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A comparison of static and dynamic visual research methods for assessing respondents' preferences of social trail use conditions as a basis for recreational trail planning in urban areas

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1 ABSTRACT:

Preferences for trail use conditions in urban recreational areas are dependent on many environmental and social factors. This study investigated four social factors: number of visitors on the trail, user composition, direction of movement and motion using a multivariate visual stated choice survey. Several trail use scenarios were developed and respondents (N=149) were asked which of the presented scenarios they would prefer. In order to elicit the influence of motion static (still renderings) and dynamic 3D computer animations presenting the social trail use conditions were developed. All factors under investigation were highly significant in both approaches. A high number of visitors, a high share of bicyclists and mainly oncoming other visitors were disliked by the respondents. Also a range of significant interactions between these factor levels was discovered. The dynamic approach showed strong interconnections between the level of use and the user composition and between user composition and the direction of movement. The results are from interest for city planers and park managers, because the knowledge of user groups' preferences allows managing visitor flows by providing preferred conditions.

2 INTRODUCTION:

Recreational areas are of great importance for the city inhabitants' quality of life. However, many urban recreational areas suffer from a high density of visitors and multiple uses, leading to exceeded social carrying capacities, unsatisfying leisure experiences, and use displacement (Arnberger, 2005; Arnberger & Brandenburg, in press). Non mobile social groups even lose the possibility of proper daily recreation at all. Additionally, unsatisfying leisure possibilities do not only affect the inhabitants' quality of life directly, there are also some striking indirect effects. Nowadays motorized traffic is mainly motivated by the purpose of leisure. Insufficient local leisure possibilities cause displacement of mobile groups which increases traffic flows. More (n.D.) and Tyrväinen and Väänänen (1998) found that the monetary value of realties is influenced by near recreational areas. Trends indicate that the use level of local recreational parks in build up areas will continuously increase in the next decades (Aoki et al., 2002; Sumiyoshi & Uchiyama, 2002; Spies et al., 2006). This is caused by an increase of the average age of the people in general and the higher popularity of leisure sports and leisure activities (Arnberger & Eder, 2007; Spies et al., 2006). This will tighten the task of providing acceptable recreational areas.

Beside the environmental resource conditions, the social trail use conditions, such as the level of use, user composition and user behaviour have a strong influence on the visitors' leisure experience. A range of studies have been carried out to investigate visitors' social preferences for managing recreational trails, using narrative and visual research methods. Recently multivariate visual methods have been used to investigate the relative importance of various factors which influence the visitors' perception of crowded conditions (Arnberger & Haider, 2005).

The number of visitors on a trail is found as an important predictor for how acceptable social trail use conditions are (Manning et al., 1996; Manning, 2004, Arnberger & Haider, in press; Reichhart et al., 2006). However, the number of visitors in a recreational area is not the only responsible factor for the visitors' evaluations and sensations of the use density. Much more, it is the individual situation-based affective evaluation of these social circumstances (Arnberger, 2003; Manning, 1999). The personally perceived visitor load can differ from the actual user load. The theory of "stimulus overload" and the theory of "social interferences" are mainly used to describe this complex socio- psychological connection between social environment and individual experience. These theories were adapted for the crowding experience in recreation areas (Andereck & Becker, 1993). The "stimulus overload" theory focuses on stress appearance when people are confronted with complex situations, such as crowded environments. The theory of "social interferences" roots in the personal space needed to fulfil requirements, as for example for solitude or space for carrying out some sport activities. These theories indicate in a theoretical way what a pile of empirical studies have meanwhile confirmed; additional factors, such as user composition and behaviour of other visitors have a significant influence on respondents' preferences (Roggenbuck et al., 1993; Rudell & Gramann, 1994). For urban park management this is important, because it is often easier to control one of these factors than directly limiting the amount of visitors, which is not an acceptable management measure especially for urban regions (Arnberger & Haider, 2005).

3 METHODOLOGY

Multivariate visual methods have proven as a sophisticated possibility to gather respondents' preferences for trail use (Manning, 2004; Arnberger & Haider, 2005). However, static images or photos can not provide all information, which visitors would experience in the real world, such as motion, noise and smell. This study compares a static multivariate research method using still renderings with a dynamic method by means of 3d computer animations. Beside the investigation of visitors' preferences for social trail use conditions, the two research methods (static and dynamic) were carried out in order to investigate if and how motion has an influence on the respondents' evaluation of visually presented social trail use conditions. A stated choice model was used to investigate the role of several social factors for trail use preferences.. In both methods, static and dynamic, the same three social factors with three levels each were included (Table 1). Out of the choice decisions the respondents took, it was possible to estimate the relative importance of each factor under investigation. For analysis of the discrete choice experiment the random utility theories of McFadden (1974) builds the basis. The analysis was undertaken in SPSS 14 using logistic regression.

Factors and factor levels	Level 1	Level 2	Level 3
Number of visitors	4	8	16
Direction of movement	25 % come to / 75 % go away	50 % come to / 50 % go away	75 % come to / 25 % go away
Composition of users	25 % Cycling / 75 % Walking	50 % Cycling / 50 % Walking	75 % Cycling / 25 % Walking

Table 1: Factors and factor levels

To create the dynamic and static scenarios, we needed a technique which allowed a very accurate control over all parameters in the filmstrips. The following methods to produce films displaying social trail use conditions in a dynamic manner were tested: "real film", "blue box" and "3d computer animation". It turned out that modelling and animating the crowded scenes in a 3d application is the most practicable way to fulfil the very strict needs of a proper choice model.

In total, 27 static trail scenarios and 27 animated trail scenarios were produced using the 3d software 3d Studio Max. The character animation was handled by the integrated tool "Character studio". The trail scenery was three dimensionally rebuilt within the software, ensuring that the motion and perspective caused scale as well as the visibility of the characters looked close to a real world film. For modelling of the characters common 3D polygon modelling techniques were used.

For the still renderings a typical moment of the 20 sec animation strip was extracted and saved as a static slide. The background of each film and image was created using a manipulated photo of a 120 m trail section in a recreation area in Vienna in order to generate an impression of the characters moving in a real world environment.

The still rendering sets and the 3d animation sets showing different social trail use conditions were presented to 149 landscape planning students during a lecture. All images and animations were shown in pairs of two, i.e. choice set, and the respondents had to choose which of the two trail use conditions they would prefer. The order of presentations was changed to avoid any starting point biases: two groups had to first evaluate their 16 static trail scenarios organised into pairs and, afterwards, the 16 dynamic scenarios in pairs as well, while the other groups started with the dynamic scenarios. Each set was shown for 60 seconds. All choice sets where shown in a standardized manner with two video beams to two different groups at the same time. Each student evaluated eight 3d animation sets and eight still rendering sets. The scenarios and the combination how the scenarios were combined have been exactly the same for the dynamic and the static sets.

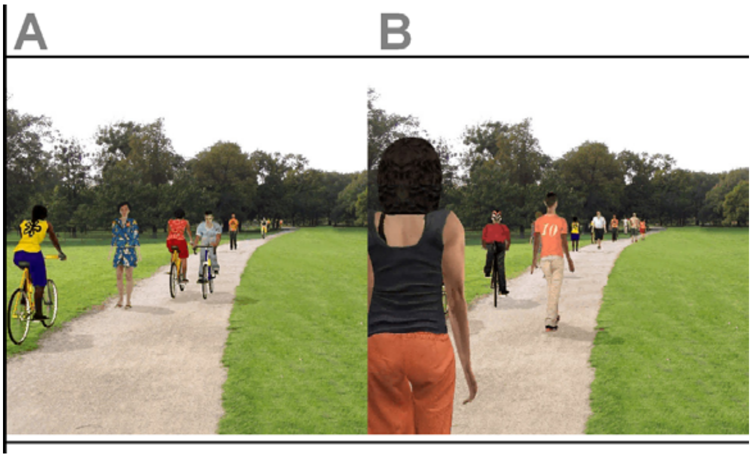

Figure 1: Choice set consisting of two still renderings

4 RESULTS

Figure 2 and Table 3 presents the results of the binary logistic regression models, for the static and the dynamic approach, including the main factors under investigation. The regression coefficient indicates the "part worth utility" of the presented factor level, which shows the relative influence on the respondent's choice. A positive part worth utility describes that compared to the basis level, the respondents tended to chose scenarios with these factor level presented, whereas negative values indicate that the presented factor level was disliked by the respondents.

In both approaches most factors were highly significant (Figure 2, Table 3). The number of other visitors on the trail was the most important predictor variable for the respondents' choice decision. The scenarios with only four people in view were most preferred. The composition of visitors played also a major role. Scenarios with few bicyclists were preferred over scenarios with many bicyclists. The direction of movement was in both approaches (static and dynamic) for the level "75% facing the observer" highly significant. However, its influence was rather small compared to those of the other two factors.

In the static survey the number of visitors was more important for the respondents' preferences than this was the case for the dynamic survey. However, the other two factors, direction of movement and user composition, seemed to influence the respondents' choice decisions more in the dynamic approach than in the static. This may indicate that the visitors' behaviours were evaluated more sensitively in the dynamic approach.

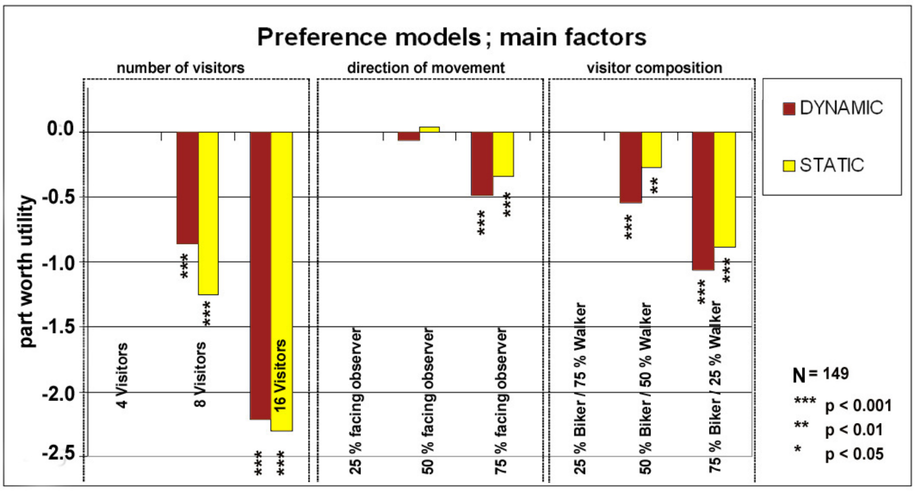

Figure 2: Part worth utilities for the main effects only models regarding preferences for trail use conditions depending on the kind of presentation

In a next step, interactions between the various factor levels were included (Table 2). Using the likelihood ratio test (Louviere et al., 2000) the models' quality increased significantly compared to the main effects only models for both approaches. The model of the dynamic approach predicted 68.8% of cases correctly, the model of the static approaches 70.9%. In the dynamic approach seven interactions were significant, whereas only three interactions were significant in the static approach. Most factors and interactions, which were significant, tended to be rather similar in both approaches (Table 2). However, some interactions were only significant in the dynamic approach, such as the interactions "16 Visitors x 50 % Bicyclists" and "16 Visitors x 75 % Bicyclists". Additionally, interaction between use level and user composition were experienced more importantly when motion was presented. This indicates that using the dynamic methodology it is possible to estimate more precisely interconnection and dependences between various factors. In particular, at peak use level the dynamic model showed that various social factors were of great importance for the respondents' perception of the conditions. Similar to the main effects only models, the number of visitors remained the most important factor for the respondents' choices. However, in the dynamic appraoch some interactions such as between use level and user composition had a stronger regression coefficient than the number of visitors. The user composition played an important role in both models. In particular, fast moving user groups (bicyclists) were evaluated more negatively in the dynamic approach. The direction of movement was in all approaches significant; in the dynamic approach, however, it had a stronger influence.

Factors and factor levels	**Static Presentation**	**Dynamic Presentation**
Number of Visitors	Parameters	Parameters
4	0.000	0.000
8	***-1.255	***-.874
16	***-2.146	***-1.449
Direction of Movement		
25% facing/75% go away	0.000	0.000
50% facing/50% go away	.156	.320
75% facing/25% go away	**-.387	*-.350
Composition of Users		
25% Cycling/75% Walking	0.000	0.000
50% Cycling/50% Walking	-.312	*.454
75% Cycling/25% Walking	***-.592	*-.344
Interactions		
(16 Visitors) x (50 % Bicyclists)	-.075	***-1.178
(16 Visitors) x (75 % Bicyclists)	*-.522	***-1.722
(50 % facing observer) x (50 % Bicyclists)	.099	**-.773
(50 % facing observer) x (75 % Bicyclists)	*-.545	**-.669
(75 % facing observer) x (50 % Bicyclists)	***-1.255	***-.874
Constant	***1.633	***1.324
Correctly predicted	70.9%	68.8%
Cox & Snell R-square	.190	.216

Table 2: Regression coefficients for the main effects and interactions for respondents' choice decisions (N = 149); ***p <.001; **p <.01. *p <.05

In a further step, preferences of respondents with rich experience in bicycling were compared to respondents who rarely went cycling. We undertook this investigation to prove whether experienced bicyclists have other demands than inexperienced bicyclists. The sample was divided into two groups, using the mean of bicycling activities respondents carried out during the last year. Respondents who went cycling more at least four times a year were referred to the specialised bicycling group. It is discussable whether respondents who go cycling more than three times a year can be called "specialised" in this activities or not. The estimated part worth utilities of cycling specialists differed slightly compared to the model for respondents who do cycling less than four times a year(Table 3). We did not include any interactions for this comparison, because of the low sample size of experienced bicyclists (n=28).

Factors and factor levels	Cycling > 3x/year	Cycling > 3x/year	Cycling <= 3x/year	Cycling <= 3x/year	General model	General model
	STATIC Presentation	DYNAMIC Presentation	STATIC Presentation	DYNAMIC Presentation	STATIC Presentation	DYNAMIC Presentation
Number of Visitors	Paramter	Paramter	Paramter	Paramter	Paramter	Paramter
4	0.000	0.000	0.000	0.000	0.000	0.000
8	***-1.182	**-.783	***-1.279	***-.860	***-1.253	***-.855
16	***-2.139	***-2.309	***-2.380	***-2.215	***-2.301	***-2.206
Direction of Movement						
25% facing/75% go away	0.000	0.000	0.000	0.000	0.000	0.000
50% facing/50% go away	-.197	-.263	.272	-.070	.033	.133
75% facing/25% go away	-.485	**-.702	**-.365	***-.493	**-.343	**-.461
Composition of Users						
25% Cycling/75% Walking	0.000	0.000	0.000	0.000	0.000	0.000
50% Cycling/50% Walking	-.318	-.122	-.030	***-.548	*-.274	***-.609
75% Cycling/25% Walking	***-.999	*-.503	**-.396	***-1.064	***-.885	***-1.061
Constant	***1.819	***1.630	***1.439	***1.846	***1.717	***1.803
Correctly predicted	68.8%	70.7%	67.7%	66.9%	69.0%	68.1%
Cox & Snell R-square	.178	.191	.182	.189	0.183	.193

Table 3: Regression coefficients for main effects – comparison between respondents who cycle more than 3 time a year, respondents who cycle less than four times a year and general preference model (N = 149); ***p <.001; **p <.01. *p <.05

The “number of visitors” was highly significant across all models, and therefore did not differentiate between the respondents regarding bicycling. The number of visitors was in all models the strongest predictor for the choice respondents’ would take. The factor level “16 other visitors in view” was most disliked, but also 8 visitors in view were evaluated more negatively than 4 visitors in view. Comparing the part worth utilities of the static models with those of the dynamic the results indicate that in particular 8 visitors in view were evaluated more negatively in the static approach than this was the case for the dynamic approach.

Investigating the preferences of respondents’ who went cycling more that three times a year some minor differences between the survey approaches were gathered. Whereas the static model only suggests that beside the number of visitors the user composition played a significant role for the choice decisions, in the dynamic model also the direction of movement was from importance. The dynamic approach shows that regular bicyclists do like to cycle in the same direction as most other visitors. Both models static and dynamic indicate that a high share of bicyclists was disliked by regular cycling respondents.

For respondents with low cycling activity the direction of movement was significant in both models. Similar to the dynamic cycling model the respondents preferred to walk or cycle in the same direction as others. For user composition the dynamic model for non regular cycling respondents estimates the factor levels “50% Cycling/50% Walking” and “75% Cycling/25% Walking” as highly significant, wheras the static model only indicates the highest share of bicyclist as singifcantly negatively contributing to the respondents’ choice decisions. This describes that particularly in the dynamic approach the user composition was evaluated more sensitively, which could be explained through the differences in speed. Over all a high share of cyclists is disliked from all user groups (walkers and bicyclists), however non-cycling respondents evaluated high shares of cyclists more negatively that bicyclists did.

This study is explorative in a methodical point of view and therefore it was of interest to investigate, how the respondents did perceive the survey method. For both approaches more than half of the respondents could put themselves well or very well into the shown scenarios. People pretended they could put themselves better into the trail scenarios when they were presented in a dynamic way. While for the still renderings 54.5% of the students answered they could put themselves very well and well into the shown scenarios; for the animation strips 60.2% answered they could put themselves very well and well into the scenario. However, these differences were not significant.

For the dynamic approach also the extent of realism was investigated. Surprisingly, even though the graphic style of the animations was rather poor, almost 70% of the students evaluated the animations as very realistic or realistic. Additionally, the respondents were asked to evaluate the quality of the virtual character behaviour. The evaluations of the behavioural realism were much worse, than the general evaluation of the grade of realism. Only 38% of the respondents found the behaviour of the presented visitors very realistic or realistic. This is due to the somehow robotic animation style. However, it could also indicate that the strict design of this choice survey (the exclusion of many factors from real world) appears not to be realistic to the respondents. A correlation was found indicating that people, who stated that they could imagine themselves well into the shown scenarios, also rated the images and animations as more realistic.

5 DISCUSSION

A range of studies used visual presentation of recreational conditions (Manning et al., 1996; Vallerie et al., 2006; Arnberger & Haider, 2006; Arnberger, 2003) concluding that the results are usable to estimate real visitor preferences. Haider (2002) points out that stated choice surveys might collect very accurate and close to real behavioral data, because the respondents basically also have to choose between alternatives if they go to a recreational area. Manning (2004) argues that visual presentations of recreational scenarios are more suitable to identify recreational standards than narrative methods. So far, however, it was not known how motion has an influence on the respondents' preferences for social trail use conditions. Therefore, two visual research approaches were compared to investigate the role of motion.

All factors under investigation did significantly contribute to the respondents' choices in both approaches. However, the dynamic approach was more sensitive to the interactions between the factors. Although some differences in the evaluations of the static and dynamic trail scenarios were ascertained, the study indicates that both static and dynamic choice experiments seem to have the capability to assess respondents' preferences for social trail use conditions.

The number of visitors was the most important factor for the respondents' choice; the more people were on the trail, the less preferred was the scenario. This result matches with several other studies in this field (Arnberger, 2005; Manning et al., 1996) and is in line with the stimulus overload theory. The relative importance of the factor "composition of visitors", presented through various shares of bicyclists and walkers, was differently evaluated in both approaches. In general, scenarios dominated by walkers were more preferred than bicyclists dominated ones (Figure 2). However, the interactions revealed that the higher the use levels were, the less preferred were bikers, particularly in the dynamic scenario. A high share of fast moving users in crowded situations seem to have evoked respondents' safety concerns. This result documents that bicyclists can lead to a reduction of the recreation quality in recreational areas.

The direction of movement was significant in both approaches. It is remarkable that also the static approach is capable to investigate motion related factors. However, dynamic models were more sensitive to the direction of movemen. In particular, interactions between the direction of movement and the user composition could mainly be observed with the dynamic approach The evaluations of the recreational scenarios worsen when the direction of movement was towards the observers. Particularly oncoming bicyclists received low preference scores. Respondents seemed to dislike being confronted with many oncoming visitors, while preferring to walk or cycle behind others or being confronted with an equal share of oncoming and going away persons. The students were more sensitive to the direction of movement when the dynamic presentation was used (Table 2). Surprisingly, no significant interactions between a high level of use and the direction of movement was found.

Summarizing, high use levels, oncoming users and a high share of bicyclists were evaluated negatively. In particular, using the dynamic appraoch it was possible to asses respondents' preferences and interconections between various factors in detail. Although the number of visitors was in most cases the strongest predictor for respondents' preferences, some interactions with other social factors played a major role. At peak use times, for example, the evaluations of high share of bicaclists even worsen which would be of interest for park management. A similar results received Arnberger (2005) using a static image-based choice model of another recreation area in Vienna interviewing on-site visitors.

Because directly limiting the amount of visitors in urban recreational areas is not an acceptable management measure, the significant influence of other social factors on visitors' leisure experience offers additional options for managing urban trail use. The user composition of visitors and the direction of movement are found in this study - similar to several other studies (Arnberger & Haider, 2005) - as influencing social factors. A large share of bicyclists was evaluated negatively from all user groups, even regular bicyclists. Separating user groups and offering different trails for walkers and bicyclists might be an option to reduce conflicts. The direction of movement should be regulated for cycle trails, because oncoming bicyclists reduce respondents' acceptance of the trail conditions dramatically. For heavily crowded trails the acceptance could be improved through a rather homogenous direction of movement.

Limitations of this explorative study pertain to the low sample size and the homogeneous structure of respondents. All the 149 respondents were students of the BOKU in the second year of their "landscape architecture "study. To increase the quality of this study more respondents would have been necessary. Additionally, on-site visitors could be interviewed, but technically, this is not possible with the used presentation techniques (Video Beam). Also the graphic style and the motion of the presented visitors were till far away from realism, and probably could be improved a lot. It would be also interesting to investigate if and how different graphic styles and the abstraction from the genuine world influence the results.

Even though motion is one additional attribute in the investigation, there are other missing sensations people would have in real world like smell, noise (Newman, 2006; Manning, 2004) and even taste. In this study only three attributes were included, because of its focus on the comparison between static and dynamic trail use scenarios. However, animated choice experiments could include much more attributes (Haider, 2002). Also the issue how interactivity in means of how the respondent itself would move through a certain scenario might be of highest interest. Through recently rapidly developments real-time render- and sound engines it should be possible to investigate different factors which influence social carrying capacities of visitors in virtual environments.

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