road safety) about a pedestrian route, link or crossing. The aggregation of these results enables the operator to identify specific features which should be improved. The pedestrian level of service (LOS) methodology used by Gallin (2001) is another approach which provides an "overall measure of walking conditions on a route, path or facility" examining design factors (e.g. path width, obstructions), location factors (e.g. connectivity) and user factors (e.g. pedestrian volume). A weighting system is then applied recognising that certain factors are more important to pedestrians. The LOS approach has also been used to assess pedestrian trip quality based on more qualitative factors such as enclosure and proximity to traffic (Jaskiewicz, 2000).

Other examples of methodologies for assessing the walkability of the pedestrian environment focus on checklists or observations that are completed by the pedestrians themselves. Walkinginfo (2004) produced a "walkability" checklist, which asks residents to assess their local community (e.g. Did you have room to walk? Was it easy to cross the street?). Living Streets (2004) produced a DIY community street audit which focuses on identifying what communities want improving. More recently mobile methods are increasingly being used. Definitions of such methods are varied, contested and evolving, but defined broadly they are methods in which either the researcher moves on the journey with the person being studied or the method used is mobile in the way it captures the journey's or mobilities of whatever is being studied. The strength of such methods is that they provide spatially referenced information about aspects of the walking environment which are of interest or problematic (examples of such work include Brown and Durrheim, 2009; and Jones et al, 2008). More recently ethnographic techniques have been used where the researchers aim to become part of the environment in which they are working, but also to observe and find out about activity (see for example Pooley et al, 2009 or Kusenbach, 2003).

A number of studies have sought to produce monetary valuations for different aspects of the pedestrian environment (see for example Kelly et al, 2007). Typically these use stated preference (SP) modelling techniques where respondents are presented with hypothetical choices which represent the attributes of the scenario being tested. Then based on the choices that are made the relative value (willingness to pay) for the individual attributes can be determined. Such an approach provides a means of understanding the relative importance of various features of the urban environment to pedestrians (for example traffic noise versus quality of pavement provision) and hence a basis for the allocation of scarce resources towards improving facilities for pedestrians.

3. From the problem to the solution: a window of opportunity?

The previous sections illustrate the current lack and short-comings of data collection but also the broad range of available methods with their strengths and weaknesses. To advance further from this situation, two main approaches are needed. First, the data collection methods need to be adequate for walking and sojourning. This requires awareness of the characteristics of walking as well as the needs, abilities and wishes of pedestrians. Secondly, the data should be collected in a way that at least some results are comparable. This requires some standardisation and harmonisation of indicators and data collection procedures.

Within the PQN project the decision was made to start work based on both of these requirements and not just (once again) deplore the fact that data are missing and cannot be compared. The idea is to start remedying the situation by setting a process in motion and strive for a “consistent methodology for recording pedestrian activity, to create easy to use auditing tools and guidance on national and local procedures for monitoring walking” (excerpt from the PQN objectives). It was also decided to try and co-ordinate these efforts on a global basis. Concurrently with the start of the PQN project the participants at the 2006 international WALK21 conference in Melbourne concluded that it was time to develop a set of “international guidelines for the collection, analysis and dissemination of qualitative and quantitative techniques for measuring walking” (Walker 2006).

This situation is also a window of opportunity. The fact that little is known while at the same time the interest to collect data is increasing rapidly, that more and more data are being gathered, surveys and audits performed, new methods developed and technologies placed on the market, is all a big step forward and a chance to use the momentum. It is the right moment to establish some common ground before everyone creates their own typology and data sets.

3.1 Characteristics of walking and the implications for measurement

Creating good urban spaces requires knowledge of the characteristics of walking and sojourning and also the needs, abilities and wishes of pedestrians. In technical terms, it means that we need to know what the system properties of pedestrian traffic are and base our work around these.

Understanding characteristics of walking is needed, for example, to create an appropriate institutional framework with laws, norms and financing procedures that properly include walking. The same is true to design, build and maintain adequate infrastructure provisions for pedestrians and sojourners in public spaces. Furthermore, the perception and communication by the public, media and politicians has to be grounded in the qualities of walking and, last but not least, also the methodologies and data collection tools to assess walking and sojourning have to be rooted in this knowledge to adequately measure it.

Since one of the basic problems is the inadequate understanding and tools to measure walking, it is the aim of this sub-section to focus on a phenomenological approach to some of the characteristics for walking and their implications to measure pedestrian activities. The following list indicates some of the key characteristics of walking:

- Walking is important as a distinct transport mode but also as link between other modes: Walking is the glue of the transport system which means it is often linked to other modes. It is important to always measure and present both the walking-only trips and the walking stages. When counting attention has to be paid to places where pedestrians are 'born' or 'disappearing'.
- Multiplicity of motivations, purposes and route choices: When measuring (e.g. in surveys), all simultaneous purposes, motivations, route choices and way-finding strategies need to be included.
- Flexible and small scale movements: Pedestrians are very flexible and characterised by their small scale movements. They can stop immediately and change direction quickly. Where possible direct routes tend to be taken. It's important to take all this into account when evaluating route choice and desire lines.
- Easy transitions between walking and sojourning: With no other means of transport can one switch so easily between moving and stopping, walking and sojourning. We need to record not only the walking but also the time spent in public spaces, the activities enjoyed there and the underlying motivations (e.g. to meet other people).
- Sensitivity for the immediate environment / surroundings: Pedestrians are very sensitive to the environmental qualities of their immediate surroundings. This includes architecture, flora and fauna, people present as well as influences of the weather. It concerns all senses and includes the feeling of security and the general atmosphere of a space.
- Communicative and social aspect: Walking is a highly communicative and social activity. We walk with other people and meet strangers, friends and neighbours. The potential for such communication is in itself a measure of the quality of the space.
- Socially inclusive and environmentally friendly: Walking excludes few people and is, thus, the most democratic form of transport. It is a low impact mode of transport and has fewer environmental implications than other modes.
- Walking is healthy – mentally and physically: The contribution of walking to health is increasingly being recognised. The current focus is on physical activity, but walking also is important to relax, contemplate and reduce stress.
- Walking happens everywhere, anytime: Walking is ubiquitous: often quality assessments and surveys concentrate on the city centre, but people on the urban fringe walk as well. We also need to consider the influence of season and time of day, not only counting at some assumed peak hour.
- People on foot often do not see and define themselves as pedestrians: Pedestrians, when surveyed, are often not aware how much they are walking (or have walked) and answer with other modes in mind. They may prefer to give their opinion from a car driver's perspective even when asked about their views as pedestrians. Since the media often shapes perceptions of walking (and other modes) it is helpful to look at current discussions in the media and politics.

From these descriptions it becomes evident how important it is to develop indicators and methodologies based on the specific qualities and characteristics of walking and pedestrian behaviour. They also illustrate the need for careful thinking and new research to find reliable and valid data collection techniques.

3.2 Relevant concepts in the field of measurement

There are a wide range of concepts used to measure walking and pedestrian activity. Often the terminology is confusing. Here we examine three selected aspects that influence the development of measuring techniques.

Qualitative versus quantitative and subjective versus objective assessments
Our position is that these varied approaches all have their merits and disadvantages and their use depends on the objective. Figure 1 tries to integrate and discuss these different ways of measuring, giving different examples of each.

	"qualitative" results usually based on small numbers, approximations, judgments, descriptions (verbal data)	**"quantitative"** results usually based on larger (representative) figures
"subjective" results usually based on personal perceptions and opinions	*Example:* Community street audit *(How community members judge safety of a crossing)*	*Example:* Population survey about attitudes towards walking *(How safe people feel generally)*
"objective" results usually based on 'immediate reality' ('objectivated' judgments)	*Example:* Expert street audit based on norm checklist *(How well a street fulfills official safety requirements)*	*Example:* Counts and 'hard' data collection *(How many people got killed and seriously injured)*

Figure 1 Classification of assessment methods

There is no hierarchy or implied importance between the different approaches; they are all valid in their own right. They need to complement and correct each other and their use also depends on the needs and requirements of the assessment.

Main types of assessment
Three main types of assessments can be distinguished which are illustrated in Figure 2.

Situational assessment	**Controlling (compliance)**	**Benchmarking**
Analysis of current situation	Comparison of current situation vs. desired outcome or given standard	Comparison of situation between different places or levels
=> To obtain a description of the current state, gain new insight	=> To obtain information about the degree of achievement, compliance	=> To obtain a ranking or characteristics describing best practice
- situational or project-related assessment (single project) - input for planning / policy - answers to specific research questions	- set objectives / goals: e.g. city strategy - norms / standards or other agreed principles - people's expectations, wishes	- horizontally: between towns/cities; different spaces in same city - vertically: between different state levels
Monitoring: rarely done	**Monitoring:** comparisons over time re controlling and benchmarking	

Figure 2 Three alternative types of assessments

Situational assessment: This usually analyses the current situation of a specific space and does not aim for any comparisons. It results in a description of the characteristics of a space or peoples behaviour answering a specific research question. It is often done by academics and other researchers to provide new insights but is also used to provide input for planning or policy. Due to its static and non-comparative nature, situational assessment indicators and methods can be freely chosen according to the research question and/or interest.

Controlling or compliance: A second type of assessment compares the current situation with a desired outcome or given standard. It aims to obtain information about the degree of achievement or compliance. The standard against which the situation is measured can be a set objectives or goals (e.g. city strategy) or it can be a normative standard (e.g. usable width of a sidewalk as defined by the national guidelines) or it can be measured against people's expectations or wishes as provided in a survey (e.g. quality of a space). Since this type of assessment explicitly aims to make comparisons, the indicators and methods have to relate to the objectives i.e. they have to be valid and measure what they need to measure. The methodology employed has to be replicable and cannot change between different data collections. The data can be ‘absolute’ (e.g. km of footpaths) or ‘relational’ (e.g. number of walking trips per capita).

Benchmarking: The third type of assessment compares situations between different places or different levels. It aims to obtain a ranking or compare characteristics and can also be used to evaluate best practice. We can distinguish between ‘horizontal’ benchmarks of comparable towns, cities or specific spaces and ‘vertical’ ones between different state levels e.g. when comparing mode share of walking on the national level with the one on city level. In order to achieve valid and reliable results most statements and indicators have to be relational (e.g. per capita) and they need to be comparable in terms of adequate sample and perimeter. Intercultural comparisons are particularly difficult (even if the same methodology is applied) since the cultural understanding and concepts may widely differ. Benchmarking is often used as the broader term which includes also controlling as sub-category. However, the two concepts are kept separate here for easier communication.

Situational assessments are not usually aimed at comparing over time while controlling and benchmarking are usually implemented as part of a monitoring programme each with several measurement points in time. This also influences the detail and precision of the data necessary. While a situational approach may be pragmatic with approximations, data for comparing before with after situations need to be of higher quality to avoid arbitrary results.

Improving quality step by step

The current situation in terms of pedestrian facilities and measuring walking differs substantially around the globe. There are not only huge differences between countries and regions of the world, but also large differences within countries, specific regions or cities. Car-oriented societies with large urban sprawl, for example, differ widely from more compact cities with well established public transport infrastructure. The situation in small towns and cities is very different from that in large mega-cities. Provision for walking in old cities is often very different to newer suburban areas.

These developments can be seen in both diachronic and synchronic terms. Diachronic in the sense, that we can see differences in developments over time. Synchronic in the sense, that even in the same era the development differs substantially between regions or within the same city.

This wide range of situations has to be reflected in assessment tools. We can distinguish two requirements: first, the approaches and attitudes taken by the administration and those in power and, secondly, the degree of refinement an indicator or method has. Both requirements are briefly discussed below.

Approaches and attitudes: the quality ladder

The quality management literature defines several stages to achieve excellence (see EFQM, 2010) with regards to the attitude and approach taken by those in power and the integration of the different parts of the system. This kind of quality rating has particularly been developed and applied in the safety world. Fleming (1999) has, for example, developed the so called safety culture maturity model which then was refined by Hudson (2001). Methorst (2010.) has adapted these models to walking. The version of the quality ladder shown in Figure 3 is slightly enlarged to include a possible bottom step to the ladder. The reason is that it could be argued that measuring walking is based on so called pre-conditions. It requires and assumes the existence of knowledge, sensitivity to the issues and (political) willingness as well as a certain level of development in terms of walking policy and infrastructure. However, how do we reflect a stage where this is not given or only marginally established? Our model is, therefore, enlarged with a stage of “complete ignorance” where the above mentioned pre-conditions are not yet established.

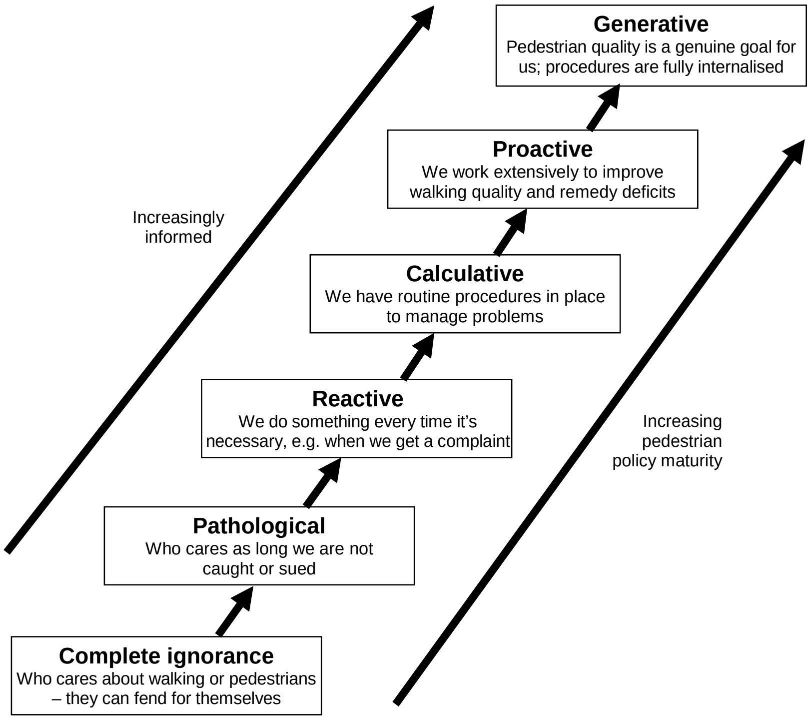

Figure 3: Maturity of pedestrian quality policy (adapted from Methorst, 2010)

The 6 phases or approaches can be more closely described as follows:

- Complete ignorance: This approach is characterised by complete disregard of walking and inactivity of the relevant bodies. The attitude is that pedestrians do not need any provision, they can fend for themselves. In extreme circumstances walking may be considered as an ‘enemy’ standing in the way of ‘progress’.
- Pathological: This approach requires a minimal awareness of pedestrians and their needs. The attitude is that we don’t care as long as there are no negative repercussions.
- Reactive: This approach is based on obvious problems and received complaints. The attitude is that we do the minimum and act if there is a serious problem or grievance brought to our attention.
- Calculative: Established procedures are in place in this approach to deal with problems of pedestrians. But every intervention is treated as a singular event. Managing problems is routinely done but in an isolated manner.
- Proactive: The work is organised in a way that the quality of pedestrian facilities is improved constantly and widely. Deficits are remedied on a regular basis and the people involved strive to optimise the system and co-operate with different partners.
- Generative: Pedestrian quality is a genuine goal for all of the involved. Improving walking policy is a permanent task, the procedures are fully internalised and the ‘antennae’ into the world are wide open meaning new ideas are actively sought and integrated, strategic partnerships (within and outside the administration) are developed and draw from a range of ideas.

Degree of indicator and methodological refinement

The approaches described above also have to be translated into different indicators of quality levels and methods. A big city probably has different needs, opportunities and means to measure walking compared to a small town. In a more advanced city it may be desirable to fine-tune the information collection and go into more depth compared to other places where a simple indicator might suffice. To make indicators and methods adaptable to different situations while still being comparable we propose a modular approach. This also allows pragmatic approaches as well as the integration of new developments (e.g. technological advancements). For the time being it is suggested to differentiate between three quality levels (basic, intermediate and elaborate) which also relate to a corresponding time frame of their use (short-, mid- and long-term).

4. Assessment Model for Measuring Walking

When looking at what needs to be measured we can distinguish four main dimensions:

- How much walking?
- What is the quality?
- What are the perceptions?
- What are the institutional conditions?

These four dimensions were derived from discussions and go beyond traditional approaches which usually just comprise the first and second point. Subsequently, we have developed a more comprehensive Assessment Model to analyse walking and the public realm. It essentially shows what needs to be addressed in terms of measurement. Of course, there are many different ways in which such an assessment framework could be constituted. The one developed within this project is based on the Excellence Model by the European Foundation for Quality Management (EFQM, 2010) and Beckmann et al. (2004) and has been adapted and further developed from a cycling benchmarking assessment matrix from New Zealand (New Zealand Transport Agency, 2009). The content is adjusted to the specific requirements for assessing walking and public space.

The current model shown in Figure 4 developed as a result of a long discussion process over several stages with input from many international experts. Broad international support and agreement is important if we want to share and adhere to a common framework which will allow us eventually to compare results.

The Assessment Model is intended to serve as a reference point to ensure walking and public space are considered in a comprehensive and comparable way. It can be used as a resource for fine-tuning the different elements within the model. The Assessment Model itself stands on four main pillars: input, output, outcome and impact which are characterised as follows:

<u>Input</u> describes the institutional framework in which walking is situated and informs about the financial, material, organisational and human resources made available by authorities or other organisations as a basis for providing good walking conditions. This section specifically comprises the leadership given by politicians and (senior) officials, strategies and policies including the laws and norms as well as the implementation procedures, the resources allocated (in terms of staff and funding), the research settings and approaches and the co-operation within and between administrations, citizen participation and partnerships with stakeholders outside the administration.

<u>Output</u> focuses on products and activities by (institutional) actors, which are achieved through their efforts and activities. Outputs in the field of walking comprise land-use, the resulting accessibility and the (degree of) integration between different modes; infrastructure provision, features and qualities of public spaces; information, promotion and the marketing of walking and the enforcement (e.g. re speeds and parking of motor vehicles).

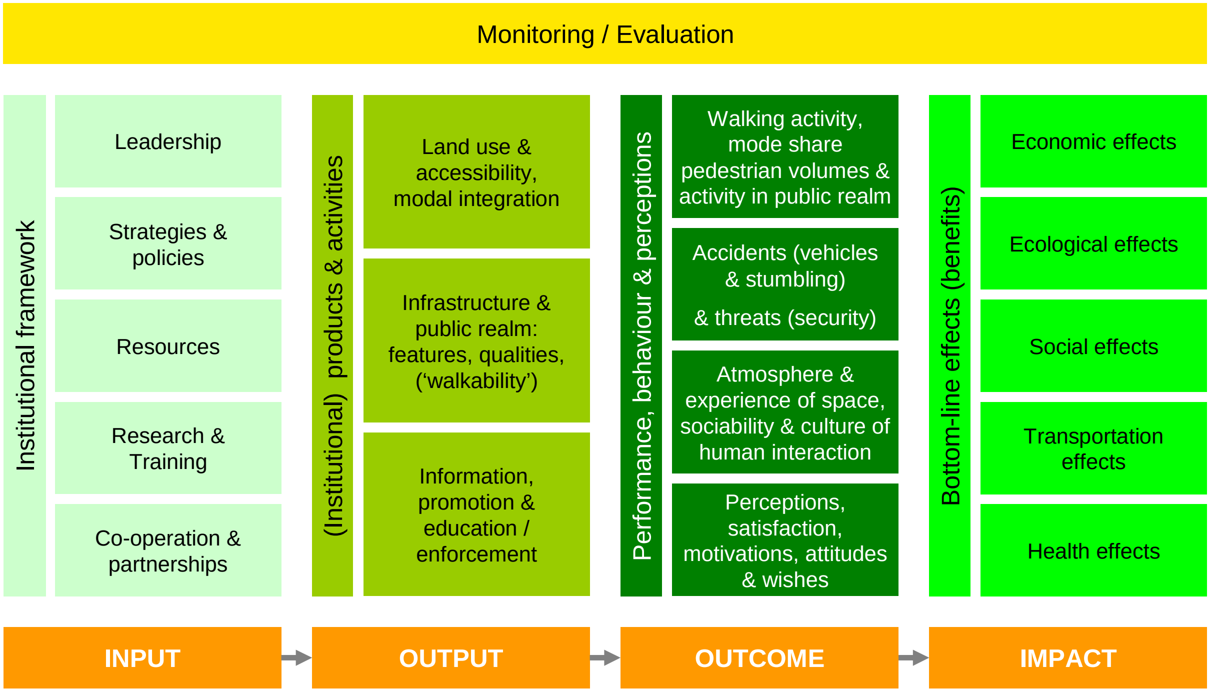

Figure 4 Assessment model for measuring walking

Outcome is the primary and immediately observable result of input and output for the recipients or beneficiaries. Outcome is measured as levels of walking and sojourning, user activities and behaviour, also in terms of accidents (with vehicles or as a result of falls) and security (threats and attacks). Outcome can also be observed as atmosphere of a space. In contrast to the 'hard' infrastructure, the sociability and mood of a space is created by the people using it. The final yet crucial dimensions are perceptions and levels of satisfaction, attitudes and motivations as well as expectations and wishes of users or non-users and of politicians and the media.

Impact is a secondary outcome usually with longer lasting, often indirect effects. It is often hard to measure. We can distinguish between individual and collective effects with the latter usually being of most interest. They include the bottom-line economic, ecological and social benefits (effects) and can also be discussed in terms of specific effects regarding transportation or health.

Based on the above elements it is possible to consider how effectiveness and efficiency may be derived. Effectiveness is calculated from the ratio of actual and planned output (or outcome / impact respectively) and efficiency is the ratio of output (or outcome / impact respectively) in relation to the costs (input).

While the current analysis of walking usually focuses on 'output' and 'outcome' (e.g. qualities of walking environment and walking activity), the political discussions and decisions often refer also to the 'input' and 'impact' factors (e.g. investments and ecological effects). So it is important to look at all relevant factors right across the board. The Assessment Model is not, however, a simple cause and effect model. There are far too many side, counter and reinforcing effects that influence the different parameters. They may also, for example, be influenced by such factors as changing transport demand, exogenous demographic and economic conditions (oil price) and social trends. All these factors and repercussions are not included in the model since it is static. A dynamic model to take account of these factors could ultimately be envisaged, but is beyond the scope of this paper.

5. Towards the creation of key performance indicators

Given the objective to define adequate standardised methods to measure walking, the next steps are to use the Assessment Model and its related dimensions to develop a set of indicators and methods. This will happen in several stages:

5.1 Identifying and selecting indicators

1) Firstly, a list of indicators has been identified and assembled based on the wealth of pre-existing indicators used in different professional fields and geographic areas (see annex).
2) Secondly, it is necessary to rationalise the large number of indicators and agree on those that capture the many dimensions of walking best and that can be easily used in different contexts worldwide.
3) The final stage may consist of creating indicator sets, i.e. to group them into applicable tools to be used for different purposes (see below).

One possibility is that the full list of indicators could be indexed in a relational data bank according to different criteria. This would serve as a resource for researchers who want to go beyond the agreed indicators for specific applications. The indexed indicators could be linked to suggested applications, methods and tools. Given the other tasks it is, however, not a priority to develop such a comprehensive resource.

5.2 Specification of methods on how data should be collected

When the indicators are assembled into sets the methods can be defined to specify how the data for the indicators should be collected. Only if the same kinds of data collection procedures are applied will we reach comparable data. The result will be recommendations and guidelines consisting of minimal standards about how walking and pedestrian activities should be measured. The methods have to orientate themselves with the characteristics of walking and measure what they ought to measure (validity) as well as possible (reliability).

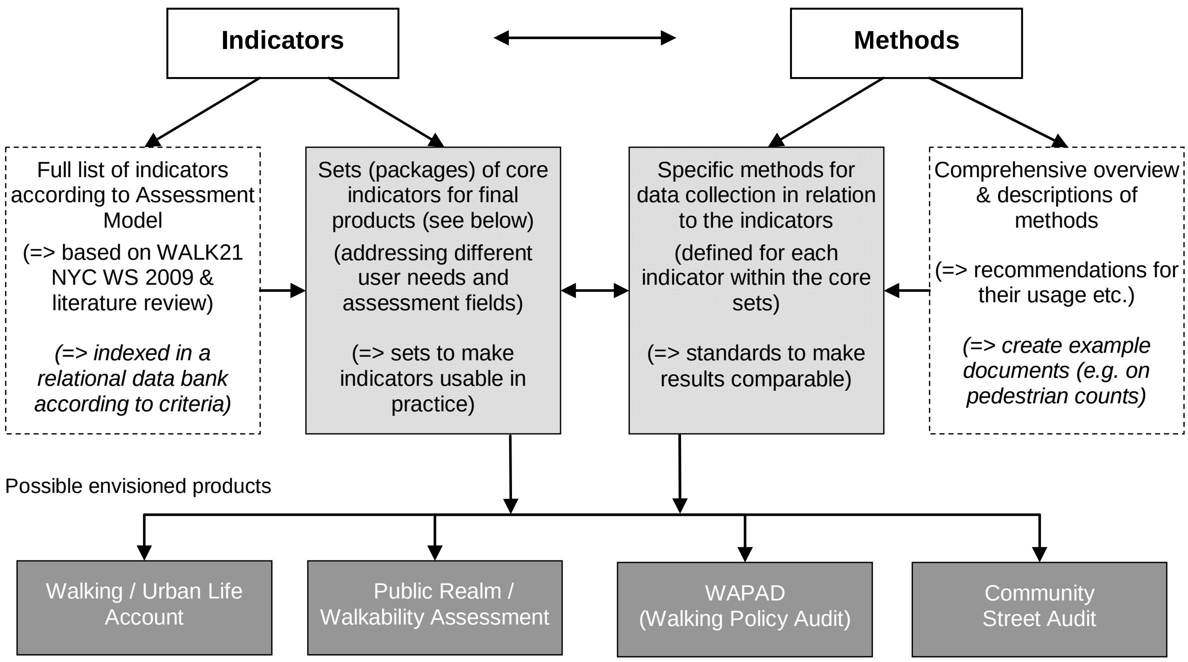

Figure 5 Overview of the next steps

* The boxes in light grey are those next steps which are seen as a priority; the boxes in dark grey are possible products that can be envisioned when combining the indicator sets with the specific data collection methods.

Just as with the indicators it should be possible to create a comprehensive data bank of methodologies relevant for measuring walking. This could contain (minimal) standards about data collection procedures to make sure walking activity and public space qualities are adequately assessed. First ideas and suggestions for methodological standards were made by Sauter and Wedderburn (2008). The comprehensive data bank would go beyond the immediate needs for agreement on methods for the indicators and, therefore, is not a priority. This process is shown in Figure 5.

As stated earlier this work does not aim to standardise all indicators and methods. The idea is to concentrate on core indicators which are easy to implement and which assure a minimal degree of comparability. Theses standardised indicators and methods could be grouped into products that reflect the needs of different users and address different purposes when measuring walking. Four core sets of quality indicators are envisaged and briefly described below.

Walking or Urban Life Account

The Walking Account or Urban Life Account would provide a set of key figures for each city to benchmark itself against other cities or towns. The Account would comprise indicators from all four pillars (input, output, outcome and impact) and would address policies and invested resources, figures on accessibility and pedestrian facilities, share of people walking and activities/time spent in public realm, perceptions as well as economic, social and ecological impacts. A range of methods would be employed to get the information including existing data from the cities and population survey data.

Several existing products can serve as examples and input for the Account, such as the Copenhagen Bicycle Account see www.kk.dk/english.aspx, City of Cyclists); Bicycling and Walking in the United States: Benchmarking Report 2010 (see www.peoplepowered-movement.org) or the project ‘Making Walking Count’ (see www.walk21.com).

Public Realm / Walkability Assessment

The Public Realm or Walkability Assessment would focus on the qualities of specific spaces, e.g. a square or a street. It would not comprise the whole city but selected areas where a more in-depth analysis could be performed. It is these spaces that are then compared. The assessment would include elements from all ‘pillars’ of the model but focus mainly on the output and outcome level. Methodologically the data collection may mainly be based on quantitative and qualitative data assembled on site or by GIS, possibly expanded by surveying local residents or performing on-site interviews.

There are many current products and studies that can serve as examples, among them studies by Project for Public Spaces (see www.pps.org) and Gehl Architects (see www.gehlarchitects.dk); information from the European ASI project (see Forward, Kaufmann & Risser, 2005 or Martincigh, 2009); the Pedestrian Environment Review System (PERS) (see www.trl.co.uk); Walkscore or walkshed (see www.walkscore.com or www.walk-shed.org). Many resources can also be found on the websites of Active Living Research (see www.activelivingresearch.org) and the Pedestrian and Bicycle Information Centre (www.walkinginfo.org).

WAPAD: Walking Policy Audit Tool

The Walking Policy Audit Tool would analyse in detail and in a comparable form the input side, i.e. the institutional framework: leadership, strategies, resources, research and training as well as co-operation and partnerships. These elements are all very difficult to measure quantitatively so a rating will be developed of the commitment by the towns, cities, national and regional governments.

The tool would probably be oriented along the lines of the European Quality Management model (see EFQM 2010) and more specifically along the excellent example of BYPAD (Bicycle Policy Audit - see BYPAD Consortium 2008, www.bypad.org). The audit could take on two different versions: a) similar to BYPAD where trained external auditors are doing the assessment during so called consensus meetings in which politicians, members of the administration and people from civil society (NGO's) rate the city's performance and come up with ways to improve the situation; or b) to make a self-assessment tool for the officers and/or the users so every interested person in a community could rate performance.

Among the examples for this kind of product are the already mentioned Bicycle Policy Audit BYPAD or the report by the New Zealand Transport Agency (2009).

Community Street Audit

Community Street Audits are a way to evaluate the quality of streets and spaces from the viewpoint of the people who use them, rather than those who manage them. It is about the stakeholder perceptions and input into improving spaces. A Community Street Audit usually is carried out together with local residents, business/store owners and visitors, all having many different backgrounds and capabilities. They comprise assessment elements from all 'pillars' with a special focus on accessibility and public realm qualities. It is important, however, to also include strategic and resource issues (input), perceptions (outcome) and impacts (e.g. on social inclusion).

The main objective of creating a Community Street Audit tool would be to standardise procedures and to a lesser degree make results comparable. Such an audit should be designed so that interested community members and groups (neighbourhoods, NGO's etc.) could use them without much professional help. This would be in contrast to the other tools which require some expertise to perform. Of course it would be desirable if the audit process was accompanied by people with experience. Methodologically, a Community Street Audit can take on many different forms. Usually it is centred around a site inspection, possibly complemented with workshops, focus groups and/or surveys. Among the examples of this kind of product are the Community Street Audits by Living Streets (see www.living-streets.org.uk) or the Assessment Tools by the Project for Public Spaces (see www.pps.org).

6. Concluding remarks

The increasing interest in measuring walking and using this information to create walkable cities is a very welcome sign of progress. For too long the potential of walking to create enjoyable public spaces and liveable cities has been neglected. The increased interest is a window of opportunity to create measurement techniques and procedures that are adequate to the characteristics of walking and, at least to some degree, are also standardised enough so the data is comparable. This will allow a city to benchmark itself against their neighbours or other cities in the world. We know from experience that this is one of the main drivers today to improve the public realm. What London does in Trafalgar Square, New York does in Times Square and Melbourne does in Federation Square reverberates through many cities and towns across the world, creating a great momentum.

Measuring and understanding the many aspects associated with walking and enjoyment of public spaces requires an adequate and comprehensive assessment model. In the framework of the PQN project such a model has been developed and can serve as a basis to create indicators and methodologies to appropriately measure walking. There is still a long way to go, but looking back at the dismal days of no information at all, the future looks promising.

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Annex: List of key performance indicators (or elements to create them)

Based on the framework of the Assessment Model a list of key performance indicators or elements necessary for creating them has been developed (status: June 2010).

	Main Criteria	Key performance indicators (or elements for creating them)
Input: Institutional framework	Leadership	• **Politicians and (senior) officials** • Extent to which politicians and (senior) officials take a lead and direction in supporting walking and public space improvements • Sensitivity and awareness of walking and public space issues • Content and form of communication about walking and public space
	Strategies & Policies	• **Walking strategy & integration of walking in other strategies** • Presence and quality (content) of a walking and public space strategy • Presence and quality of strategies/policies closely related to walking e.g. land-use, health, transport/mobility, social integration, environment => Degree of integration between these different strategies/policies: coherence, conflicts • Policy principles supporting walking (e.g. polluter pays, 'true cost' approaches, 'complete streets', 'vision zero' etc.) • **Implementation procedures** • Type of implementation programmes / action plans • Type and degree of integration within 'Input' level, i.e. between policies and resources • **Legal framework** • Laws, norms & regulations; supportiveness of legal framework for implementation
	Resources	• **Funding** (incl. infrastructure investments, promotion, maintenance, research etc.) • The level and continuity of funding for modes/projects … **a)** with adverse effects on walking; **b)** for rectifying poor walking situations and **c)** to genuinely improve walking conditions / public spaces • **Staff** • Number and qualifications of staff, their seniority and training • Position and power of walking unit within administration
	Research & Training (Education)	• **Funding** • Research and monitoring (funding) procedures in place (yes/no) • Resources allocated (funds, staff, share of resources for walking and other modes) • **Institutional setting** • Research institutions (staff, position, funding, etc.), coordination with other research areas (on national level), position and power within administration of monitoring unit • Education: students & professionals = continue education (engineers, health, architects); walking and design of public space included in curriculum • **Approach** • Type of research: basic as well as applied research – creating new insights & monitoring
	Co-operation & Partnerships	• **Co-operation within and between government agencies ('vertically' and 'horizontally')** • On / between all government levels (local, state, federal) • Between different departments (transport, health, environment, etc.) • Between different tasks (e.g. planning, maintenance, regulation, promotion, monitoring) • **Public involvement / citizen participation in decision making, consultation** • Procedures, degree of decision-making powers • **Co-operation and dialogue with stakeholders outside government/administration** • NGO's, advocacy groups, economic interests (developers, retailers etc.), 'friendly forces' and potential opponents

	Main Criteria	Key performance indicators (or elements for creating them)

Output: (institutional) products & activities	Land-use & modal integration	• **Land-use**
		  • Land-use: functional mix; mixture and density of uses
		  • Space allocation and distribution (e.g. green space, walking vs. other transport space)
		• **Distances, (macro-) accessibility & connectivity**
		  • Distances to amenities / provisions / destinations (‘walkscore’ / ‘walkshed’),
		  • Accessibility and connectivity (macro level)
		• **Modal integration**
		  • Integration of walking with other modes, especially with public transport, cycling, car-share
		  • Accessibility of facilities at interchanges

	Infrastructure & public space	• **Walking network**
		  • Length, density and extension of footpath network e.g. according to type/category: sidewalks, greenways/trails, other stand-alone footpaths, pedestrian areas, pedestrian priority areas, shared space
		  • Connectivity, permeability, detour factors, micro accessibility
		• **Space (unobstructed)**
		  • Space allocated to pedestrians and sojourners, e.g. sidewalk width
		  • Amount of open spaces, spaces to relax, to stop, sit and/or stand
		  • Size of designated clear path, unobstructed walkways (opposite: density of obstructions)
		  • Seeing distances, visual perspectives (vistas)
		• **Pedestrian scale buildings & usages**
		  • Type of ground floor usage / frontages (shops, cafés, etc.), diversity, uniqueness
		  • Dimensions of buildings and facades (human/pedestrian scale), quality; e.g. number or proportion of buildings with human scale front structures on street
		  • Proportions of building height to street width
		  • Aesthetics of buildings, e.g. allowing a sense of history and context (‘landmarks’)
		• **Quality of environment, provisions**
		  • ‘Green’ and ‘blue’ on the street, i.e. trees, green areas, (accessible) water, fountains etc.
		  • Micro-/climate moderation and protection: sun, heat, rain, wind
		  • Seats provided: formal (benches) or informal (ledges), or in outdoor cafés; arrangement of seats (conducive to watching and interacting with other people)
		  • Availability of toilets and other services
		• **Street lighting, security**
		  • Street lighting generally, pedestrian level street lighting & its quality: ‘warm’ light
		  • Windows facing the streets, ground floor shops light up (no closed shutters)
		  • Number of people & activities in street spaces at night
		• **Crossings / road danger (safety)**
		  • Number, location and quality of crossings: well marked, distances minimal, no detours (neither vertically nor horizontally)
		  • Traffic lights timed to needs of pedestrians: calculated crossing speed, waiting times
		  • Crossings and traffic lights equipped for mobility and sensory impaired pedestrians
		  • Street(s) with speed limit(s) lower than 30km/hr (20mph) or traffic calmed streets (e.g. proportionate to all streets); actual speeds driven (V85) above 30 km/hr
		  • Vehicles (illegally) parked obstructing space and overview for pedestrians
		• **Wayfinding (orientation and signage)**
		  • Orientation/navigation intuitively possible, ‘legible’ street design, clear vistas
		  • Wayfinding system in place for major destinations in area,
		  • Tools are easy to follow and consistent (maps, signage), ‘landmark’ orientation

	Main Criteria	Key performance indicators (or elements for creating them)
Output: (institutional) products & activities (continued)	Infrastructure & public space	• **Pollution & disturbance by motor traffic** ◦ Noise level: e.g. proportion of street length or population exposed to traffic noise above certain levels; or: percentage of population feeling disturbed by traffic noise (day/night) ◦ Air pollution: e.g. proportion of street length or population exposed to pollution above certain levels ◦ Intrusive motorized traffic: volume and composition of motorized traffic; number of on-street parking spaces in proportion to streets length or surface area • **Maintenance** ◦ State of good repair (no holes and other stumbling elements, lights functioning) ◦ Cleanliness e.g. negatively measured as waste left on the ground per m2, dog poop ◦ Snow removed from walkways and transit stops in winter time (degree, efficiency, time)
	Information, promotion & education/ enforcement	• **Information / communication** ◦ about services and offers by public authorities and private actors ◦ about achievement and improvements made • **Promotion and marketing** ◦ Number and scale of promotional activities for walking ◦ Incentives / reward programmes for pedestrians ◦ Efforts to create a culture of walking and a culture of respect and tolerance between users of public space / road users ◦ Media coverage of walking (& related issues) • **Education and law enforcement** ◦ Driver education and enforcement of rules e.g. re speeds, parking ◦ Education re infrastructure accessibility / design for all (e.g. for private investors) • **Co-operation with third parties** ◦ Programmes together with third parties, NGO's, civil society, private companies etc. (e.g. events, services, communication etc.)

	Main Criteria	Key performance indicators (or elements for creating them)
Outcome: Performance , behaviour & perceptions	Walking activity, mode share pedestrian volumes & activity in public realm	• **Walking activity / levels of walking** ◦ Daily walking trips (stages), distance and time walked per person (according to age, gender, social status etc.) ◦ Mode share of walking (in relation to other modes) ◦ People walking for exercise (leisure walking: hiking etc.) ◦ Walking levels/intensity contributing to physical activity (WHO recommendations ◦ Children walking to school (unaccompanied) • **Pedestrian volumes & density** ◦ Number of pedestrians per hour (according to day and night time, diff. seniors and kids and if they and if they walk alone) ◦ Density (crowdedness): number of pedestrians per meter street/path width (Fruin) • **Activity in the public realm; route choice** ◦ Number of people in public spaces, activities performed (according to age, gender, social status, type and activity, groups day and night time, are seniors and women by their own present; kids playing, recording if they are accompanied) ◦ Intensity of use: average number per 100 m2 ◦ Time spent in public spaces, type of night activities ◦ Route choice & flows • **Car-related information** ◦ Number of cars per household (share of car-free households) ◦ Short car trips (proportionate to all car trips; short = below 1km / 3 km)
	Accidents & threats (safety & security)	• **Road danger (safety)** ◦ Traffic accidents with pedestrians (involving at least one vehicle): killed and severely injured pedestrians (relative to population and time walked) ◦ Percent of users who witnessed directly or indirectly a traffic accident in the area during the last 5 years ◦ (Actual) speeds being driven by motor vehicles • **Single pedestrian accidents** ◦ Number of falling and stumbling accidents: Killed and severely injured pedestrians (relative to population and time walked) • **Security** ◦ Density of crime; threats, attacks, harassments ◦ Number of people on street at night (according to gender and age), type of night activities
	Atmosphere of space & culture of human interaction	• **Sociability & human interaction** ◦ Social aspects: sociability, social interaction, conflicts (people showing affections, spontaneous friendly interactions; eye-contact between strangers; smiles etc. but possibly also conflicts and hostile encounters ◦ 'Mood' of space created by users ◦ Culture of human interaction between street users, e.g. respect shown by car drivers towards pedestrians ◦ Number and type of local activities (flee-markets, concerts, etc.) ◦ Sensory aspects: sounds, smell, tactile impressions etc. ◦ Appropriation of space by users
	Perceptions, satisfaction & wishes	• **Perceptions & satisfaction** ◦ Personal satisfaction, happiness, comfort ‚measuring the smiles' ◦ Mental well-being, emotional responses in space • **Motivations & attitudes towards walking** ◦ Motivations and barriers to walking ◦ Attitudes and general image of walking, awareness • **Expectations & wishes** ◦ Expectations, hopes, wishes and visions; e.g. expected quality by user

	Main Criteria	Key performance indicators (or elements for creating them)

Bottom-line effects (benefits)	Economic effects	• **Individual economic impacts**
		  • Cost savings re transportation
		• **Collective economic impacts**
		  • Cost savings: e.g. in terms of infrastructure, health, accidents and pollution
		  • Increased efficiency and effectiveness of mobility
		  • More retail activity (shoppers)
		  • Less unemployment
		  • Possibly higher real-estate and rental prices (for shop owners, residents etc.) (=> adverse effects)

	Ecological effects	• **Individual ecological impacts**
		  • Smaller individual carbon footprint
		• **Collective ecological impacts**
		  • Energy savings (fuel) and savings of other resources
		  • Reduced pollution, CO2 emissions, carbon footprint
		  • Less climate change effects
		  • Reduced noise
		  • Reduced land-use
		  • Reduced severance (better connections for people and animals)
		  • Reduced sealed surfaces => more permeability, flooding prevention
		  • Increase of ecological diversity

	Social effects	• **Individual social impacts**
		  • More autonomy, independent participation in social life (children, people with disabilities, elderly persons etc.)
		  • People feeling socially more included
		• **Collective social impacts**
		  • Increased social inclusion, more community cohesion,
		  • More social equality; democracy: participation for everyone in social life possible
		  • More peaceful interactions, less criminal offences

	Effects on transportation (system)	• **Individual transportation impacts**
		  • Time savings
		• **Collective transportation impacts**
		  • Less need for transportation space
		  • Less congestion, higher efficiency
		  • Infrastructure cost savings

	Health effects	• **Individual health impacts**
		  • Mental health: improvements in mental well-being => less stress, more happiness
		  • Physical health: improvements in physical well-being
		  • People live longer (healthier)
		• **Collective health impacts**
		  • Lower health costs
		  • Fewer health inequalities

Emotions of the urban pedestrian: sensory mapping

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'…[...] suggests that designers, planners, and managers have control over the emotional experience of [park] users...'
Hull & Harvey, 1989 p. 19

Summary

The present pilot study explores the link between the urban environment and psycho-physiological arousal responses based on the idea that different urban spaces influence the emotional experience of individuals. The data was collected a) in a real-world situation by 30 participants walking a pre-defined path in the city of Lisbon, Portugal; and b) in real-time by a sensor-wristband measuring the participant's electrodermal activity (EDA) as an indicator of emotional brain processing. The calculated skin conductance responses (SCR) were compared with the arousal-eliciting environments of the path. Subjective emotional experience served as control measures. The results suggest that different urban settings have an effect on an individual's peripheral-physiological changes. Another result is that these changes can be feasibly measured in real-time experiments using wearable bio-physiological sensors and the applied methodology, therefore, serves as a tool for the qualitative measurement of walking.

1. Introduction

Hull & Harvey (1989 p. 19) come to the conclusion stated above because *"the significant relationship among preference and pleasure and arousal [...] suggests that the emotional quality of the park may have some influence on behaviour"*. How people feel has a huge effect on how people behave. Understanding more about emotions within cities is a central challenge for usable, accessible and sustainable modern cities in our time. An understanding of the city walker's emotions might enable us to optimize physical, mental and cognitive performance and the overall quality of living. It gives us hints regarding how to have better designs accommodating to the qualitative needs of pedestrians to support the greenest mobility possible.

To acquire information about the location of emotionally relevant places, one can draw upon specialists such as planners, architects or other experts in the field of urban sciences as part of a top-down planning approach. Nevertheless, these experts' knowledge is necessarily limited. As it is impossible for these professionals to identify all of a city's *emotional hot spots*, one solution could be to *let the user identify the emotionally important locations* as part of a democratic, bottom-up planning approach. This can be done with the help of mental-maps drawn by participants during interviews, etc. However, the relative value of such information is curtailed by the obvious problems of interviewer effects, memory effects as well as the conscious experience of feelings on the one hand and the high cost in terms of labour on the other. One means to possibly reduce these disadvantages is the use of reliable quantitative techniques by which the emotional reactions of individuals to their physical environment can be captured simultaneously in real-time.

It is clear that different environments provoke different emotional states (van den Berg & ter Heijne, 2005) Traditionally, the primary technique for assessing emotional states is subjective self-rating based on subject's recall - with all its known problems (Fahrenberg, 1996). Alternatively, one can draw upon psycho-physiological research which observes momentary emotional states as reflected in physiological changes - for instance in electrodermal activity. In a similar vein, Giuliani & Scopelliti (2009 p.385), in a recent review of empirical research in environmental psychology, argued for *“taking advantage of recent developments in neurosciences”.* Evidence coming from these disciplines suggests EDA as being a *“bodily window on the arousal dimension of emotion”* (Sequeira et al., 2009 p. 52).

The present paper demonstrates the results of a six-month final project exploring a methodology for a technique of qualitatively measuring walking. It combines the approaches taken by psychophysiology and ambulatory assessment with a new, emerging method of assessing space qualities. Therefore, the physiological indicator EDA, as an index of brain activity in relation to varying urban spaces, was measured outside of laboratory environments in real-time.

1.1. EDA and its potential as an indicator of emotional processing

Emotional responses manifest themselves on three levels or systems: (a) *physiological* - autonomic responses related to emotions and the brain structures and neural mechanisms supporting them, (b) *behavioural* - overt behaviours related to emotions, and (c) *cognitive* - subjective experience of the emotions. The specific physiological, behavioural, and cognitive patterns are manifested in order to adjust the behavioural repertoire of the subject to the demands of the situation (Sánchez-Navarro et al., 2008).

Neuroelectrical and behavioural expressions of arousal, indexed by electrodermal activity, could be a pertinent window to the body regarding emotional processes (Sequeira et al., 2009). Embedded in autonomic activity as a relevant body-brain interface (Mangina & Beuzeron-Mangina, 1996), neural studies clearly implicate EDA as a bodily window of reticular, limbic and cortical areas related to major mental components such as emotions, preparation to action and vigilance processes (Sequeira et al., 2009).

EDA fluctuation depends on variations in sweat secreted by eccrine sweat glands. These sweat glands are located within the hypodermis of the palmar and plantar regions and excrete through sweat ducts. The glands´ activity is under the control of sympathetic innervations which transmit influences from the central nervous system to the eccrine glands. Thus, EDA fluctuations are considered to be sensitive markers of events having a particular significance for subjects, mainly related to emotional, novelty or attentional fields (Sequeira et al., 2009). Eccrine sweat gland activity is also known as palmar, mental or emotional sweating (Asahina et al., 2003) as opposed to thermoregulatory sweating. The Skin Conductance Method is the international standard technique of EDA measurement (Boucsein, 1992) and was used extensively for more than a century in studying psycho-physiological reactions in mammals (Sequeira & Roy, 1997).

It is assumed that EDA is a good indicator of reticular activation (Sequeira et al., 1995) and seems to reflect the energetic dimension of behaviour and particularly of emotion (Hot et al., *2005)*, regardless of emotional valence (Sánchez-Navarro et al., 2008). The use of EDA amplitude as a suitable indicator of emotional arousal is illustrated by several studies on emotional pictures and emotional words (Sequeira et al., 2009; Silvert et al. 2004).

In other words, EDA reflects, apart from other autonomic adjustments, arousal elicited by both pleasant and unpleasant stimuli and therefore seems to have a strong correlation with emotional processing, which might be the underpinnings of emotional experiences. Before proceeding, it seems to be helpful to embed the concept of arousal into an emotion theory.

1.2. The arousal dimension of emotions

Following the evidence presented above, autonomic measurements have been proved to vary as a function of the affective valence and arousal of the stimuli. SCRs evoked by pictures and words increase when arousal is high and decrease when it is low, showing a positive relation to the valence and arousal ratings towards pictures and words.

These results can be contextualized into the "biphasic theory of emotions" proposed by Lang et al. (1993). This theory emerges from a motivational perspective pointing to emotion as a behavioural tendency of a subject to approach or avoid/withdraw from a stimulus. In accordance with this perspective, the biphasic theory states that emotions are organized in two motivational systems of the brain that respond adaptively to two basic types of stimulation, appetitive and aversive. All emotional expressions (overt and covert) are determined by the dominant motivational system in the subject and by the intensity level of such a system. Thus, according to this classification, emotions can be organized as pleasant/appetitive or unpleasant/aversive which constitute the first bipolar dimension of the model – the affective valence. As each motivational system mobilizes energy, and therefore varying levels of activation or intensity, the model establishes a second bipolar dimension – arousal – the poles of which are defined as calm and excitation. Taking in account these two orthogonal dimensions, a two-dimensional space is defined in which all emotions are located according to their valence and arousal (Sánchez-Navarro et al., 2008). A similar model is proposed by Russel & Mehrabian *(1978)* in which the affective valence is represented in the horizontal plane by a dimension ranging from ugly (displeasing) to beautiful (pleasing), and arousal is represented in the vertical plane by a dimension ranging from arousing (intense) to unarousing (numbing).

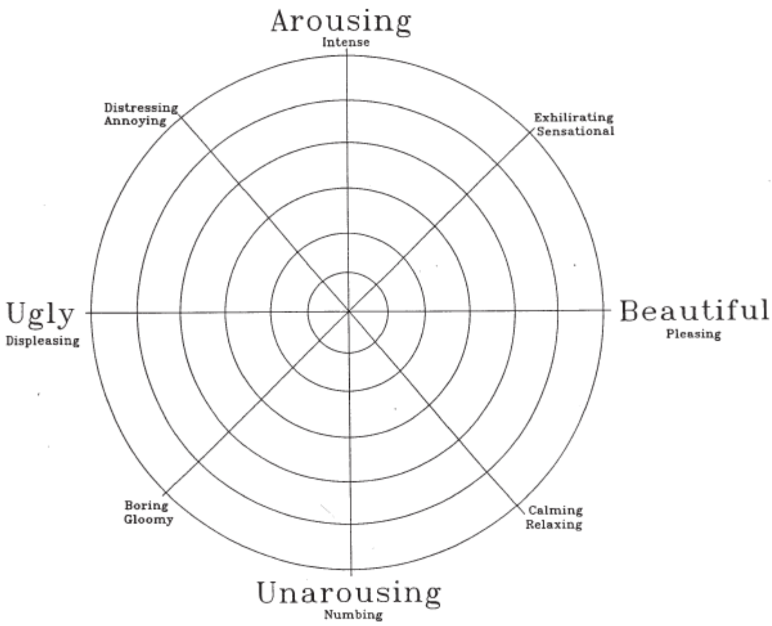

Figure 1 The Two Orthogonal Dimensions of Valence and Arousal

Having clarified the theoretical construct of EDA and what can be deduced from this indicator, namely someone's arousal state, we now precede to the approach of Ambulatory Assessment. Ambulatory Assessment is a relatively new emerging orientation to gain psychological data outside of laboratory environment.

1.3. Ambulatory assessment: real-time-, real-life-, real-environment research approach

Although the idea of measuring the arousal intensity towards different landscapes is not necessarily new, the methodological approach used here is. It is this distinction in which the presented study varies from traditional sensory mapping. Traditional studies that focus on the arousal-landscape relation are mainly conducted in laboratory environments presenting more or less virtually realistic landscape scenes (Aoki, 1999). One study shall be addressed concerning the traditional methodological approach to landscape and arousal. De Kort et al. (2006) investigated electrodermal activity and its relation to the size of a screen, as often used for the presentation of different types of landscapes. Their findings show that there are different effects on Skin Conductance Levels depending on screen size. Therefore the way the environment is presented to subjects does have an impact on person's psycho-physiological experiences. Another criticism of traditional data acquisition considers that reports, such as verbal reports, are often made from memory, a process that lowers the accuracy of such retrospective ratings. Further, a retrospective effect may exist as subsequent events and experiences may systematically influence and even distort the subjective evaluation and weighting of previous states.

Ambulatory assessment tries to break with these methodological concerns. It is a relatively new orientation in behavioural and psycho-physiological assessment with an approach which relates to everyday life observation. That means that research questions are investigated in real-life situations where relevant behaviour can be *"much more effectively studied than in the artificial environment of laboratory research"* (Fahrenberg, 1996 p. 8). The concept originated from a number of rather independent research orientations, whereas ambulatory assessment brings together those research approaches that correspond to each other in their basic ecological perspective. It involves the collection of psychological data and/or physiological measures in everyday life (i.e., natural settings). It is claimed that ambulatory assessment has outstanding practical utility for various objectives in many scientific areas, as empirical social research (Papastefanou, 2009) or psychology (Fahrenberg, 1996), including environmental psychology.

As a result of technical progress, wearable and mobile digital recorder/analyser systems are available that allow for multi-channel recordings and real-time analysis with the aim to overcome experimental issues of field study versus laboratory experiment. Both are alternative strategies in psychological research, whereas the latter approach is artificial. On the other hand, field experiments *"designates the multitude of real life settings where behaviour occurs naturally, e.g., without being induced by an investigator"* (Fahrenberg, 1996 p. 11) and therefore ambulatory assessment *"should provide an explicit assessment strategy"* (Fahrenberg, 1996 p. 14). Ambulatory Assessment provides a methodology which is suited to the precisely timed acquisition of behavioural measures, performance data, self-ratings or mood changes with the advantage of a higher reliability and ecological validity than traditional data acquisition.

2. Method

The experiment took place on a 2.8 kilometre distance route in the city centre of Lisbon, Portugal. As ambulatory assessment, in contrast to a standard laboratory environment, relates to specific settings or a sequence of settings in real-life situations (Fahrenberg, 1996), the route was designed by the investigator to possibly cross different types of potentially arousal-eliciting places, i.e. shopping zones, residential areas, landmarks, nightclub zones, junctions, station areas, park areas and business districts. The current subject's arousal state was measured by a wearable sensor-wristband recording EDA fluctuations. For the interpretation of the EDA data, specific characteristics of arousal-potential places are considerate to be treated as the independent variable even though independent variables were not controlled and a statistical analysis due to study's experimental design issues cannot yet be conducted.

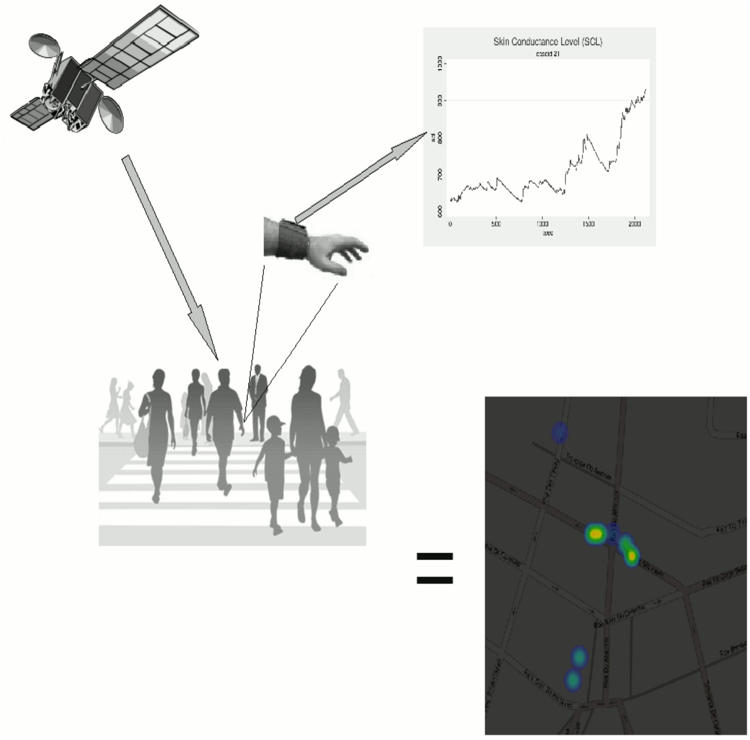

Figure 2 Creating an Arousal Sensory Map: Subject's Location is Captured by GPS-Signal; Psycho-Physiological Responses are Recorded by Sensor-Wristband

2.1. Subjects and devices

In the experiment, 31 participants walked the predefined pathway in the city of Lisbon. Subjects were 13 male volunteers (M = 28 years, SD = 3,6 years) and 18 female volunteers (M = 28 years, SD = 8,7 years); 15 walked the pathway from the north to the south, 16 subjects from the south to the north. The experiment took place in December '08 and the first week of January '09. Due to appointment time, every walk took place after 6 p.m. All subjects were instructed to walk the path from a certain starting point to reach an arrival point without doing any special performance during their walk. The run of subjects' walks was recorded by an i-Blue 747 Bluetooth GPS-Logger with an MTK GPS-chip *(© Transystem Inc.)*. The GPS-Logger was carried by the subject and recorded his or her location in 1-second intervals. The variations of electrodermal activity were recorded by a wearable sensor-wristband including an integrated data logger *(© bodymonitor.de)* with metallic electrodes (nickel-free zinc-coated brass) located near the wrist on the inner side of the forearm. The electrodermal activity was recorded at a 100 Hz sampling rate (10-bit resolution). A 1 gigabyte SD-card was used as memory storage, placed within the sensor-wristband. Before starting the walk, a calibration experiment was conducted with each participant to evoke a fearful reaction with the aim to gain a comparable value of personal SC-Response towards an uncomfortable situation. To evoke such a negative emotion, a balloon was blown up until it burst in front of the participants face (Boucsein, 1992; Lykken & Venables, 1971). The value gained by this means was used in the EDA maps to constitute a quantitative threshold of "fear" responses. Right before walking, the participant read a baseline story (reading time ca. five minutes) without any offending context. The objective was to affect a similar psychological load in all participants.

2.2. The retrospectively drawn sensory maps

As part of the study, subjects were asked to report on their emotional states after reaching the arrival point agreed upon during instruction. A ground plan of the navigated part of the city was presented to subjects on an A3-sized paper with the request to retrospectively colour locations according to their emotional experience during the walk. The relevant concerns regarding retrospective memories are discussed elsewhere (Fahrenberg, 1996). The experiences were sampled by two positively valued (interesting and comfortable) and two negatively valued (nervous and uncomfortable) emotions, each related to a special colour (e.g. uncomfortable situations were coloured blue). Figure 3 shows an example of one subject's drawn sensory map:

Figure 3 Retrospectively Drawn Sensory Map

On this basis, taking into account all subject-labelled spots of experienced emotions, the participants' maps were translated into a geographical information system (GIS) with the aim of designing one map for each of the four emotions mentioned above. As an example, one map for each of the two emotional dimensions (positive/negative) shall be presented below. The map on the left shows the route evaluated according to comfort, the map on the right shows the route evaluated according to discomfort.

On the basis of the results shown by these two maps, it can be inferred that participants experienced different feelings. Further, as the display size of the data reflects the number of people who identified a specific location as comfortable or uncomfortable, a greater number of people seem to have felt comfortable.

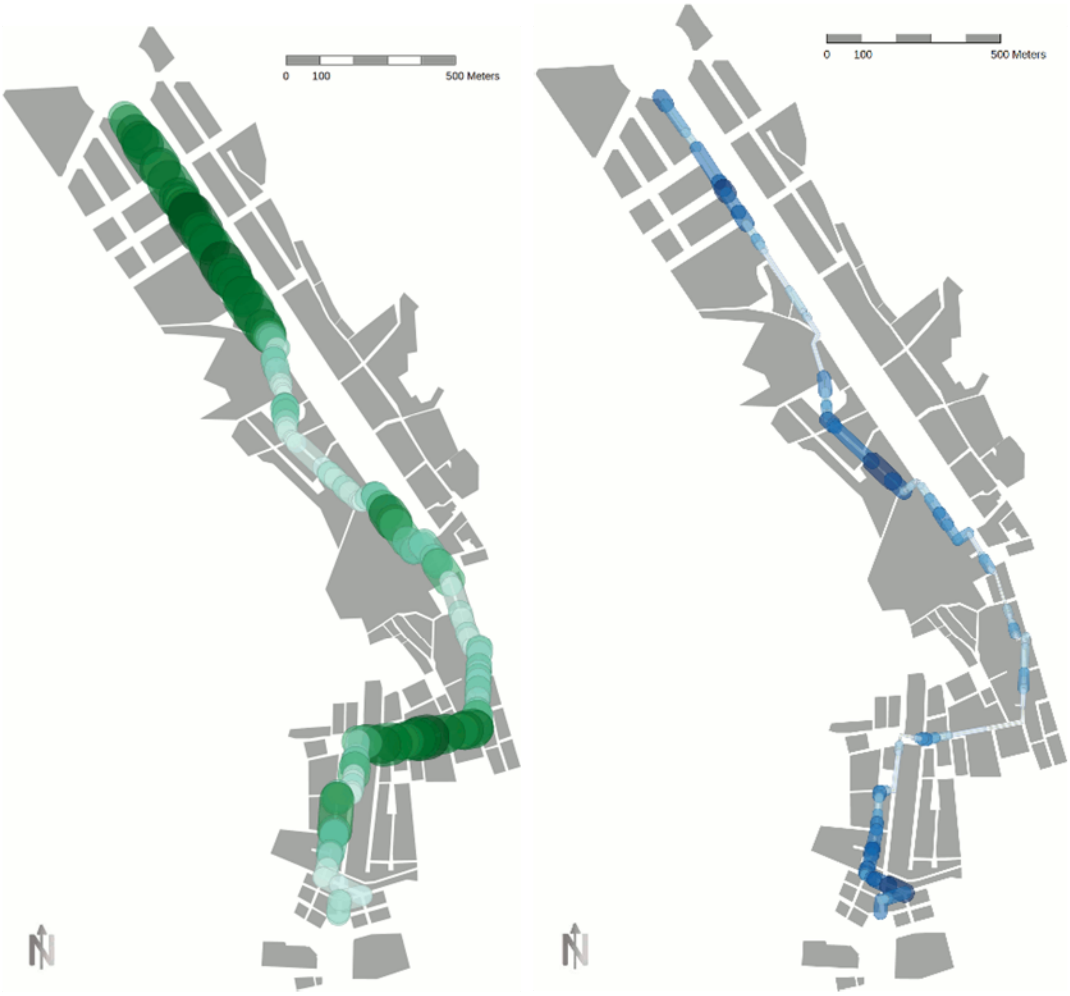

Figure 4 Retrospectively Drawn Maps; left: Comfortable Experience; right: Uncomfortable Experience

According to the study's design, we treated the experienced emotions as triggered by the urban environment. Interpretations as to what might be the trigger of these emotions for these particular map results cannot be discussed here. However, some distinctive feature differences of the two maps shall be mentioned. Different parts of the whole path elicited different emotions. This emotional variance differs in relation to urban space. For example, more people rated their walk through the pedestrian zone as comfortable; likewise, more people rated uninhabited and dark side roads as uncomfortable. Taking a closer look at one particular section of the path (e.g. the pedestrian zone; Figure 5), another difference appears: while the pedestrian zone taken as a whole elicited a comfortable overall experience, specific areas within it received an uncomfortable rating. In other words, the pedestrian zone is generally experienced as a comfortable space but seems to have some small-scale cues that are experienced as uncomfortable. The reason why this specific location is causing uncomfortable experiences might be explained by its characteristics: it is a crowded part of the pedestrian zone with a complex arrangement of features, with the metro's entrance and a café's seating accommodations extend into the walkable area and hence complicating wayfinding at first glance. According to findings of environmental psychology, the attributes of crowding (D'Atri, 1975), complexity (Nasar & Hong, 1999) and difficulties in way-finding (Hull & Harvey, 1989) operate as arousal-eliciting stimuli and therefore could influence someone's emotional experience.

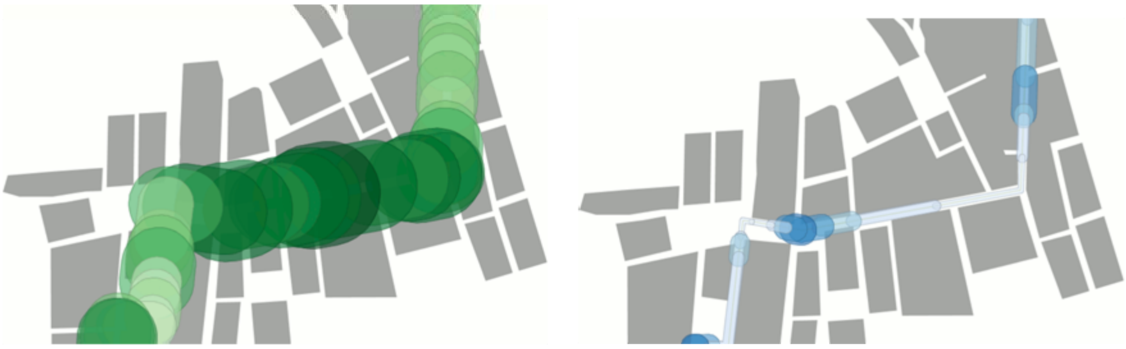

Figure 5 Retrospectively Drawn Maps Showing Experiences in Pedestrian Precinct; left: Comfortable, right: Uncomfortable

Apart from interpreting the above findings in terms of environmental configuration, it should be noted that retrospectively described processes may be criticised as being imprecise. It might be the case that a subject relies upon a personal global memory of zones, leading to an evaluation of a zone as being overall comfortable, instead of memorizing emotions triggered by specific stimuli at a specific place. The reason why a specific location still appears (as seen in the right map of Figure 5) might be explained by people having been more aware of emotional experiences. Nevertheless, it could also be as trivial as this location having only affected a few subjects. Taking into account the characteristics of the indicated setting, the author suggests, in accordance with evidence coming from environmental psychology (D'Atri, 1975; Nasar & Hong, 1999; Hull & Harvey, 1989), at least an arousal-eliciting potential of that specific location.

2.3. Emotional arousal maps

Figure 6 shows the typical results of a subject's EDA recordings while doing the walk. The graph shows the Skin Conductance Level (SCL) over time calculated as the reciprocal value of the skin resistance-data measured by the sensor-wristband. The different segments of an ideal run of the EDA-curve can be seen clearly, with the increases (also called Skin Conductance Responses (SCR)) as indicators of heightened sympathetic nervous system arousal and the decreases as indicators of less or no sympathetic nervous system arousal respectively recovery-time. As one first finding, it can be observed that measuring people's arousal trajectory in real-time/real-world environments with wearable bio-physiological sensors generates laboratory-comparable data (for comparable arousal trajectories, see Boucsein 1992).

The Figure 7 presents the SCR data calculated from the positive and negative gradients of the SCL-data trajectory. The following can be seen:

- stronger SC-Responses (SCR-value > 0)
- weaker SC-Responses (positive SCR-value tending towards 0)
- recovery-time (SCR-value < 0)

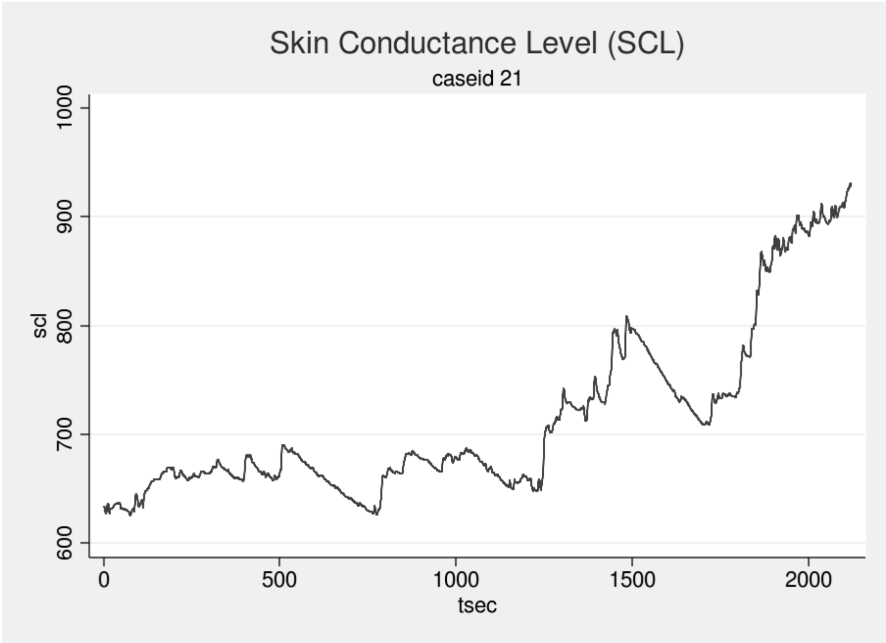

Figure 6 Skin Conductance Level

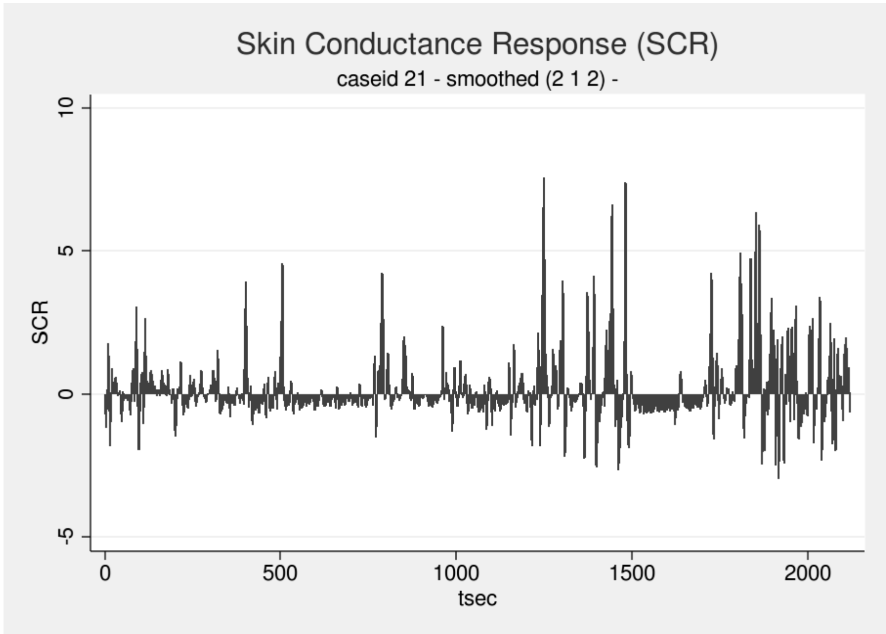

Figure 7 Skin Conductance Response (z-scored)

Based on this calculation, in what follows, only the SC-Responses (SCR ≥ 0) were taken into account. Taking the subjects' SCR and location data into consideration, sensory maps for each subject were designed. This was done by using an on-line geographical information system *(© Universal Mind, Inc., 2009)*. Figure 8 shows a part of a subject's arousal trajectory in the south of the pathway at its most detailed zoom factor limited by the on-line GIS. The gained calibration value of the balloon experiment was incorporated into the illustrated SC-Responses by only colouring those responses that are equal or higher than the balloon fear value by a colour gradient from yellow to red. Weaker responses appear as bluish spots. These arousal maps were calculated for each subject throughout the whole path.

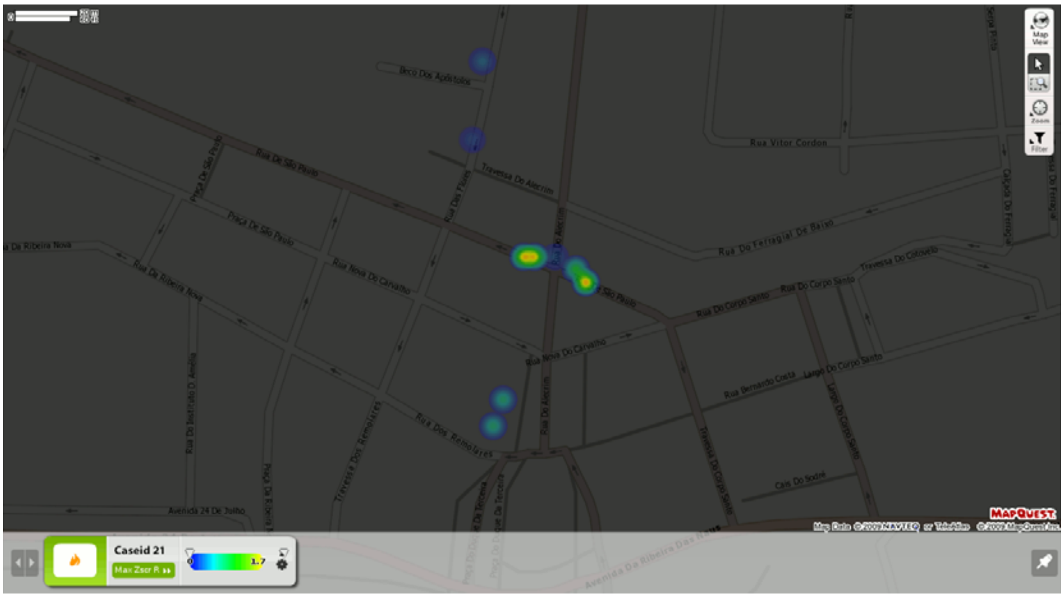

Figure 8 "Arousal Spots" of CaseID 21; Visualizing the SC-Responses in the first 130 Seconds (as seen in Figure 7)

2.4. Drawn map versus emotional arousal map

Following Fahrenberg (1996), ambulatory assessment provides more reliable (or at least similar) results than retrospectively made assessments. Therefore, we have taken a closer look at the comparison of the drawn versus the arousal maps. As an example, Figure 9 shows the retrospective drawn map of CaseID 16 compared to its arousal map.

It is apparent that the arousal map has a lot of information in common with the drawn map. The map on the left side shows the feelings of CaseID 16 as experienced during the walk. The map on the right side shows CaseID 16's autonomic activity. What seems particularly striking is the fact that the negatively rated experiences on the left map (indicated by the red lines in green circled areas (red stands for “nervous”) have an autonomic counterpart on the right arousal map. From this, it seems likely that emotional experiences, as recorded in retrospective ratings, are accompanied by physiological reactions recorded by measurement of electrodermal activity and indicated by Skin Conductance Response. For a deeper analysis of the phenomena shown above, the following part will discuss two sections of the negatively-valued drawn maps with corresponding arousal maps.

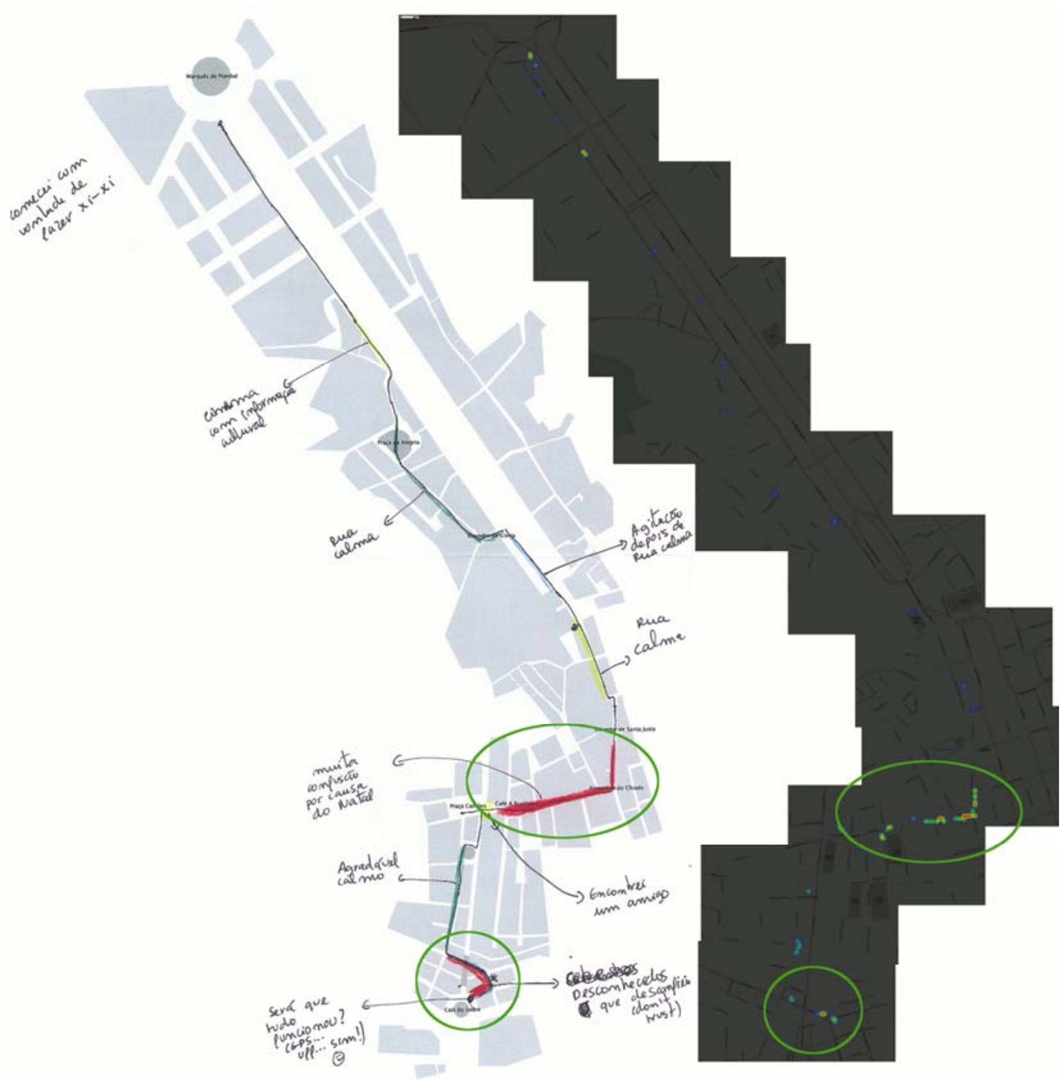

Figure 9 Comparison of Drawn Map (left) and Arousal Map (right)

3. Reactivity of SC-Responses to urban design ─ A detailed view of comparison

The graphics below show locations where people's autonomous activity is matched with an accumulation of negatively rated spots. Three examples of such matches are presented below. In the illustration, the map on the left shows the *nervousness* map for all participants, the two in the middle are the *arousal* maps and on the right accumulated *uncomfortableness* map is shown. For interpretation purposes, the attempt to explain the arousal eliciting potential of indicated locations is supported by panorama photographs.

3.1. Example I

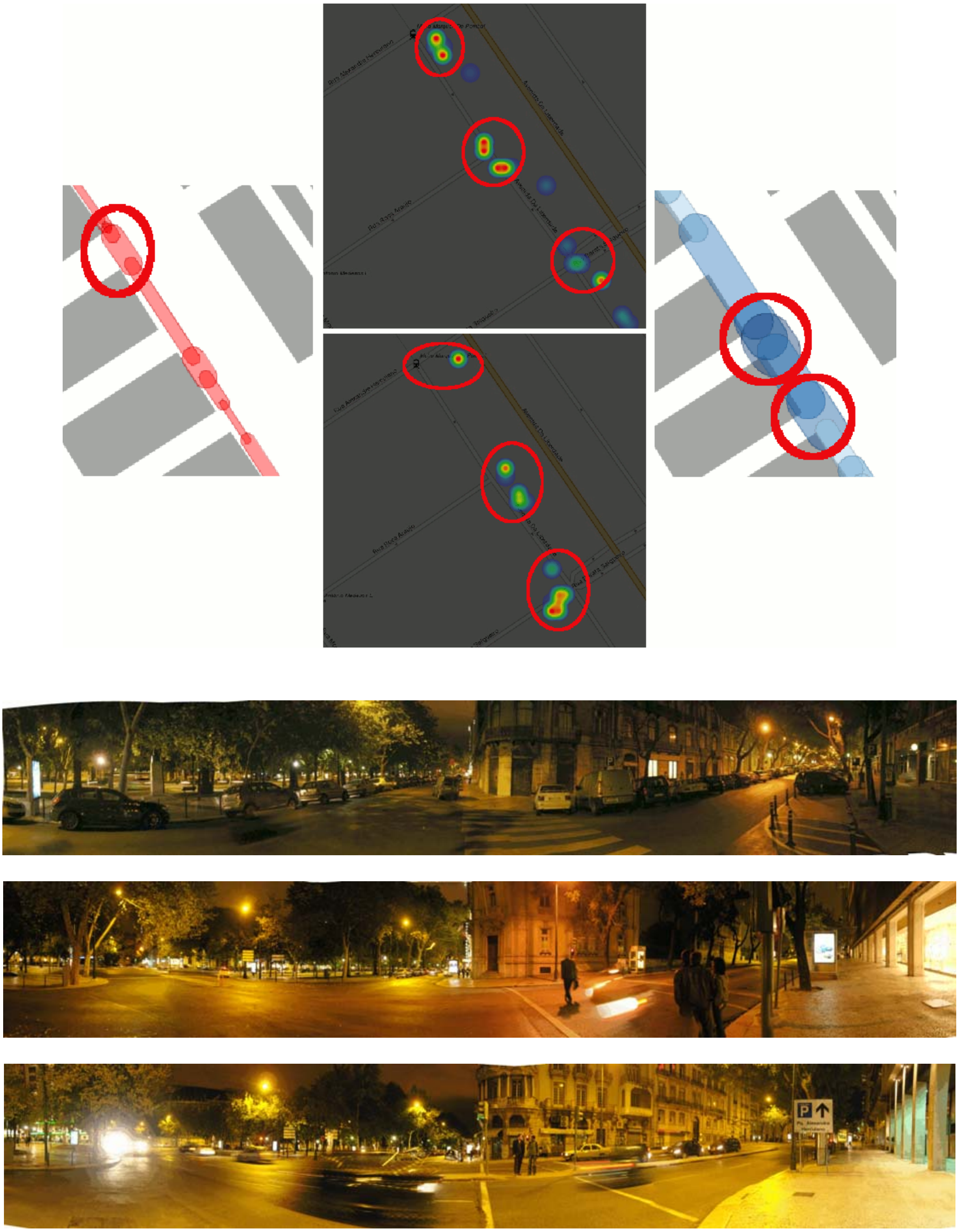

Figure 10 Arousal Spots on Drawn Maps and Arousal Maps with Corresponding Panoramas (I)

The drawn maps indicate the existence of three locations where the number of people that valued them as being nervous or uncomfortable increases. These locations are marked by the red circles. Comparing the arousal maps of these locations, an interesting correlation appears: the three locations, as marked on the drawn maps, seem to have an SCR-counterpart at exactly the same locations in the arousal maps. As can be seen in the panorama photographs above, all of the three locations are intersections with high-velocity car traffic which obliges the participant to stop for crossing reasons.

3.2. Example II

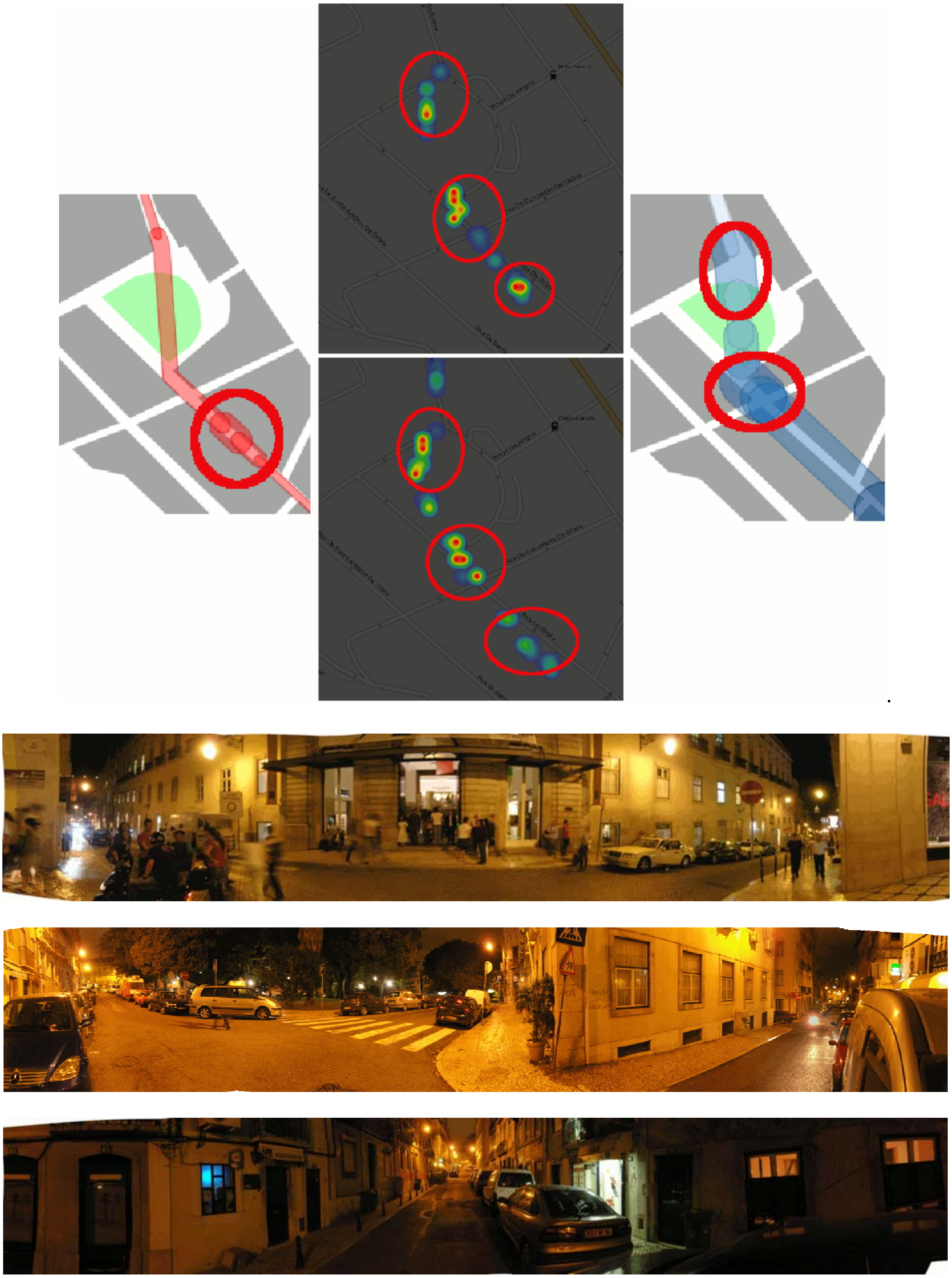

Figure 11 Arousal Spots on Drawn Maps and Arousal Maps with Corresponding Panoramas (II)

This comparison shows a replication of the finding in the section above. A similar match between the drawn and the arousal maps appears. The arousals illustrated in the first two panoramas each seem to be triggered by an intersection with crossing motorized transport and line-of-sight obstruction through parked cars, whereas the third spot may arise from the brightly lit store front (right part of the panorama), likely as a novelty compared to the previous walk throughout a sparsely illuminated street.

3.3. Example III

Figure 12 Arousal Spots on Drawn Maps and Arousal Maps with Corresponding Panoramas (III)

Once again, this example shows locations that have corresponding markers in both the drawn and the peripheral-physiological maps. The first location (first circle from right to left; first panorama) is a mix of a highly frequented shopping mall entrance and an intersection of motorized traffic. The next two circles again (second + third panorama) show traffic intersections. The fourth spot (fourth panorama) then shows a bustling part of the course where the space and people are influenced by a café's seating-accommodation extended into the walkable area and the entrance of a metro station.

It is not possible to show all of the arousal spots in this paper, but the trend is obvious: autonomous activity seems to be elicited at locations that have specific significance for subjects. By visual examination of all arousal maps, a high percentage of the indicated arousal spots are exhibited at intersections where the pedestrian comes into conflict with other space/road users. This result is in agreement with Nold's findings on arousal and motorized traffic (Nold, 2009). The minor part of all exhibited SC-Responses seems to deal with novelty or other cognitive orientation responses. Novelty (Delplanque et al., 2009), for example, seems to influence brain processing while passing by a location that differs from a coherent arrangement walked through before. Cognitive or orientation processing might be reflected in the EDA-data when a person comes to an environment that demands attention, for example in maintaining wayfinding (Hull & Harvey, 1989; Heath et al., 2000; Hietanen & Korpela, 2004; Kaplan, 1987) or entering a highly complex scene (Kaplan, 1983), and therefore demands higher cognitive load to understand and interpret the environment.

In agreement with Sequeira et al. (2009), the appearance of arousal spots seems to be highly correlated with emotional responses. Following LeDoux (2003), the fear reaction, amongst other emotions, is crucial in ensuring a person's survival by helping to avoid life-threatening situations. Transferring this argumentation onto the major part of arousal eliciting situations indicated in this study, one could easily imagine that survival might be threatened at intersections with car traffic. In other words, the brain detects this threatening trigger, which therefore activates the fear processing system in the brain. LeDoux (1999) show strong evidence for the amygdala being a central brain structure involved during fear processing. As described earlier in this paper, activation of the amygdala, as a part of limbic areas, is one of the events indicated and assessable by EDA variations. By (a) the theoretical consideration of crossing an intersection being a possibly life-threatening situation, (b) the assumption of the amygdala being reactive to fearful situations, and (c) the capacity of EDA variation reflecting amygdala activation, the author suggests a high correlation of SC-Responses and fear inducing situations.

Another possibility of interpreting the measured EDA data (which have not yet been further investigated) that might have a lot of informational value for urban design shall be addressed in the following via the presentation of some raw data. A graphically edited participant's walk shall exemplify this consideration (Figure 14).

4. Reactivity of SC-Level to urban design ─ Theoretical considerations

As described earlier, the EDA data implies two types of information – the Skin Conductance Level (SCL) and the Skin Conductance Response (SCR). These two constructs themselves provide different information regarding one's personal state: SCL refers to the tonic and prolonged level of activation whereas SCR refers to the phasic sympathetic nervous discharges that can be used as indicators of short-term brain processes. As for the localization of arousal spots above, where the SC-Responses as indicators for reactions towards an external trigger were used, in the following the focus will be on the SC-Level. Before preceding, the influence of phasic sympathetic nervous discharges on SCL and its consequences for interpreting the SC-Level shall be taken into account.

As described above, brain processes can be assessed indirectly through EDA measurement by variations in sweat secretion. In other words: certain brain processes lead to a higher sweat production that, in turn, results in a higher sweat level within the sweat glands. This occurrence is one factor for the "filling" of sweat ducts. The other factor, influencing the level of sweat, is the natural evaporation, or absorption, of the excreted sweat. These antagonized "forces" have an influence on the characteristics of the Skin Conductance Level. The following illustration depicts these effects on SCL:

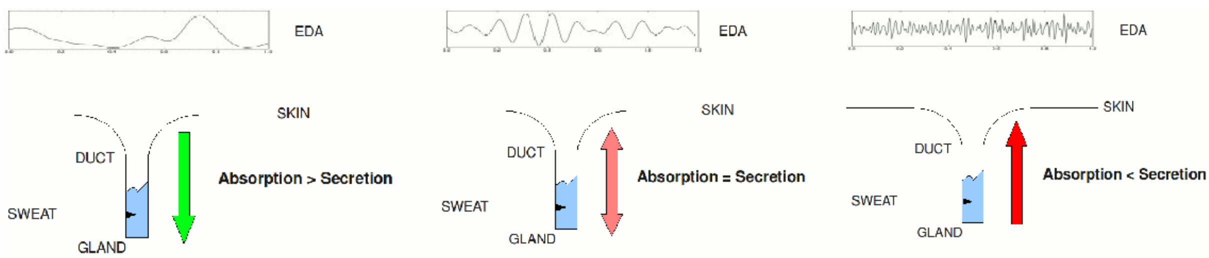

Figure 13 Three Characteristics of SCL development

The illustration shows three different possibilities of how brain activity influences SC-Level. In the upper part of the illustration, one can see different EDA trajectories with few SC-Responses in the graph on the left and many SC-Responses in the graph on the right. The EDA trajectory in the middle is somewhat between a few and a lot SC-Responses (a SC-Response can be identified by a trajectory's peak). The lower part of the illustration shows a simplified sweat gland and the brain's processing impact on its sweat level. The left case shows some rare brain activity patterns in the EDA, which means little sweat secretion. As the absorption of the sweat is higher than the secretion, the SCL-values are decreasing which is an indicator of recovery (Boucsein, 1992) or tranquillisation. The illustration in the middle shows some higher EDA activity. The brain is employed with processing activities that lead to the secretion of the same amount of sweat as that being absorbed. Both "forces" (of absorption + secretion) seem to cancel each other. This means for the EDA trajectory showing a constant SC-Level. Tentatively, this can be interpreted as a state of steady but moderate activation. The third graph (on the right) illustrates the category of large brain activity. In this case, the sweat glands secretion rate is higher than the absorption rate. The SC-Level increases and this state can be interpreted as being highly activated or aroused.
Summing up, the SCL developing of values provides at least three different analysis options: (1) recovery, (2) moderate activation, (3) high activation. Transferring this model to a participant's walk yields to the following result:

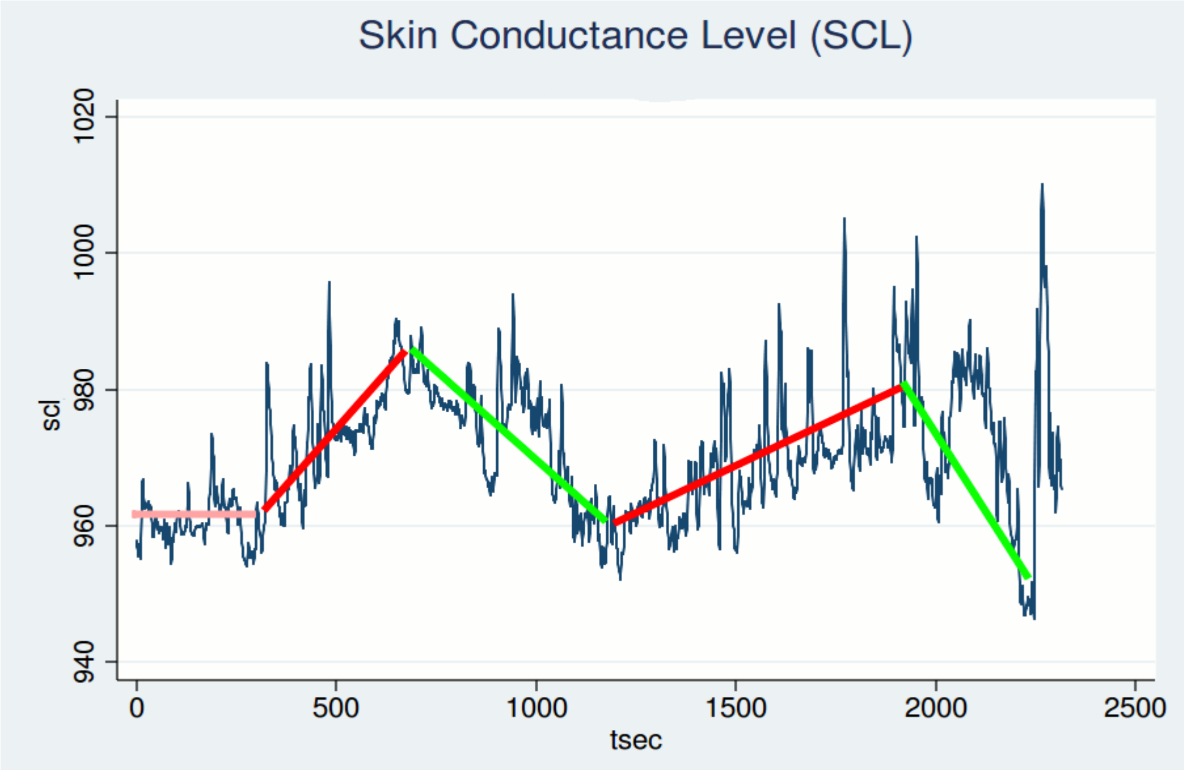

Figure 14 Different Arousal States; rosa: Moderate Arousal, red: High Arousal, green: Recovery

The graph shows a participant's SC-Level course over the time of walking (tsec) and its SC-Level values (scl). The colours used in this illustration (Figure 14) correspond to the colours used in Figure 13; i.e. *green* reflects tranquillisation, *pink* moderate activation and *red* high activation. One can clearly see that the person underwent different states of activation. Beginning with a five minute moderate activation level (sec 0 - 300), the course exhibits a high activation episode from tsec 300 to tsec 650, followed by a section of tranquillisation from tsec 650 to tsec 1200, and so on. These sections are ca. 500 meters. This extension of space could be enough to find landscape design principles to predict user behaviour. In the present case, the two tranquillisation sections are calm side roads with rare and slow traffic, low in noise exposure and without many disruptions hindering the continuity of walking. These results are in line with many authors about *restorative environment concepts* (Hartig et al., 2003; Kaplan & Kaplan, 1989; Herzog et al., 2003; Ulrich, 1986; Hartig, 2004), which is the *"process of renewing physical, psychological and social capabilities diminished in ongoing efforts to meet adaptive demands"* (Hartig, 2004 p. 2).

5. Conclusion

Everyone is familiar with the idea that walking in different urban spaces evokes different emotional reactions. Many professionals are interested in locating these emotion-evoking urban spaces and getting answers as to *why* these locations trigger emotional reactions. With the progress of technical devices, the present study tries to apply the latest wearable bio-sensor technology as a tool for investigating emotional reactions towards landscape architecture. The method employed peripheral-physiological measurement for momentary *quantification* and a GPS-Logger for momentary *localisation* of emotional arousal. One purpose was to explore whether technical devices in real-time experiments can reproduce emotional arousal towards certain urban environs.

As a first result, the data strongly suggest that locations related to specific emotional significance can be measured reliably by recording a person's EDA variations while walking. In other words, EDA measurement in combination with positioning systems seems to have the ability to serve as a tool for indicating emotion-related locations. On the basis of examinations, the arousal spot maps seem to have more in common with the negatively valued maps. A greater amount of indicated spots appears to be more likely at emotionally negative arousal locations. Therefore, the author suggests a methodology – by considering SC-Responses as the object of investigation – as a tool for indicating urban environments which are more likely to be negatively experienced, even though locations of novelty and cognitively demanding situations seems to be reflected in SCR data. Nevertheless, one should bear in mind that no statistical control was conducted so far and the correlation presented here is the result of visual data exploration. A further critique is in regards to the author’s interpretation of arousal spots – a more precise investigation of the specific characteristics of arousal spots is needed. This may lead to a more concrete conclusion of SCR measurement as an indicator of negative or positive emotional arousal. Another possible contribution to a deeper understanding of landscape design is the usage of SC-Level. As described above, the tonic level of EDA measurement shows the shifting of activation states over time, varying as a function towards different urban spaces. Episodes of high and low activation can clearly be distinguished. Therefore, the author suggests the methodology as a tool not only for investigating the arousal-eliciting triggers of specific locations (such as intersections) but also for gaining numeric information about the affective impact of different landscape settings.

So, what is the use of a *“technology that can record, visualise and share with each other our intimate body-states”* (Nold, 2009 p. 3)? Nold, who can be considered the originator of the device used in this study, stressed his vision of usage as a *“reflexive and participatory methodology”* (Nold, 2009 p. 4). Nold, who has carried out 'Bio Mapping' since 2004 involving thousands of participants in over 16 countries, describes his experiences with the tool as follows:

> *“Once I started to work with local community organisations for longer periods of time and in less central town areas, where people lived in and cared about (and not just worked or shopped), the annotations changed dramatically. Instead of being just about their momentary sensations in the space, participants told stories that intermingled their lives with the place, local history and politics. The discussion often followed a trajectory of noticing the bodily effect of car traffic on one person's emotion map, often leading to discussing the lack of public space and identifying its social and political causes. This progress of scaling-up and seeking connections between issues encouraged people to talk both personally and politically in a way they had often not done before with other local people.” (Nold, 2009 pp. 6-7)*

Following this observation, the device seems to be a tool of *integrating bottom-up participation into the planning process* (Höffken et al., 2008), or as Craik & McKechnie *(1977 p. 155)* stressed: *“The increasing participation of the general public in broad environmental policy formation requires an expansion of the research focus to include non-professionals as well.”* By integrating non-professionals into the planning process, planners might gain insight into how pedestrians experience their city and therefore *gather important information about the (designed) configuration of urban space*. The device's data suggests that the methodology is likely useful for (1) identifying arousal spots (by considering the SCR values), mostly correlated to a low amenity of places, and (2) gaining information about one's more general arousal reactions towards different urban settings, possibly being interpreted as zones of recovery and alertness, respectively. The device can be easily applied on large groups of people and therefore provides an *efficient and financially economical* tool to support decision-making. Further, to understand behaviour towards the environment, Evans & Eichelmann (1976 p. 87) emphasize a *“considerable need for longitudinal multivariate, exploratory analysis of the nature of the human-environment interface”*. The sensor-wristband's easy-to-wear design and its large capacity of memory storage could be aspects which help to achieve that purpose.

The presented approach of measuring walking offers a simple and efficient application of *extensive pedestrian data collection and analysis*. On the one hand, the GPS logger provides travel behaviour data that can be used to analyse walkers' activity and time spent in public spaces. On the other hand, the wristband sensor provides emotional arousal data that can be used to analyse walkers' emotional experiences. Therefore, the presented methodology offers a *quantitative* and *qualitative* technique for measuring walking. As the exploratory analysis of the data shows, the evidence that the EDA-variations correlate with different urban environmental settings seems to be strong and hence the approach provides environmental assessment in real-time/real-world. The EDA reacts to the walking environment, accessibility, public space quality, infrastructure usage, space avoidance, safety issues and spatial usage conflicts. As it could be argued that most of the mentioned factors could potentially elicit arousal in all humans, the approach could serve as a *benchmarking tool* for comparing walkability in different cities. Another benchmarking approach is the comparison of different settings, such as park vs. different built environments, walking in car-dominated areas vs. pedestrian zones, noisy versus quiet, etc. As an overall conclusion, the latest sensory mapping technology might be a tool to understand how to make cities better.

In closing, the author would like to turn the reader's attention to the *What's not counted doesn't count* issue in which the employed methodology might have a great impact on landscape planning:

> *"It should also be pointed out that compared to studies based exclusively on intuitive or subjective procedures, investigations utilizing physiological or medical measures have been very much more successful in motivating governmental action and public concern regarding environmental quality. It is therefore possible that human-environment research using physiological measures will prove to carry greater weight in planning and decision-making contexts, and be more effective in terms of implementation." (Ulrich, 1981 p. 5)*

6. Recommendations

Further research is recommended. This recommendation applies to data analysis as well as to subsequent study design. As stated above, statistical verification to support the author's drawn relationships is needed. As the study so far only focused on the emergence of SC-Responses, *patterns* of SCR and SCL have not been taken into account. SCR-patterns, as duration or magnitude, might provide further information about different space qualities. It could be hypothesized that longer SCR duration are elicited when a situation or location demands more attention – a process which might have influence on emotionality. Similarly, as only SCR was investigated, the SC-Level trajectory might also provide information about subject performance – SC-level's increasing/decreasing time patterns provide information to discriminate different, e.g. anxiousness eliciting or restorative, settings.

Apart from a critique of general methodological concerns (e.g. the possibility of emerging consecutive effects), subsequent research design should be directed at advancing stimulus identification. To achieve this aim, the methodology could be expanded with other measures. These could include a camera to control subject's viewing direction, a microphone to record noise level and personal statements on actual situations, measurements for surrounding density as well as illumination. The necessary technical equipment - small and high-quality - is available for future integration. Finally, multivariate and multilevel approaches of autonomic activity measurement *"may facilitate the identification and development of autonomic markers of affective and cognitive processes"* (Sequeira et al., 2009 p. 52).

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Architectural and urban atmospheres.
Shaping the way we walk in town

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Summary

This contribution contains the results of a qualitative research funded by France's National Research Agency (ANR) on walking in towns. Research focussed on two cities: Geneva (Switzerland) and Grenoble (France). Starting from a simple question – what prompts us to walk in town? – and an innovative methodological protocol, we call "the three-person walk" – the author queries the implicit relations between the act of walking and atmospheres. How and to what extent do architectural and urban atmospheres affect our decisions when walking in town and influence a pedestrian's gait? By constituting two lexicons – one describing sensory configurations that are more or less favourable to walking, the other describing the types of relation possible between pedestrians and the city – the author makes two contributions to the debate on urban walking: first, that there are many ways of walking; and second, that we adapt our gait to suit architectural and urban atmospheres.

1. What makes us walk in town?

With environmental concerns the focus of much debate, walking is becoming increasingly popular again, both in France and all over Europe. In the ideological battle with cars, urban walking has several obvious advantages: it consumes little energy and occupies less space, it is healthy, and it sustains social links. Despite this favourable evaluation, the amount of urban traffic made on foot is far less than that made in motor vehicles. Though we need to ask why, we also need to understand what makes us walk in town.

Some engineers, transit-economists and policy-makers cite circumstantial or structural reasons to explain the low amount of urban traffic made on foot. Geographers and town planners prefer to focus on the determining factors for urban walking, highlighting the influence of urban morphology on modal choices. Whatever their merits, both working perspectives all too often reduce the act of walking to its motive, restricting research into the conditions that make walking possible to merely the built or developed qualities of towns. Our approach differs from these two lines of research. First, we consider walking as a social, sensory and plastic act. Walking in town brings pedestrians into contact with others, requires them to deal with bodies in movement and their proximity, anticipate eye-to-eye contact and so on. All these constraints implicit in walking, apart from those imposed by urban design, demand, on the part of the pedestrian, a number of navigation techniques (Ryave & Schenken, 1975; Livingston, 1987) and body techniques (Mauss, 1954). When we glance forward to anticipate the presence of a crowd, slide a foot across the ground to gauge the slope, or even dodge slightly to one side to avoid a crowd, we are indulging in forms of movement that make travel on foot possible. Secondly, we assume that urban and architectural atmospheres impinge on modal choices and the way we walk in public spaces. With its tightly packed or empty places, the activities it accommodates, and its materials, a town maps out spaces of visibility, listening, touching and so on, that may be plural, contrasting and changing. These urban and architectural atmospheres shape and modulate the way we walk as much as urban morphology or spatial design. Furthermore, they contribute to the existence and expression of different ways of walking in town: *"walking is (…) often described as a unique form of locomotion and then contrasted with running; but attentive observation reveals that there are several types of walk, that the graduation between them is not continuous, but rather that each one his is own particular intensity"* (Morris, 1978). From this point of view, the quality of urban design is probably not enough to encourage us to walk in town. We need to explore the capacity of architectural and urban atmospheres to affect modal choices and shape multiform ways of walking.

This proposition was the focus of a qualitative Franco-Swiss research action recently funded by the National Research Agency (ANR)[1]. Teams of sociologists, architects and town planners observed *in situ* the real walking practice of pedestrians. The work was guided by two assumptions. The first assumption posits the existence of heterogeneous, variable ways of walking in town depending on sensory contexts: walking is not a generic category of travel on foot (Thibaud, 2007); it varies in its form, pace and expression as a function of architectural and urban atmospheres (Thomas, 2004, 2007). The second assumption posits the existence of operational relations between walking and atmosphere: the nature of the relations established, by walking, between a pedestrian and the city may well impact modal choices. This means we must qualify such relations and understand how and in what respect architectural and urban atmospheres can work as triggers for walking in town (Thomas, 2008).

The present article is divided into three parts. After reminding the reader of the methodology used for the purposes of this research action and the locations where it was deployed, we present two of the main results of our analysis[2]. The first result concerns the constitution of an exploratory lexicon describing a number of "sensory configurations" that are favourable or unfavourable to walking. The second hinges on the attempt to qualify "walking situations", describing the nature and intensity of relations between pedestrians and architectural and urban atmospheres.

2. The three-person walk[3]

This project required innovative methodological protocols, the purpose of which was not only to avoid disassociating the subject of research from empirical techniques but also to establish a dialogue between the accounts of heterogeneous pedestrian routes. In this respect, it meant "setting out on foot" in the field, observing and experimenting various ways of walking in town in the company of pedestrians (alone or with several others, strolling, passing through, hurrying, etc.) in order to gain a better grasp of the processes at work in

[1] Research was coordinated by Yves Winkin, Deputy-Head of the Ecole Normale Supérieure Lettres et Sciences Humaines in Lyon. The results presented here are taken from the work done by the Cresson team: Thibaud Jean-Paul (ed.), Bonnet Aurore, Leroux Martine, Thomas Rachel (2007). "Les compositions de la marche en ville", Contribution by the Cresson team to the final report, Winkin Yves and Lavadinho Sonia (ed.), Des villes qui marchent, tendances durables en urbanisme, mobilité et santé, Projet ANR SEST 05 019, Final report, Université de Lyon, ENS-LSH, 113 p.; Intermediate report, Cresson, volume 1, January 2008, 105 p.

[2] This article reports on the work of the Cresson team as a whole, but the two results refer more specifically to analysis by Rachel Thomas concerning the establishment of exploratory registers for "types of walk", "walking describers" and "walking situations".

[3] For a detailed presentation of this methodological protocol, see: Thibaud, Jean-Paul (2008). Je-tu-il, la marche aux trois personnes in *Urbanisme*, n° 359, March-April, pp. 63-65.

pedestrian movement, the tiny modulations to which walking lends itself and the sensory “affordances” (Gibson, 1986) underpinning it. To this end, an innovative methodological protocol was tested in four districts – two in Grenoble (France) and two in Geneva (Switzerland): the “three-person walk”. This new methodology – proposed by JP. Thibaud – is based on the articulation of three complementary approaches which all give meaning to the subjectivity at work in the practices of city dwellers, and to the community of perceptions and feelings underpinning them.

2.1 Walking in the first, second and third-person singular – I, you, he or she

In the first-person (“I-walk”), the researcher is immersed in the study zones taking photographs at whim for half a day. He or she walks freely, without previously defining a route, drawn onwards by the terrain and atmosphere. A dictaphone is used to record passing impressions, in conjunction with a digital camera to fix noteworthy events, situations or vistas. Once this non-directional walk is complete, the researcher produces a summary document in which the narrative and photographs bear witness to the route as it was perceived and felt. The middle column in the table contains all the comments and photographs collected *in situ*. The right-hand column isolates the various elements brought into play while walking for each place. The classification of these elements into three categories – built, sensory and social – refers to the three dimensions of the urban environment that shape pedestrian practice: architecture and urban design; architectural and urban atmospheres; forms of public sociability. Lastly, the left-hand column contains a lexicon of ways of walking in town. It was obtained by cross-referencing data analysed in the other two columns.

QUALIFICATION OF WALKING	REFERENCE TEXT PHOTO ILLUSTRATION	ELEMENTS BROUGHT INTO PLAY BY WALKING
SHOP FRONT STROLL (Along the Cours) - Stroll, without hurrying, but marked by pedestrian vigilance, the need constantly to avoid bumping into or rubbing against the bodies of others - Being carried away by the sights and physical feelings. Sense of being drawn despite oneself by the street and pedestrian flow (required by other bodies to walk at a given place and pace, avoiding contact). - Pleasure accompanying walking.	Fluid traffic on Cours Berriat. Long, wide thoroughfare, stretching into the distance, pulling a well-ordered flow (everyone has their appointed lane) but comprising several forms of traffic (trams, pedestrians, cars, cyclists). Impression of being carried away visually and bodily by this flow.  At the St Bruno tram stop the impression of fluidity is broken. From here on everyone is constantly renegotiating the trajectory and pace of forward movement.	*Buildings* - Long, wide thoroughfare - Homogeneous, low-rise buildings *Senses* - Framed vista but opening onto distant prospects. - Coloured lights at night - Sound trail: tram - Emergence: tram bell - Rhythmic sound and vision - Metabolic: steps and voices at the St Bruno stop - The street has a certain beat *Social* - Organized flow of people on the move, with various means of locomotion (trams, bikes, cars, walking) - Quiet, unhurried activity, loitering. Valid day and night - Social throb of the street, at the St Bruno tram stop, with large numbers of pedestrians arriving and departing

Figure 1 Example : Drift down Cours Berriat (Grenoble)

In the second-person ("you-walk"), the researcher carries out a series of pavement interviews with pedestrians. Accompanying them on a portion of their journey, he or she questions them on the reasons for their journey, the choice of route and how they see the neighbourhood. A dictaphone is used to record their answers as they walk. If the person being interviewed agrees, the initial exchange at the end of the route may be extended, turning into a semi-directive interview. In this case, the questions raised previously are explored in greater depth though it remains an open discussion in which the pedestrian is free to express his or her views. Speech is recorded during the walk, as for the first-person I-walk, using a dictaphone. About 60 people were interviewed in this way in France, the field location on which we have focussed our analysis. These pavement interviews have helped to plot the routes taken on a map and serves as the basis for a transcription of the answers given by pedestrians. This analysis has two merits. First, it reveals the social and collective representations linked to each neighbourhood and the pedestrians' appraisal of its qualities. Second, our analysis highlights the relation between personal motives that may prompt us to walk and the various conditions that enable walking actually to happen.

Lastly, with the third-person ("he or she-walk"), the researcher carries out "route reproductions". He or she follows unidentified pedestrians at a distance, paying attention to their practical actions (how they cope with the developed space, practical activities, stay in space…), their social conduct (how they handle encounters, the presence of others or a crowd), their body attitude (rate/rhythm of displacement, visual orientation, trajectory of the step) and the events and characteristic of the crossed contexts. This sort of tailing, also recorded on a dictaphone, is transcribed in two ways: plotting on the map of the observed route; and a written description (gestures, trajectory, speed of movement, events, etc.) recorded *in situ*.

Route account n°11 – On Place du Grésivaudan, a woman who was on the left-hand side and has just crossed is now on the opposite side, walking towards La Tronche. She is carrying two loaves. She starts hurrying. She must be in her 70s. She crosses the road just to the right of the pedestrian crossing and enters a little side street, Rue Farconnet, which slopes gently downwards. She is walking on the pavement, but about 15 metres further along she steps into the road as if she was taking a short cut. Ten metres later she returns to the pavement, having taken a minor short cut at a bend in the street. She carries on walking along this very quiet street, going quite fast. There is a bin taking up almost the entire pavement, so she moves to the right but without stepping into the road. She carries straight on. She seizes something with her hands and looks up to the top of a building, then goes in (n°4).

Figure 2 Example of a transcribed account of a route – Grenoble, Ile Verte

We recorded 143 route accounts in France. Analysing them gives us a grasp of the way pedestrian mobility is modulated, in the dynamic of movement and depending on the context.

2.2 Europole and Ile Verte districts of Grenoble: two fields of experimentation

We experimented with this survey protocol in Grenoble, in two districts: Ile Verte and Europole[4]. This was not a random choice: both districts have a strong identity in the town and enjoy direct links to the town centre (by car, tram and on foot). They also seem to lend themselves to walking (in that both have amenities dedicated to this form of travel) while offering very different, multiple conditions and settings for walking.

[4] In Geneva the Equiterre team deployed these survey protocols, assisted by the Cresson team, in the Cressy and Le Pommier districts.

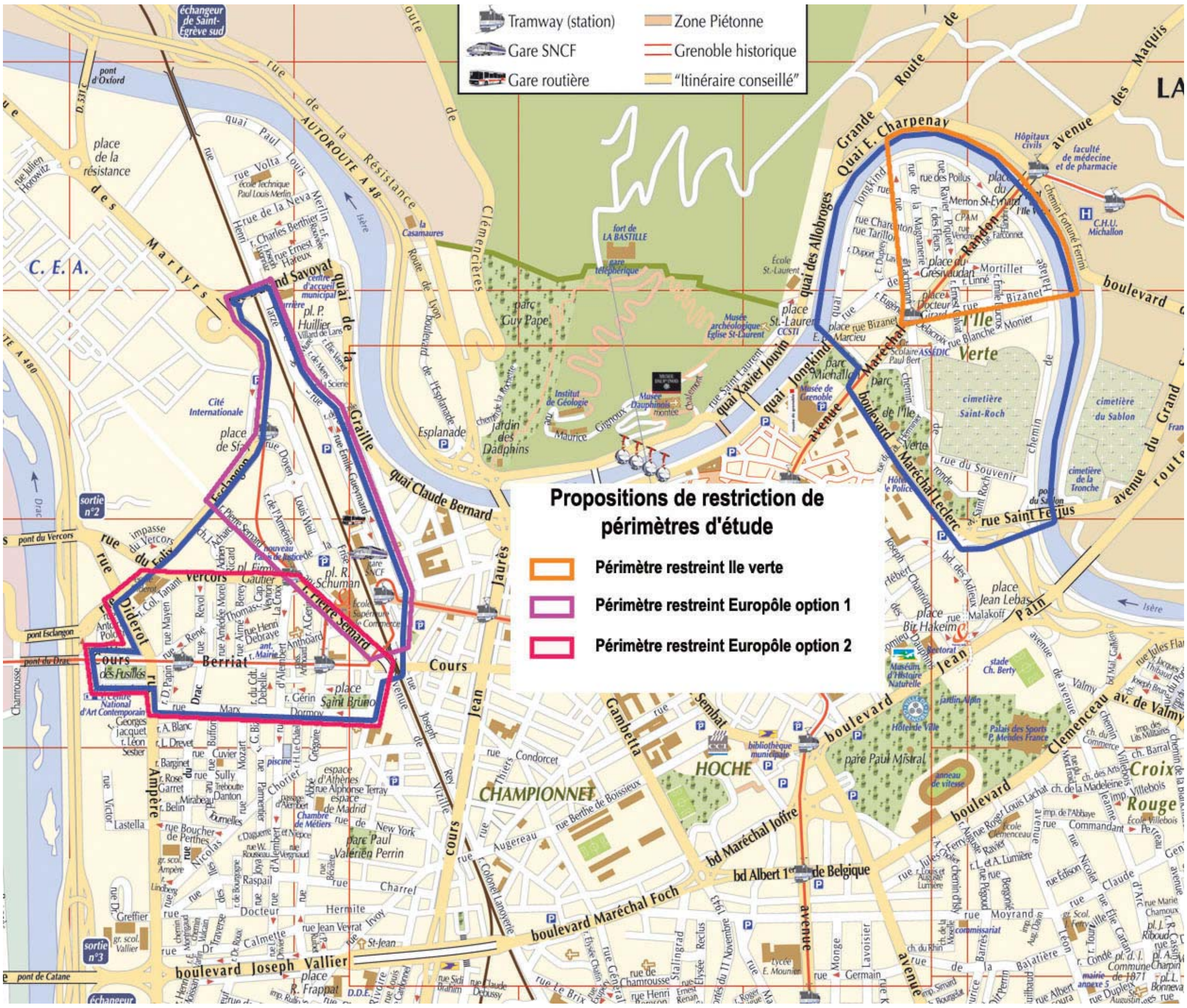

Figure 3 Map of the districts covered by the study

The Ile Verte (green island) district, located to the north-east of the town centre, is a setting that certainly impacts the way pedestrians choose to travel. It is quiet and residential, organized around a network of often deserted streets, where the slightest presence attracts the interest of local people (fig.4.1). The Isère river runs around more than half of the district's perimeter and paths have been laid out along the banks, attracting large numbers of walkers, runners and cyclists on weekends (fig.4.2). Over and above the significant role played by vegetation in the urban scene (extending into St Roch cemetery, referred to as the area's "green lung"), Ile Verte has a wide range of shops and services along the main thoroughfare, Avenue Maréchal Randon. This road is comparatively mineral in its make-up, with dense traffic, connecting the centre of Grenoble to the nearest suburb, La Tronche (fig.4.3). Place du Docteur Girard, halfway along the avenue, has a surprising star configuration, now operating as a roundabout, with pedestrians, cyclists, cars and trams coexisting in considerable confusion demanding plenty of give-and-take on all sides (fig.4.4 et 4.5).

Deserted streets (fig.4.1)

Riverbank paths (fig.4.2)

Av. Maréchal Randon (fig.4.3)

Place du Dr Girard (fig.4.4 et 4.5)

Figure 4 The urbanscape of the Ile Verte district[5]

The Europole neighbourhood, located to the west of the city centre, is the new business district. Designed primarily for services (World Trade Center, law courts, international secondary school, graduate business school, etc.), much of the area is given over to recently built office blocks, in which steel and glass play a predominant part (fig.5.1 et 5.2). Through its centre runs Rue Pierre Sémard, divided into two separate streams of traffic with a regular, reasonably peaceful flow of cars and trams (fig.5.4). In this largely mineral environment, pedestrian use of public space corresponds to a regular and often rapid back-and-forth movement. They cross Avenue Doyen Gosse (fig.5.1) or Place Schuman (fig.5.3), often without stopping, very probably taking advantage of these hygienic expanses (smooth surfaces on the ground and on the facades, no rough edges, high proportion of masonry) to keep their walking functional. The decor and atmosphere change as they approach Cours Berriat (fig.5.5). This street marks the border between an old, working class neighbourhood, St Bruno, and the new business district. Cours Berriat reflects this mix: in the forms of transport (pedestrians, cycles, motorcycles, cars and trams all pass through here), in its population (a blend of classes and ethnic origins), and lastly in its trade (with restaurants, sandwich bars and a wide range of shops and services). Pedestrians seem quite at home in this mixture and abundance, constantly adapting their behaviour to the micro-events that colour the location and make it attractive.

[5] All the photographs in this document, and all the commentaries on the various districts under study, are taken from the "Je" campaign. They were all taken, or made, by Aurore Bonnet, Martine Leroux, Jean-Paul Thibaud and Rachel Thomas.

Av. Doyen Gosse (fig.5.1)

Place de Sfax (fig.5.2)

Place Schuman (fig.5.3)

Rue Pierre Sémard (fig. 5.4)

Cours Berriat (fig.5.5)

Figure 5 The mineral character of the Europole district

Each of these neighbourhoods thus had the benefit of viewpoints – by an outsider (researcher or one-off pedestrian testing the terrain) and an inhabitant – who, far from offering any opposition, contributed to a cross-referenced acquisition of the atmosphere and the various elements contributing to each neighbourhood's walkability.

3. The sensory configuration of walk

The analysis carried out as part of this research action shows that architectural and urban atmospheres contribute just as much to the choice of walking as do the quality of urban design available to the pedestrian. Choosing to walk, over and above personal or passing motives, depends on the ability of a neighbourhood to embody multiple forms of spatiality. In other words, its capacity to prompt attachment or aversion, pleasure or fear (Watson, 1995), to allow meetings or the expression of a whole range of walking styles … are all qualities of the environment that weigh on the choice of walking and contribute to our attachment to a district. From this point of view, it is possible to identify some sensory configurations more conducive to travel by foot than others. By "sensory configuration" we refer to the result of the process by which pedestrians select, organize then shape the sensory material structuring their perception and action during the journey (Thomas, 2005). This restructuring of space, in the walking dynamic, should be understood as a *"deformation of the built environment as it was designed and a recreation of the space through feeling and motivity"* (Augoyard, 1979). Six sensory configurations were identified: attractive, spreading out, mobilizing, suspensive, accelerating and inhibitive. Each one operates jointly or separately on motor action and affective level. In the following we present four configurations.

For example, the attractive mode encourages exercise through walking and triggers pleasure in the pedestrian. This sensory configuration is characterized by powerful, rhythmic sound, numerous visual openings and lively sociability. The combination of these characteristics not only contributes to setting a tempo for walking but also awakens the subject's senses. Caught up in and carried away by the atmosphere, pedestrians adjust their gait to the pace of the place, listening to their surroundings and extending their visual attention. Bodily and perceptive immersion prompts a state of harmony that procures a feeling of pleasure and well-being. Strolling or ambling embodies this pleasant relationship. Walking in this way, pedestrians are open to others and to outside events. In Grenoble, Cours Berriat generally attracts walkers, despite significant design faults and dense, multimodal traffic. But this space, which offers many different views and is busy at all times, gives pedestrians an impression of leaving the town and being caught up in the rhythm of the place.

Back with other pedestrians, I allow myself to be caught up in the movement (dynamic) of Cours Berriat. This attraction coincides with the impression of returning to a neighbourhood, in the sense that its population is visible, with activity and a sense of presence (fig 6.1 and 6.2). All along the street there are neighbourhood shops, shoppers, clutter on the pavement: shop displays, advertising signs and so on. The pedestrians on this route display bodily movements expressing avoidance and contortion, sometimes stopping to allow the person coming the other way to pass. People's movement or simply their presence prompts me look into the side streets (Rue du Drac, Rue d'Alembert).

I reach Cours Berriat and here it is much more lively, with more light, people getting into their cars and driving off. The Fontaine end of Cours Berriat is less attractive, not very brightly lit, whereas on the other side it leads to the town centre. Several youths are withdrawing cash outside the bank. A young woman cycles past on the tramline. There are one or two other people also cycling. I decide to cross the road. On the other side there is a kebab joint and a sandwich bar, with several people inside. I notice various meeting places, each with a few people. It is more conventional here, in the sense that there are bright, multicoloured lights, and traffic lights. Earlier on it was a feeling of solitude, really very quiet, giving the impression that one is no longer in the lively part of town, a neighbourhood with history, people, things going on and bright lights.

Figure 6 Cours Berriat – Grenoble Quartier Europole extended

The pleasurable feeling is also prompted by the suspensive configuration, but unlike the previous one it replaces walking with loitering or longer stays. In other words the suspensive configuration suddenly breaks the pace of progress, raising the pedestrian's perceptive acuity and reducing contacts with others: under the influence of crystal-clear or reverberating sound atmospheres, rough or slippery surfaces, a landscaped or stylized backdrop, the pedestrian stops walking and adopts a contemplative pose. In this case, the aim is to take the time to enjoy the environment's remarkable qualities. The public park and the square are common examples of this type of configuration which is found frequently in the Ile Verte district. But the "suspensive" configuration can also be linked to the space having a particular functionality as a market, cemetery, tram stop or railway station, which can also encourage this variation in the pedestrian's pace and perceptive acuity. This is particularly the case as we pass through the railway station. This cube-like space, with large expanses of plate glass and a ground surface that is shiny and slippery, is characterized by a high level of sound and light reverberation. We observed three regimes of social interaction: short waits; long stays; and passing through. The combination of these qualities gradually reduces the speed at which pedestrians can move, forcing them to disperse their attention, which sometimes means they stop walking altogether.

The inhibitive mode is an illustration of the ambivalence of the urban development. In this case, places offer pedestrians ideal conditions for walking – wide, unencumbered pavements, smooth surfaces, agreeable night-time lighting, visual directionality, etc. Yet, paradoxically, they also make walking somehow inadequate. To be more precise, walking makes the pedestrian feel ill at ease and out of place. Faced with an anti-septic environment, the pedestrian feels foreign and, at the same time, exposed to the glances of local inhabitants. Moving through this vacuum, walking turns into flight, a brief crossing or a form of infiltration. In the first case, the pedestrian suddenly starts to hurry. In the anguish of this haste, their body shrinks in on itself, gestures become jerky, the torso and face turn downwards, bowed over in self-protection. In the two other cases, the style of walking betrays a functional relationship with the surroundings. Crossing involves taking advantage of design features that facilitate faster progress and a more streamlined gait. Infiltration is a slower, more cautious way of walking, the aim being to enter a place discreetly while keeping watch for visual and audial events that may reveal another's presence. This configuration was observed on Avenue du Doyen Louis Weil, in the Europole district. The middle of this long, straight thoroughfare is occupied by two-way road traffic. On either side rise recently built office blocks and flats, often quite high and faced with glass panels, framing the distant landscape. At the foot of these buildings, wide pavements, clear of any obstacles and dotted with designer street lamps, await the occasional pedestrian, soon tired by this overly smooth environment.

On Avenue du Doyen Louis Weil I decide to venture as far as the international secondary school. The pavement is wide and comfortable, so as a pedestrian I feel at ease. Ahead of me rises the Chartreuse range. For the first time in Grenoble, I have the impression of being hemmed in, halted at the same time as being drawn towards the mountains. Their presence is not stifling. They resemble a goal to be reached, concentrating my gaze. Perhaps because in my immediate surroundings there is nothing really captivating. I walk down the avenue, which is almost deserted, going into the wind, which is unpleasant. The occasional car passes going one way or the other, in the middle of the street, looking for somewhere to park. The rare pedestrians I meet are walking slowly. Since leaving Place Schuman, I have been able to hear birds chirping, getting louder as I go on. They cover up the sound of the city. In fact I really get the impression I am outside the city, yet at the same time the facades of successive buildings along the avenue play a powerful role in the landscape, constricting the way I walk and where I look. I am not ill at ease, just bored. I look for a way out and decide not to carry on a far as the school.

Figure 7 Avenue du Doyen Louis Weil – Grenoble Europole

The accelerator is a powerful configuration in the Ile Verte district. The key characteristic of this configuration is that it speeds up pedestrian movement. This quality results primarily from a mixture of specific spatial properties: strict alignment of facades, high buildings and a broad thoroughfare affording visual prospects and giving the place a form of “directionality”; cadenced frequency of passing cars and/or trams, matched by the pendulum-like movement of pedestrians, giving the place a visual and acoustic rhythm. In the same way, the sensory qualities of the space – and in particular its ability to confront pedestrians with sudden changes of atmosphere – contribute to the swift pace. As we walk through the Ile Verte district, we perceive and cope with rapidly increasing and decreasing levels of noise, with variations in its source too, and the sudden appearance of a frame around the view. These characteristics – present, for example, on Rue de Mortillet, Rue Lachman or Avenue Maréchal Randon – have a psycho-motive effect: they change the pace at which pedestrians walk and encourage them to adopt a more linear route.

The width of the avenue constitutes a visual and aeraulic opening to the outside of the town. The pavements are not in contradiction with the overall scale, but their repeated narrowing to allow for parking can be troublesome outside the shops opening onto the street. After doing some neighbourhood shopping, people go home to one of the smaller side streets in the vicinity, between the river and this thoroughfare. The wide avenue has a central reservation for the tram lines, and on either side a stream of road traffic – cars, buses, etc. This constitutes a major divide in the avenue that is not easy to cross. Observing passers-by shows that attention focuses on the various crossroads, but the wish to cross somewhere other than the pedestrian crossings – particularly as the avenue sometimes seems relatively empty – leads to risk-taking. A woman with a stroller ventures out, counting on the kindness of a motorist.

Here, there is a change of decor, a fairly abrupt shift in the atmosphere, with urban bustle, cars, trams and quite a high noise level. It all "takes hold" of me. I might feel out of place if I did not swiftly yield to the rhythm of the place. However something attracts my attention, an area slightly to one side where the urban bustle seems to have subsided momentarily. It is the sun-drenched terrace of a cafe, Le Grand Café, where a few people are taking their time over coffee and a chat. I watch them, wondering how comfortable they are, then concluding that the avenue displays a graduation in traffic rhythms: a break on the cafe terrace, a buffer zone formed by the pavement, the road and then the tram line.

Figure 8 Avenue Maréchal Randon – Grenoble, Ile Verte

For each of these sensory configurations, the architectural and urban atmospheres consequently exert an influence on the two registers of walking, doing and experiencing. By providing pedestrians with a sensory basis for their conduct and awakening in them a range of emotions, they contribute just as much to walking as does urban design. Furthermore, they prompt ways of relating to the city that are probably related to our daily choice of a means of locomotion.

4. The intensity of walking situations

In other words, architectural and urban atmospheres also play a part in the intensity of the relationship between the pedestrian and the city. We may distinguish walking situations that reflect such relationships: paradox, opposition, adjustment, neutrality and conniving. These situations are neither predefined nor stable during an urban journey. They evolve, succeed or confront one another depending on objective material conditions, fuzzy, fluctuating sensory conditions, and the affective state of the pedestrian.

Paradox thus reflects an ambiguous relationship, a disparity between the (physical and sensory) contexts of walking and the pedestrian's (perceptive and emotional) expectations. This situation is observed in two specific cases. Firstly, the quality of urban design fails to make up for the poverty and the unappealing atmosphere. Walking is chosen and the location traversed for strictly functional, practical reasons: shopping, going to a meeting or to work. In this type of context, walking does not become a set habit and another form of locomotion, less in keeping with the environment, may take its place:

Immersion on 6 April 2006 : *I "enter" the avenue walking along the left-hand pavement. The pavement is wide and comfortable, easy on pedestrians. Ahead, the Chartreuse range rises, but it is not at all overwhelming, more a goal to achieve on which my gaze is concentrated. Perhaps, too, because nothing much in my immediate surroundings is really captivating. The avenue is deserted and I am walking into the wind, which is unpleasant. The facades of the building that line the avenue are very forceful in the landscape, a constraint on the way I walk and where I look. I am not ill at ease, just bored, looking for a way out.*

In the other case, the quality of the atmosphere makes up for the shortcomings of the design and makes the place genuinely attractive. The prospect of various routes, a pulsating sound atmosphere and an open visual field that excites the senses, instils a feeling of freedom and well-being, and contributes to the overall good mood. Pedestrians really settle into this environment to such an extent that they frequently walk through here or turn a simple walk into a pleasant stroll :

Immersion on 20 April 2006 : *The thoroughfare is immediately attractive. There is a quiet bustle of activity on the shaded left-hand pavement: young people around a cash point, others sitting outside a café, passers-by, cyclists, trams. There are not many cars at this time of day. The contrast between sunlight and shade, which one cannot fail to notice, is both an invitation to take sides and an ingredient all the way along the route in some ephemeral spatiality. I am inclined to start by walking along the street, without hurrying, fitting in with the easy-going springtime mood, then perhaps to digress.*

A relation of complicity occurs when the expectations of pedestrians and the sensory quality of a space converge. In practical terms such complicity is fostered by the co-existence of attractive urban atmospheres and amenities that facilitate walking. Smooth or green environments that are peaceful and away from the urban drone, such as the small protected enclaves one may find in town centres, favour a feeling of freedom with scope for investing the place and a sense of ease in pedestrians. In addition to this attractive side, these sensory configurations have the power to suspend the rhythm of walking, giving pedestrians an opportunity to slow down or stop for a while. The peaceful atmosphere of parks and squares may nurture such a relation, but some contemporary spaces may also lend themselves to such complicity. Mineral areas with smooth, reverberating surfaces, intermediate spaces with only sparse urban furniture, and recently refurbished historic sites sometimes become occasional places of intimacy or places where contacts may occur, with other people and with the fabric of the place.

<u>Drift on 7 April 2006 :</u> A parenthesis in urban life. The riverside is split, at this time of day, into two climatic strips: one part in the sun; the other in the shade (on the built side). I opt to walk in the sun. I am cut off from the noise of road traffic, now barely audible far behind me as a background hum. Birdsong is predominant, wrapping me in a sound bubble. I walk slowly.

<u>Drift on 17 April 2006 :</u> Here we enter a square. It has little walls on which one can sit. It is nevertheless quite large and spacious. A youth is practising tricks on a skateboard. Two other people are roller-blading. That makes quite a lot of people on rollers, but there are also one or two pedestrians. It is about 21.00, on the holiday Monday of a three-day weekend.

The relation of complicity between pedestrians and urban atmosphere gives rise to quite different types of walk. People may be seen strolling through shopping streets and parks. This relationship is characterized by less vigorous use of the body, glances cast in all directions and a greater inclination to listen to new sounds. Strolling is *a particular form of slow walk which does not visibly imply any desire to reach anywhere* (after Morris, 1978). Strolling is an aim in itself, a way of observing the urban scene just as much as a way of enjoying the city's shifting moods. Urban glide [roller-blading, skateboarding, etc.] is a special case and is probably linked to the development of a style of contemporary architecture with few affordances, a fabric dominated by fluidity, as the city is embodied in a stripped-down plasticity. Urban glide differs from strolling in its speed, in its stylized postures and its repeated friction with textures. Leaning forward, looking far ahead, arms swinging beside the body, the pedestrian penetrates the air, brushes against or catches on available surfaces to better to push him- or herself through space. Mobile among the mobile, those who glide are in some sense archetypal figures in the contemporary urban world where fleeting relations rule.

Adjustment, though similar to complicity, differs noticeably. On the one hand, complicity is characterized by harmony, whereas adjustment is more a matter of conforming. In other words, when this relation is formed between pedestrians and the urban environment, it depends more on functionality and neutrality than on affects or affinity. On the other hand, although atmosphere plays a key role in complicity, urban design is a major factor in adjustment. This betrays a strictly practical relation between pedestrians and the city. It reflects not so much the pleasure of walking as its adaptation to the pedestrian's goals and the scope it offers for taking advantage of the qualities of a given space.

<u>Drift on 7 April 2006 :</u> Change of scene, with a fairly radical change in atmosphere: urban agitation, motor vehicles, trams, quite a high noise level. All this "takes hold" of me. I might feel out of place if I did not swiftly yield to the rhythm of the place.

<u>Drift on 17 April 2006</u> : I enter the street. There is a wide pavement, actually quite pleasant for walking, really wide. Here it is really modern, with non-slip, white paving stones that afford a really good grip. There is a light cool breeze but that too is quite pleasant. The street is really very longitudinal. There are not many alternatives; all there is to do is go straight forward. An avenue with modern buildings on either side but it is not too overwhelming. Contemporary design. I carry on walking, the ground still affording good traction. It is quite pleasant for walking. White lighting, pointed street lamps in a line, one after another, giving a sense of perspective and direction.

This relation of adjustment between the pedestrian's goals and urban atmospheres is reflected in a particular type of walk: crossing. Crossing a space means passing through or moving across it, either by necessity or because it is on a route taking the pedestrian from point A to point B. Like urban glide and flight, crossing is a type of swift walk: the goal for pedestrians is to complete the trip efficiently, taking advantage of spatial components to speed up their pace and give greater direction to their progress. In this type of walk, pedestrians adopt a form of behaviour that is stylized but less flexible than the urban glide: the breast is thrust forwards, the gaze switches constantly between the far distance and the ground in front, and the ear is alert to any remote sounds that may indicate a change of bearings. Every aspect of pedestrians' behaviour and attention to urban atmospheres reflects their walking savvy and ability to anticipate.

Induction reflects a relation of causality between the pedestrian and urban atmospheres. In this type of relation, pedestrians' behaviour and attitude are directly shaped by the sensory qualities of the spaces through which they pass. The "efficacy" of architectural and urban atmospheres is expressed in heterogonous sensory configurations. Some atmospheres mobilize (i.e. set in motion, make more mobile) the pedestrian's pace and attention to such an extent that they sometimes require an adjustment of gestures, the rhythm of movement and/or, less usually, the actual route. Thus, mobilizing places are often homogenous in terms of the buildings, being laid out in straight lines with a linear perspective. Framing of the view and minerality are two other characteristics. Most covered arcades or passages act as mobilizers. Other types of sensory configuration contribute to a relation of induction. But as well as mobilizing pedestrians' pace and attention, they contribute to distributing and spreading them in space and time. In many cases, they are in fact nodes, joining or articulating several spaces. In addition to offering pedestrians a choice of routes, they are characterized by two noticeable sensory qualities: a high noise-level in conjunction with a wave effect; one or more lines of visual flight, allowing pedestrians to anticipate the route to be taken at some distance.

<u>*Drift on 6 April 2006 :*</u> *The passage seems empty, cold, white and slippery. I want to hurry on and get out of this place quickly. I walk faster. I keep looking towards the horizon. Then I slow down, realising that if I walk faster my heels ring on the ground and the sound causes reverberation.*

At the tram stop, routes cross, with pedestrians hanging around at the stop, others getting on or off trams, pedestrians coming and going between the two nearby squares or walking along the street on the left-hand pavement. All these pedestrians have one thing in common, they are walking quite fast, giving the impression they are only passing through, that they did not come here for a stroll but because they have a specific purpose.

In this type of sensory configuration, flight or crossing are habitual styles of walk. Flight reflects the pedestrian's feeling of unease or insecurity. It differs from urban glide in the action and emotion it prompts. Flight is also characterized not so much by speed as by a hurrying step. Pedestrians suddenly start walking faster as if they wanted to leave the place as soon as possible. In their haste and unease, they draw themselves inwards: gestures become jerky, arms are wrapped tightly round a handbag or jacket, the breast and face turn downwards. In such circumstances, there is little chance of meeting or exchange. In crossing, we are more likely to observe the tactics of negotiation and avoidance deployed by pedestrians to cope with urban facilities and other members of the public. Much like stamping, this is a jerky, uneven style of walk. Crossing varies between waiting, hesitation and haste. Less active when waiting, a pedestrian's bodily and visual mobilization increases in moments of hesitation, becoming even more noticeable with haste. This type of walk is an illustration of how motion can be "shaped" by urban atmosphere.

Conflict is probably common in the relations between pedestrians and urban atmospheres. It not only reflects the contradictions between pedestrians' expectations, the way they use a space and the city's sensory qualities, but also translates the everyday confrontation that opposes them. This opposition between pedestrians and the city feeds on the mobilizing quality of urban atmospheres. This mobilizing force sometimes determines a route and the pace of movement, but it can in some instances place a straitjacket on the mind and body. This happens in places with a lot of people and a metabolic sound atmosphere. In a context of this sort, pedestrians feel hampered or "gripped" by the atmosphere to such an extent that they may lose a degree of autonomy in their movement.

<u>Drift on 20 April 2006 :</u> Pedestrian versus amenities. Here I encounter an example of particularly complex urban design which, to my mind, encapsulates the difficulties I have as a pedestrian in Grenoble: tram lines, lanes for motor traffic – with raised tram-stops and pavements, and in some cases no real pavement, just stubby posts, bollards or fencing separating the pedestrian area from motor traffic. Here, the marks on the ground indicating cycle lanes (one in the road, one on the pavement, as I realise after thinking there are really too many cyclists here) and the pedestrian crossings make walking very complicated. Crossing is just as challenging, involving several stages. Sound plays an important part here: the passing of cars and trams is sufficiently audible in the overall calm to grab one's attention.

This conflicting relationship with urban atmospheres is embodied in a characteristic type of walk: stamping. This is a slow, jerky, sometimes impatient walk, particularly common when pedestrians want to continue on their way but are forced to stay put or only advance with small steps in keeping with the rhythm of the place or other pedestrians preceding them. In this type of walk, the body is constantly mobilized: the chest leans left and right to avoid collisions and/or anticipate the next opening; the gaze focuses on other pedestrians or further ahead while deliberately not staring at pedestrians coming the other way; lastly, the feet grip the ground, sometimes even striking it. For this type of walk, the speed is substantially lower, the feet sliding cautiously over the ground. The feet are not raised, from the heel to the toe, but remain parallel to the ground, barely lifted. Steps are very short, the feet "sliding" forwards with a scraping, dragging noise. They progress at a snail's pace, but it does avoid complete immobility (after Morris, 1978). More than any other type of walk, stamping reveals the friction that constitutes urban existence and the almost tactile roots pedestrians put down in the city.

5. Walking in town: a carnal experience?

In other words, individual neighbourhoods, places and atmospheres all shape our way of walking, which is every bit as much a type of urban travel as a form of bodily expression (Le Breton, 2000). Alternatively we may say that walking in town is a carnal experience: *"streets, pavements or pedestrian precincts are places where bodies avoid or approach one another, embrace, totter, hesitate, turn away, bend and settle into the city matter with a very special sensuality"* (Thomas, 2007). In this process of constant exchange, walking and urban atmospheres are articulated with an almost plastic flexibility. Conflict, paradox, induction and even pleasure are, as much as complicity and adjustment, types of relation between walking and urban atmospheres that evoke the intersensory dimension of the urban experience. As they walk pedestrians are constantly stimulated, inhibited, mobilized, carried away … by sounds, smells, colours and multiple flows. In these heterogonous configurations, crossing, flight or even strolling are every bit as much ways of embodying this sensory material as they are ways of taking bodily shape through the material.

The lexicons we propose here are just sketches, neither exhaustive nor closed on themselves. Other types of walk and other sensory configurations probably exist, expressing other types of relationship between walking and urban atmosphere. But these lexicons do give some indication of the complexity of the choices facing pedestrians and the ambivalence of walking processes (Solnit, 2002). The walkability of a place or neighbourhood is probably due to its material design, but what makes a pedestrian walk is also the quality of a town to offer alternatives, awaken the body and senses, stimulate emotion and exchange … ultimately modelling multiple forms of spatiality in movement. Such results raise questions about the Scandinavian norms, exemplified by the Stroget pedestrian precinct in Copenhagen, which are becoming widespread in Europe. Streets are intended to channel crowds, but the organization of traffic and the functionality of walking should also remain a collective concern (Benjamin, 1989), remaining a *de facto* means of urban expression. But, in the face of attempts to smooth the rough edges of city life, work on atmospheres – by giving meaning to the senses (Straus, 1989) – offers a way of questioning street design in terms of sensory affordances for walking. This is a new perspective which, we believe, may open the way for a renewal of the ways in which we conceptualize city walking and urban design.

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Measuring child pedestrian exposure: A tool for counting children on streets

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'Don't let people drive you crazy when you know it's in walking distance'.
Author Unknown

'Everywhere is walking distance if you have the time'.
Steven Wright

Summary

Pedestrian 'exposure' data are required for studying links between walkability ratings of a community and the amount of actual walking, assessment of changes in pedestrian activity following modification and/or improvement in network and facility design, evaluation of the impact of programs for increasing pedestrian activity and use of urban space, or analysis of changes in accident risks.

The tool described here is a method for counting pedestrians in a way that provides a representative estimate for the presence of pedestrians on the street network of a community. Details of sampling and fieldwork procedures, data analysis and examples of results are given in a context of a study on child-focused walkability assessment of 16 neighbourhoods in four towns.

The measuring process is intuitively simple, requires little training and no special equipment. It can handle a large range of pedestrian densities.

1. Introduction: The need for counting pedestrians

Walking and cycling are increasingly recognized as important, rightful, sustainable and healthy modes of transport. Pedestrians are the major users of all urban public spaces which, therefore, must be easily and safely accessible to them.

These welcome developments require tools to assess not only the quality of urban space and interconnections (streets, paths) for pedestrians or cyclists, but also the number of pedestrians using the connections (in fact or potentially), the characteristics of users, the intensity of use and distribution over time or other attributes.

With respect to motorized traffic, there are several tools for measuring motorized traffic intensity and patterns, and data are routinely collected by urban and transport planners, traffic engineers and road safety analysts.

In comparison, few tools and little quantitative data are available regarding the presence of pedestrians, especially children, on the urban (or rural) road networks. This is particularly lacking in the area of local, community focused, pedestrian network planning or safety analysis.

Correct ‘exposure’ data are required for valid estimation of community needs, assessment of changes in pedestrian activity following modification or improvement in network and facility design, evaluation of the impact of programs for increasing pedestrian activity and use of urban space, or analysis of changes in accident risks.

The work reported here is part of a larger effort by the NGO ‘BETEREM’ (National Center for Children's Safety and Health, Israel) to develop ‘Child Road Safety Indicators for Urban Communities’. The pilot project is conducted in four municipalities in Israel, with the aim of developing a general assessment method to be used by municipalities to diagnose and correct road safety issues impacting children.

The indicators are based on injury data analysis, behaviour observations, trip surveys, municipal safety management analysis, measurement of neighbourhood walkability (the extent that the road network provides safety, comfort and connectivity for children's walking trips), and counts of child pedestrians and bicycle riders.

2. The rationale of the method

The method for counting child pedestrians and bicyclists has to satisfy three criteria:

- it has to provide a measure of pedestrian presence that is representative of an entire road network of a neighbourhood community;
- it has to be conceptually related to vehicular traffic counts and to road safety;
- it has to be very easy to implement.

The first criterion was met by a process of systematic sampling of neighbourhoods in a community, with the help of a GIS database, taking into account census track information, land- use, residential building density and some roadway network attributes.

Within each neighbourhood, child-relevant walking / riding destinations are identified and marked on a map. Typical destinations are schools, playgrounds, parks, local retail streets or buildings, arts / sports and similar extra-curricular classes and activities. Every residence is also a potential origin or destination.

The second criterion was addressed by the following reasoning. The cumulative potential road risk for ‘children in the community’ is related to their chances of encountering vehicles while they are on the streets. The more children on the streets, the higher the chance that someone will encounter a vehicle.

This is actually what is meant by ’exposure’. Those children who are moving / travelling on paths that are not near motorized traffic have little chance of encountering vehicles. Furthermore, what is of interest to us from a safety point of view are potential encounters with moving vehicles and less so with parked cars. The measure of exposure, therefore, needs to be connected to moving vehicles.

The mirror situation of ‘children encountering vehicle’ is ‘vehicle encountering children’. This mirror conceptualization leads to a reframing of road risk for children in the community as the chance that a vehicle (or a vehicle stream) will encounter children while travelling on the streets of a community.

With this definition, we can measure the ‘chance’ with a standard unit, namely ‘the number of child pedestrians encountered per hour of travel' (of a car). This unit is the equivalent to how vehicles are counted on a road or on a network, i.e. the number of vehicles per hour.

The third criterion, regarding simplicity, is embedded in the details of the measuring procedure.

3. Details of the procedure

3.1 Planning a driving circuit

The procedure for counting child pedestrians and cyclists first requires planning a representative driving circuit in a previously sampled neighbourhood. The driving circuit is planned with the help of GIS, such that it goes in typical sub-areas of the neighbourhood on a variety of street types and passes by many of the destinations children in the neighbourhood are known to visit. Practical considerations of traffic controls and specific local conditions help fine-tune the driving circuits for all sampled areas.

The driving circuit is considered to be representative of the entire neighbourhood, not in the sense of being a typical driving route, but in the statistical sense of enabling ‘potential encounters’ with a representative sample of child pedestrians moving about in the neighbourhood.

The following is an example of one planned driving circuit (out of four sampled in the town) in a neighbourhood in the town of Bat-Yam, to the south of Tel Aviv. Each neighbourhood covers approximately 5 % of the town’s built- up area.

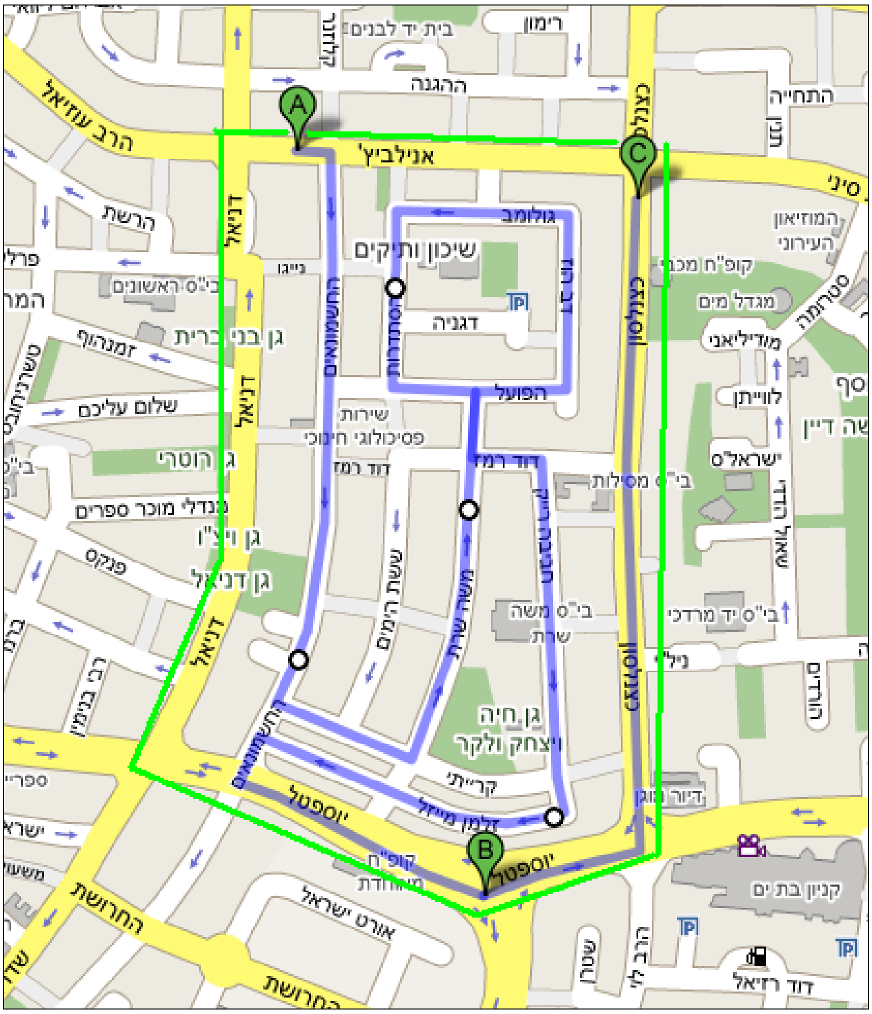

Figure 1 Driving circuit for counting child pedestrians and bicyclists

3.2 Counting procedure

The field work of counting is accomplished by a pair of field observers- one driver and one recorder. The team records the number and various characteristics of child pedestrians and cyclists they notice along the driving circuit. They drive at a normal traffic speed or a little slower when needed. Counts may be supplemented with still or video photography.

Driving cycles are repeated in order to cover different time periods and increase the sample size. However, at a given period the circuit is driven only once and the duration of the drive must be recorded accurately. A child may be counted twice or more if she is sill present in the street when the observers pass by again. From the point of view of anonymous vehicle traffic and potential conflicts over time, it makes no difference if the child on the street has been there before or not.

With good advance logistics planning, it is possible to count pedestrians and bicyclists in several neighbourhoods within one day.

Figure 2 depicts the paper form used for data collection. A physical clipboard, a block of plain paper, a quality pen or pencil and a clock is all the equipment that is needed.

The use of simple intuitive codes for recording observations is important. The recording is quick and accurate (it was tested for reliability) because observers are required to do a simple 'analogue' task. They do not actually count, and they do not place observations into pre-formatted Analysis Tables, which we found increased the mental load considerably. The only judgment observers make is one regarding the age category of the child in terms of school level: pre-school, elementary school, middle or high school. Babies and toddlers in baby-carriages / strollers were recorded as such.

Figure 2: Example of a field form after three driving cycles.

4. Analysis of field data

The field form contains the full record of individual pedestrians and bikes, retaining the sequence and makeup of original observations. The first step of analysis, in the office, is to count the number of children observed in each driving cycle and convert the data to Table form, as shown in Table 1.

Table 1 Children observed in one driving cycle in a neighbourhood of Bat Yam

Date: 25/06		cycle: 2		start: 16:49		end: 17:04						
Age 0-5				Age 6-11					Age 12-17			
alone	stroller	with adult	with older	alone	with adult	with older	group	bike	alone	with adult	group	bike
		3		4	22	1	3	1	2		5	3

Table 2 is a summary of counts in all driving cycles that took place (not consecutively) in the afternoon hours in the same neighbourhood.

Table2 Summary counts of children in one Bat-Yam neighbourhood

Date: 25/06				Number of cycles: 3					Total duration: 45 min.			
Age 0-5				Age 6-11					Age 12-17			
alone	stroller	with adult	with older	alone	with adult	with older	group	bike	alone	with adult	group	bike
1	20	37	0	8	51	4	40	3	11	5	41	3

The summary tables already provide interesting information about the presence of children on streets. Almost all pre-school children were accompanied by adults pushing strollers or holding hands. Primary school kids walked with adults, sometimes with an older sibling (or one that took that role) and many were with other kids, more or less of their own age. Relatively few walked alone. The older (middle and high school) kids walked with others of their approximate age and some were seen by themselves or with an adult. Not many cyclists were observed.

The basic unit of analysis for a standard comparison is the number of recorded pedestrians (or cyclists) of a specified characteristic per unit of time.

Table 3 shows a summary of counts in four neighbourhoods in Bat-Yam without segmenting the children as to how they were accompanied or if they were pedestrians, in strollers or on bikes.

Table 3 Children's presence on streets of four areas in Bat-Yam

Neighbour-hoods (coinciding with census areas)	Children actually observed			Children per hour		
	Pre-school Age 0-5	Primary school Age 6-11	Middle & High school Age 12-17	Pre-school Age 0-5	Primary school Age 6-11	Middle & High school Age 12-17
224 + 227	38	71	25	60.0	112.1	39.5
111 + 112	40	61	34	70.6	107.6	60.0
311 + 312	58	102	60	77.3	136.0	80.0
513 + 514	28	77	49	57.9	159.3	101.4

Clearly, there are differences in the number of children on the streets of the four neighbourhoods, as well as in the distribution of children by age. One can find support for several assumptions or assertions about the social and outdoors behaviour of children at various ages. Land use, layout of the streets, existence of specific attractors, housing density and socio-economic level of each area may also influence the extent of child activity on the streets.

The counts provide data that, together with other information, can help answer questions such as the following. For example, how many of the children who inhabit an area actually go out on the streets (other than to attend schools)? Table 4 addresses this question using census tract data for the respective neighbourhoods.

Table 4 Ratio of children living in Bat-Yam out on the streets afternoons

Neighbourhoods (coinciding with census areas)	Children living in area	Children counted per hour	Observed per hour, relative to children living in area
224 + 227	1440	212	14.7
111 + 112	1351	239	17.6
311 + 312	1553	293	18.9
513 + 514	1306	319	24.4

Census data suggest fairly similar child population size in the sampled neighbourhoods and, with one small exception, a similar ratio (15-20%) of kids being outdoors on the streets at any given time. One can not tell, of course, whether children were on their way to indoor or outdoor activity, the nature of the activity, or if they were just ‘hanging out’ in the streets.
The likelihood of encountering children riding bicycles in the town of Bat-Yam was fairly low (Table 5).

Table 5 Exposure counts of children on bikes in Bat-Yam

Neighbourhoods (coinciding with census areas	Children on bikes / hour	
	Primary school age 6-11	Middle & High school age 12-17
224 + 227	1.6	1.6
111 + 112	7.1	5.3
311 + 312	4.1	4.0
513 + 514	18.6	10.3

There are differences in bicycle presence in the areas, and the rate of use is similar in the two school age groups. Area 513+ 514 in town has clearly accounted for a larger number and proportion of children on bikes. This result is not obvious. The socio-economic makeup, housing types and density in the area are not very different to the other areas.

One differentiating element was noted however; area 513+514 has more interconnected footpaths, green areas and residential parking lots, which might have encouraged the use of bikes, perhaps even attracting bike riders from adjoining areas of town.

5. General findings about child exposure from all four towns

Looking at count findings from all four towns allows a number of generalizations:

- The range of exposure rates (observed children / hour) in the 16 areas assessed in this particular study was from less than 100 to nearly 1200 children per hour. The median was about 450.
- The proportion of children on the streets relative to their population size had a smaller range of 10% to 27% for different neighbourhoods. Within a town, the neighbourhoods had a very similar proportion.
- The most frequent age group in the counts of both walking and bike riding children were primary school (6-11) kids.
- There was a large street presence of children of all ages during late afternoon hours (shopping hours, and in summer cooler hours) on and around major shopping streets.
- Primary school kids often walked in pairs or groups of the same gender.
- Most cyclists rode on sidewalks or footpaths without helmets.
- Some pre-school kids on bikes or tricycles rode on sidewalks with helmets.

6. Conclusion about the efficacy of the new method for measuring pedestrian presence on streets

The method provides a representative estimate for the presence of (child) pedestrians on the street network of a community neighbourhood or a town, as long as the sampling of areas and the planning of a driving circuit are done with professional skill.

In addition to providing interesting raw count data, the method provides a measure of pedestrian exposure that is conceptually similar to vehicle exposure measures and their use in road risk assessment.

The measuring process is intuitively simple, requires little training and no special equipment. It can handle a large range of pedestrian densities.

The method is easily adaptable to accommodate variations in counting objectives, road network and urban form.

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