The effect of urban vegetation and traffic intensity on walking speed

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Abstract: - In two experiments participants were asked to walk inside the city Hradec Králové along a track, which consisted of streets with various amounts of vegetation and various degrees of traffic intensity. The walking speed was measured in eight selected sections. The environmental properties of the sections were estimated by raters, who described a level of naturalness of a place, intensity of traffic, noise, as well as emotional reactions in particular sections. Participants tended to walk slightly faster in sections without greenery and with a higher level of traffic than in sections with greenery and with a small level of traffic. Further, it was found that the sections, where participants walked slower, elicited more positive emotions than areas were participants walked faster. The results are discussed in terms of approach and avoidance behaviour (Mehrabian and Russel, 1974).

Key-Words: - Pace of pedestrian walk, Urban nature, Approach and avoidance behavior.

1 Introduction

Bornstein and Bornstein [2] in their seminal study reported that the walking speed of pedestrians was positively correlated with the size of the city - in larger cities pedestrians tend to walk faster than in smaller towns. Cross-cultural comparisons showed some differences in walking speed among various countries. Levine and Bartlett [2] compared walking speed of pedestrians in downtown areas of cities in Japan, Taiwan, Indonesia, Italy, U.K. and USA. They found that Japanese, Taiwanese and Indonesian pedestrians walk faster in large cities than in small towns, however differences between walking speed of pedestrians from U.K., Italy and USA were not significant. Further, Levine and Norrenzayan [6] compared differences in the pace of life in large cities from 31 countries around the world. They found that the pace of life was significantly faster in countries with colder climate, in more economically productive countries, and in individualistic culture. The faster walking speed in large cities is explained in terms of a higher density of pedestrians on the streets. It is a well-known fact that the higher level of pedestrian density results in faster movement. From the cognitive psychology point of view, the higher walking speed of people in larger cities is interpreted as a psychological response to stimulatory overload, which this environment contains [2]. More generally, fast pace of life may be the response to various urban stressors, including crowding, traffic noise, or fear of crime.

In the recent, not yet published research, Wiesman and al. [8] compared the walking speeds of inhabitants of 32 capital cites. The authors sorted the cities by walking speed of their dwellers. The most surprising fact was that the pedestrians were moving approximately 10% faster than it was registered in the same cities in the older research conducted by Levine and Norenzayan [6]. Thus, within roughly ten years the walking speed in large cities accelerated. The faster pace of life in large cities has certain negative consequences. It was shown that the faster the pace of life the greater the likelihood of heart attack occurrences. It was also observed that in cities with faster pace of life people tend to smoke more [4, 6]. Putting a movement speed and a speed of other daily activities in parallel with the Type A behavior patterns, Levine, Lynch, and Lucia [5] are even using the term „The Type A city“. They discovered a strong relation between fast pace of life and death rates from coronary heart disease.

Undoubtedly, the fast pace of life in today’s cities represents the factor, which negatively affects well-being and health of their dwellers. Certainly, a
fast pace of life is a quite complex problem that cannot be reduced by simply controlling the walking speed. However, a small contribution of environmental psychology to this problem could be to find out which physical properties of an urban environment might influence the walking speed and to seek for such design features that could be used to reduce it.

In our pilot experiment [3] participants were asked to walk along a track in the city Hradec Králové (Czech Republic). The track was divided into seven sections each of them had different environmental features – the amount of urban vegetation, the intensity of traffic, and the level of noise. The results revealed that participants walked slightly slower in the sections with higher amount of vegetation and with less intense traffic than in the sections with smaller amount of vegetation and with intense traffic and noise. Thus, some environmental properties have lead walkers to slow down in certain locations, whilst in another locations to speed up. In our pilot study we proposed that observed pedestrian behavior was explained in terms of the theory approach-avoidance behavior by Mehrabian and Russell [7].

The theory assumes that emotional response of an individual on an environment results in two forms of behavior - the individual is either trying to establish a contact with the environment and to stay inside of it (approach behavior), or he/she is trying to avoid it and to leave it (avoidance behavior). According this theory the emotional reaction of an individual in an environment may be described by using the three dimensions: satisfaction (pleasant – unpleasant), activation (activating – not activating) and domination (controlling – being controlled). The following behavioral reaction is described as approach-avoidance behavior and consists of various forms of behavior – physical movement heading into the environment (or outside of it), a level of attention given to the features of the environment, environment exploring, positive attitudes towards the environment expressed verbally or non-verbally, an attempt to perform any kind of activity in the environment or an attempt to get closer to other people in the environment.

This theory has been tested namely in a consumer research, in studies investigating effects of various dimensions of service environments (e.g. temperature, noise, music, layout, equipment, signs, symbols, etc.) on customer’s reactions. In this research area the theory has been further developed and extended by Bittner [1]. To date, this theory has not been tested in studies of responses to natural/outdoor environment. However, we assume that this theory could be also very helpful to explain certain kind of responses to outdoor environment, namely positive emotional reactions to natural element in urban streets, which are in the scope of our interest.

2 Goals

The present research continues our pilot study [3], where we investigated whether the pedestrian speed might be influenced by certain features of a surrounding street environment. The present investigations are designed to analyze environmental factors influencing pedestrian walking speed in more details.

The first goal of the present study was to validate the results gathered in our pilot experiment – changes of pedestrian walking speed in certain parts of the walking track. Since our pilot experiment was conducted in real conditions, there is a risk that the results might have been influenced by some variables, which were not possible to measure and control. Thus, we intended to conduct two further experiments in which participants were asked to walk along the identical track we used in the pilot experiment.

The second goal was to examine whether the observed behavior – slowing down in certain parts of the track and speed up in the others – could be explained in the terms of the approach-avoidance theory by Mehrabian and Russell [7]. The sections, in which the participants slowed down, should be connected with positive emotional responses that could be described in emotional dimensions satisfaction, activation, and domination. Those reactions should lead to willingness to stay in the environment.

3 Experiment 1 and 2

2.1 Method

Seventy-two participants, undergraduate students (mean = 20.3, 37 females) took part in Experiment 1, hundred-eight (mean age=20.4; 56 females) took part in Experiment 2. Experiment 1 was conducted in May 2007, Experiment 2 in April 2008.

The walking track took place in a centre of the city Hradec Králové. The passing the track lasted about 30 minutes. The track was divided into eight sections with different environmental properties. Inside each section the shorter sector was selected, where participants’ walking speed was measured. The length of the sectors varied from 39
to 74 meters. The sections, when vegetation prevailed (trees, grass) were labeled „green sections“ (sections 1, 2, 3, 4, and 5), whereas the sections with a minimal amount of greenery or totally without greenery were named „sections without greenery“ (sections 6, 7, and 8).

Participants were asked to pass the track with their normal walking speed. The track was marked by arrows to make orientation easier. Two directions of the walk on the track was employed – direction A (from section 1 to section 8) and direction B (from section 8 to section 1). The pedestrian speed was measured by observers with stopwatches. The observer was staying on the opposite side of the street and measured time duration of a participants’ walk from the beginning to the end of the measured sector.

2.1 Results

Average walking speeds in the particular sections (m/sec) are shown in Fig. 1 both for the Experiments 1 and 2. The repeated measures ANOVA was carried out. Gender and direction of the walk on the track were out were chosen as independent variables, average walking speed in particular sections was the dependent variable. In Experiment 1 ANOVA revealed the significant within subjects main effect of the type of the section \[F (7,385) = 357.07, p = 0.000]\] and the significant between subjects main effect of the direction of the walk (direction A or B) \[F (1,55) = 4.55, p < 0.05]\]. Gender had not any significant effect, there were no significant interactions. In Experiment 2 ANOVA revealed the significant within subjects main effect of the type of the section \[F (7,497)= 41.35, p = 0.000]\]. Gender and the direction of the walk have not significant effects. There were significant interactions between section, gender and direction of the walk \[F (7,497) = 2.56, p = 0.01]\].

Results showed the general tendency to walk faster in the sections without greenery and with high traffic and noise than in calm areas with greenery. The fastest walking speed was indentified in the section 6 without greenery and with high traffic and noise. The data also showed differences in walking speeds between May 2007 (Experiment 1) and April 2008 (Experiment 2). In April 2008 participants walked in general faster than in May 2007. In May 2007 there was warmer, dense vegetation and flowering linden in the section 2. It seems that all these factors resulted in generally slower walking speed and more conspicuous differences in walking speed between particular sections.

3 Experiment 3

3.1 Method

Seventy participants, undergraduate students (mean age = 20.4, 35 females) took part in the experiment. They were asked to evaluate environmental characteristics of the particular sections and their emotions in these locations. First, they described the environment characteristics with the items: (1) “There is a large traffic here”. (2) “A lot of people are moving here”. (3) “There is noise here”. (4) “There are a lot of natural elements here”. Further, they were asked to express their level of agreement with the statement: “I prefer to leave from here.” Finally, emotional reactions in the environment were measured in accord with the model by Mehrabian and Russell [7] within three dimensions - pleasure, arousal, and dominance.

3.2 Results

The one-way analyses of variance revealed the significant effect of the section on an amount of perceived natural elements \[F (7,548) = 421.44, p= 0.000]\], perceived traffic intensity \[F (7,551) = 165.10, p = 0.000]\], perceived noise level \[F (7,551) = 139.25, p = 0.000]\] and perceived amount of people in the location \[F (7,550) = 16.41, p = 0.000]\]. Further, the one-way analysis of variance revealed the significant effect of the section on decision to leave the environment \[F (7,550) = 82.85, p = 0.000]\]. The agreement with the statement “I prefer to leave from here” was higher in the the green sections than in sections without greenery and
in sections with high traffic and noise. Finally, we analyzed emotional reactions in particular sections of the track. The one way analysis of variance revealed the significant effect of the section on dimensions pleasure \( [F (7,546) = 95.34, p = 0.000] \), arousal \( [F (7,545) = 36.19, p = 0.000] \), and dominance \( [F (7,547) = 24.30, p = 0.000] \). The data showed that in the green sections the participants perceived higher levels of positive emotions (see Tab.1).

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<tr>
<th>section</th>
<th>Emotional reactions</th>
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<tr>
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<td>1</td>
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<tr>
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Tab. 1 Scores of emotional reactions in particular sections of the track. Boldfaces indicate “green” sections. The scale of “satisfaction” has the reverse scaling.

4 Conclusion

Our research has shown that the environmental properties of a city street in which the pedestrian is walking may influence his/her walking speed. During the series of experiments we conducted in the streets of Hradec Králové in years 2007 - 2008 we observed the almost identical behavior of our participants. In sections of the track that we labelled as „green” sections the most of the pedestrians walked slightly slower than in the sections we labelled as „non-green”. According to the subjective evaluation, the „green” sections contained more natural elements than the „non-green” sections. It also turned out that the greenery was not only one factor influencing the behavior of our participants. There were also lower car traffic, less noise and less people moving in the „green” sections.

The observed behavior of our participants - to slow down in certain parts and speed up in other parts - we explain by using the Mehrabian and Russel theory [7] – „approach-avoidance behavior”. This theory states that an individual reacts emotionally on the surroundings and a result of these reactions is either an effort to establish a contact with the environment and stay within it (positive emotional reaction) or quickly leave it (negative emotional reaction).

Our research has some limitations - an experiment conducted in real conditions does not enable to control fully all variables, e.g. various short-term weather changes (sun shine, heavy cloud coverage, wind) or sudden traffic density changes. It is not clear, how these immediate changes could influence behavior of our walkers. Probably because of these uncontrolled variables certain changes in walking speed appeared that are not easily explained (e.g. faster walking speed in certain sections of the track compared to some other sections). To prevent the effects of these uncontrolled variables we repeated the experiment several times in order to discover common tendencies that could be masked by changes in those uncontrolled variables.

References: