Effect of Spatial Elements in an Open Space on a Subject's Psychological Perception

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Abstract

This study clarified the corresponding relation between spatial elements and a subject's psychological perception. The evaluation of subjects concerning open space could be generally divided into three factors. They are "Activeness", "Amenity" and "Openness". Also, according to the questionnaire survey results of 70 persons, the most popular waiting spaces in terms of function were "A place to sit", "A place with shade" and "A place that is most visible to a friend". However, according to the results of subjective evaluation, "Bench" and "Emptiness" had the worst evaluations regarding "Activeness" and "Amenity", indicating that although they met the functional demands of sitting when waiting or being seen by friends, they lacked surrounding feeling, and thus could not satisfy the psychological sense of security. In view of "Tree", it met the functional demands of shading in a subtropical climate; meanwhile, the surrounding feeling and shadow formed by its crown created a visual concealment effect, meeting the sense of security and became the most preferable waiting space.

Keywords: personal space; security; psychology; waiting; environment

1. Introduction

Interpersonal communication always involves face-to-face interaction, while face-to-face interaction may like to involve waiting action. Although the development of media, such as the telephone and internet, have changed people's communication modes, the interpersonal waiting action still remains. Unlike motion, waiting is a still action, and whether a person is willing to wait somewhere is related to psychological factors, in addition to geographic conditions and other objective factors. Sommer R. suggested that there is an invisible personal space around each person that they are reluctant to have invaded. When such space is invaded by other people or objects, people shift their positions to avoid the interference. Appleton J. indicated that, humans, just like animals, prefer to stay at a place where they can see others but can not be seen, in order to obtain a sense of security. Moreover, some researches have discussed the effects of spatial scale, such as ceiling height, room size and room scale, on the size of personal space. Based on the above, it can be concluded that the desired personal space can be affected by spatial scale, thus, psychological sense is closely related to space.

The waiting action of urbanites often occurs in an open space. However, when planning and designing open spaces, designers often focus on landscape or movement paths, while ignoring the demands of waiting action. Alternatively, they may consider waiting action only according to their subjective preference, while not meeting the subjects' needs. As a result, the relationship between waiting action and space form should be clarified. Ryuzo O. discussed the effect of different positions of backing and columns on the waiting positions chosen by people. The results indicated that, people choose to wait at a place where a backing or column can be used as a backrest. Jui-wen P. studied partitions in interior space, and arrived at the same conclusion. Although these findings confirmed Appleton's theory concerning sense of security and overlook, they failed to reflect senses other than the sense of security and overlook in a certain space. Meanwhile, no discussions were conducted on spatial elements other than backing and column. Say-uncle S. carried out direct observation and found that waiting often occurs in places suitable for leaning or sitting, such as corners, adjacent to columns and shaded or shadowy places. However, this study did not discuss the various psychological perceptions of people in the above-mentioned spaces.

Based on the above, this study aimed to discuss the psychological senses attributed to open space, which
consisted of different spatial elements, in order to clarify the corresponding relations between spatial elements and a subject's psychological perceptions, and provide references for future planning and design.

2. Methodology
2.1 Research setting
This study took the urban square as the representative open space to discuss whether there are different subjective evaluations, given the different surrounding spatial elements, when people are waiting in a square. Since the physical factors in the actual space were too complicated to control, in order to minimize the interference of the non-research variables, this study utilized spatial simulation, and added different spatial elements to the same scenario to produce various still images, in order to simulate different forms of open space. This study simulated six squares as a control group (Figs.1-6.) according to Say-uncle's conclusions[8], where "Wall" is a space that has a backrest; "Column" is a space adjacent to a column; "Tree" is a shaded or shadowy place, "Bench" is a space where the subject can sit, "Hedge" is a wall-like space and "Emptiness" is an empty square. Sunlight in the image was illuminated from a 45° angle to create a shadow; the white human figure is the position where the subject stands. To minimize the effect of the spatial elements color on the subjective evaluation, the six images are presented in black and white.

2.2 Subjective evaluation
Prior to the subjective evaluation, the basic data of the subjects, their preferred spatial characteristics, and waiting time according to their usual waiting action were obtained through a questionnaire survey. The subjects were asked to view six simulated images of the open space before the subjective evaluation. Remarks are placed next to each image to explain the represented spatial elements, in order to help the subjects understand the images. The SD method (7-level scale) was applied to the subjective evaluation, and the evaluation items consisted of 21 adjective pairs. There were 70 subjects, ages ranging from 18 to 40, including 44 males and 26 females. The waiting action discussed in this study was limited to the condition of a single person waiting for a friend.

3. Results
3.1 Subjects' attributes and spatial characteristics
The analytic results of the relationship between each subject's attribute and waiting spatial characteristics based on the questionnaire results of 70 subjects are shown in Figs.7-9. Male subjects preferred spaces with "A place to sit"(66%), "A place that is most visible to a friend"(61%), "A place with shade"(55%) and "A place with a view of the scenery"(50%), while females preferred "A place that is most visible to a friend"(69%), "A place with shade"(62%) and "A place to sit"(50%) (from most to least preferred). In terms of the age group, all preferred "A place that is most visible to a friend", "A place to sit" and "A place with shade", while "A place with a view of the scenery" is preferred by those under 30 years of age. In terms of waiting time and spatial characteristics, with an increase of the waiting time, subjects' demands for "A place with backrest", "A place with bright light", "A place with a view of the scenery" and "A place to see the crowd" tend to increase. Regardless of the length of waiting time, subjects' demands for "A place with shade", "A place to sit", and "A place that is most visible to a friend" are the strongest.

3.2 Psychological effects of all open spaces
Since each subject gave an evaluation of the open space formed by six spatial elements according to the SD method, all psychological effects generated by these six open spaces could be obtained through the average value of evaluation (Fig.10.). Among all evaluation items, psychological effects caused by
"Emptiness" inclined toward "Hot", "Bright", "Boring", "Visible", "Unpleasant", "Impatient", "Uncomfortable", "Uneasy", "Inappropriate", "Solitary" and "Open", where "Hot", "Bright", "Boring" and "Visible" were stronger. "Emptiness" was the control group, which had no shading, thus, it generated the above senses. The psychological effects caused by "Wall", "Column" and "Hedge" were close to neutral, without any specialty. Effects caused by "Bench" inclined to "Hot", "Bright", "Boring" and "Visible", while others were mostly close to neutral. "Tree" had obvious psychological effects in many evaluation items, such as "Pleasant", "Comfortable", "Easy", "Cool", "Relaxed", "Satisfying", "Loose", "Carefree", "Harmonious", "Appropriate", "Interesting", "Qualified", "Bustling", "Animated", "Open", "Vivid", "Cheerful" and "Slightly", which were approximately opposite to those resulting from "Emptiness".

3.3 Structure of evaluation in an open space

To ascertain the evaluation structure of subjects concerning open space and summarize the numerous evaluation items, this study applied the Factor Analysis (Principal components, Varimax rotation) on the initial evaluation results of these six open spaces. Since there were three factors in which the eigenvalue was over 1, the evaluation of subjects concerning open space could be generally divided into three factors (Table 1.). Factor 1 comprised 10 sets of evaluation items and its explanatory power was 31%. Since multiple groups reflected the activity and positivity of an open space, Factor 1 was "Activeness". Factor 2 comprised seven sets of evaluation items and its explanatory power was 28%. Since multiple groups reflected the preference and comfort degree of an open space, Factor 2 was "Amenity". Factor 3 comprised three sets of evaluation items and its explanatory power was 12%. Since these three groups reflected the openness and close degree of an open space, Factor 3 was "Openness". Altogether, these three factors comprised 20 sets of evaluation items, and their total explanatory ability was 71%. However, since the adjective pair "Restrained-Carefree" was not highly related to all the factors, it was not included.

Based on the results, the key factors affecting the subject's evaluation of an open space were "Activeness".
Since factor loadings represented the correlation degree between each factor and each evaluation item, as shown in Table 1., the open spaces with higher "Activeness" mostly had "Harmonious", "Appropriate" and other characteristics; while those with higher "Amenity" had "Satisfying", "Loose" and other characteristics; those with higher "Openness" had "Bright", "Open" and other characteristics.

3.4 Correspondence of six open spaces with three factors

To ascertain the degrees of "Activeness", "Amenity" and "Openness" in these six open spaces, this study labeled them in the figures taking each factor as the axis, according to the factor scores of three factors (Figs.11.-12.). As seen in the figures, in terms of "Activeness", "Tree" had the best performance, and then "Hedge", the next "Bench", followed by "Wall" and "Column", while "Emptiness" had the worst. In these six spaces, only "Tree" and "Hedge" had "Activeness" in a positive direction, therefore, the open spaces full of green had "Interesting", "Vivid" and "Animated" characteristics. In terms of "Amenity", also "Tree" had the best performance, followed by "Wall", "Hedge", "Bench" and "Column", while "Emptiness" had the worst. "Tree", "Wall" and "Hedge" had a positive "Amenity", thus, these three open spaces were more "Comfortable", "Easier" and more "Satisfying". In terms of "Openness", "Emptiness" had the highest score, and then "Bench", "Tree", "Column" and "Hedge", while "Wall" had the lowest. Six spaces could be classified into three types based on "Openness": "Emptiness" and "Bench" were at the positive end, belonging to open space, "Hedge" and "Wall" were at the negative end, belonging to more closed space, "Tree" and "Column" were close to 0, neither open nor closed.

According to the differences of these six spaces the elements, "Hedge" and "Wall" were of vertical plate-shaped elements, trunk of "Tree" and "Column" were cylindrical, while "Emptiness" and "Bench" were of empty and weak surrounding-feeling spaces.

3.5 Variable factors affecting the evaluation of an open space

To ascertain whether the kind of spatial elements and the attribute of subjects could affect the subjects' evaluation, this study took "spatial element", "gender" and "age" as independent variables and evaluated subjects based on three factors as dependent variables using Three-way ANOVA. As seen from the results, in terms of "Activeness", only the main effect of "spatial element" achieved a significant level (F(5, 384)=10.54, p<0.01), while those of "gender" and "age", as well as the interaction of "spatial element", failed to achieve the 5% significant level. This indicated that, different spatial elements might produce different evaluations; however, the subjects' gender and age had no effect on evaluation. In terms of "Amenity", similarly, only the
main effect of "spatial element" achieved a significant level (F(5,384)=23.04, p<0.01), and differences in gender and age had no effect on evaluation. In terms of "Openness", the main effects of both "spatial element" and "gender" achieved a significant level ("spatial element": F(5,384)=8.72, p<0.01; "gender": F(1,384)=4.90, p=0.027), while the main effect of age, interactions of "age" and "spatial element" as well as "gender" and "spatial element" failed to achieve the 5% significant level. Therefore, "gender" would affect the evaluation of "Openness", but "age" would not.

To confirm the significant performance difference (5% significant level) of two random spatial elements on "Activeness", "Amenity" and "Openness", this study took Multiple Comparisons (Tukey HSD) on "spatial element" based on the above-mentioned analytic results. As seen from the pair comparisons, "Emptiness" and "Hedge", "Emptiness" and "Tree", "Wall" and "Tree", "Column" and "Hedge", "Column" and "Tree", "Tree" and "Bench" had a 5% significant difference concerning "Activeness" (Table 2.). Except for "Wall" and "Hedge", "Column" and "Bench", "Hedge" and "Bench", other spatial elements had a 5% significant difference concerning "Amenity" (Table 3.). "Emptiness" and "Wall", "Emptiness" and "Column", "Emptiness" and "Hedge", "Wall" and "Tree", "Wall" and "Bench" as well as "Hedge" and "Bench" had a significant difference concerning "Openness" (Table 4.).

Except for the effect of "spatial element", according to the results of the Three-way ANOVA, "gender" had a significant effect (5% significant level) on the evaluation of "Openness". Except for "Tree" condition, females had a stronger preference for "Openness" than males concerning the same open space (Fig.13.).

3.6 The effect of three model factors
Based on the results of Factor Analysis, this study took Structural Equation Modeling further to find an effective model between "Activeness", "Amenity" and "Openness". As shown in Fig.14., this model (GFI=0.801, AGFI=0.752, CFI=0.892, RMSEA=0.106) indicates that "Openness" had a significant effect on "Activeness", and that "Activeness" had a significant effect on "Amenity" (1% significant level). The coefficient of standardized effect shows that the effect of "Activeness" on "Amenity" (0.85) was stronger than the effect of "Openness" on "Activeness" (0.55). Although no direct effect was found between "Openness" and "Amenity", the former had an indirect effect on the latter (0.85×0.55=0.47). In other words, "Amenity" was directly influenced by "Activeness", and indirectly by "Openness". However, the direct effect of "Activeness" on "Amenity" (0.85) was much stronger than the indirect effect of "Openness" on "Amenity" (0.47).

4. Discussions
This study discussed the psychologies of subjects waiting in an open space, which consisted of six spatial elements. As seen from the results, whether on "Activeness" or "Amenity", "Tree" had the best...
performance, while "Emptiness" had the worst. Therefore, an open space formed by "Tree" was most "Active", "Vivid" and "Comfortable", while "Emptiness" was the opposite. According to Appleton's theory\(^2\), whether a place could be a space where people would like to wait was related to whether it could provide a sufficient sense of security and overlook function. In this study, spaces with weak surrounding feeling, such as "Emptiness" and "Bench" also had weak "Amenity", probably because it could not satisfy the sense of security understood by Appleton. "Openness" of "Tree" and "Column" were both neutral, neither open nor closed. The lower part of "Tree" and "Column" were both cylindrical shapes, however, the "Amenity" of "Tree" was positive, and that of "Column" was negative, probably because the bulky crown provided a surrounding feeling above the head and created a large shadow, thus indirectly causing a visual concealment effect. In other words, one reason why "Tree" satisfied people was that it provides a sense of security while its overlook function is not affected. Moreover, "Bench" had a seat, which "Emptiness" did not, however, there was no significant difference in their "Openness" (Table 4.). The "Amenity" of "Bench" was significantly higher than "Emptiness" (Fig.11.), probably because "Bench" met the physiological demands of waiting. "Wall" and "Hedge" were both of vertical plate-shaped elements. Although "Hedge" had more green than "Wall", it had no significant difference concerning "Activeness", "Amenity" and "Openness" (Tables 2.-4.).

In terms of overlook, "Hedge" and "Wall" had a narrower overlook range; however, their "Amenity" was next to "Tree". "Emptiness", "Bench" and "Column" had a wider overlook range, but their "Amenity" was worse (Fig.11.). A space with greater invisibility had a stronger sense of security, but mostly had a weak overlook function. As seen from the results, in a spacious open space, compared to overlook function, subjects showed stronger demands concerning a sense of security.

5. Conclusions

According to the questionnaire survey results of 70 persons, the most popular waiting spaces in terms of function were "A place to sit", "A place with shade" and "A place that is most visible to a friend". However, according to the results of subjective evaluation, "Bench" and "Emptiness" had the worst evaluations concerning "Activeness" and "Amenity", indicating that although they had the functional demands of sitting when waiting or being seen by friends, they lacked surrounding feeling, and thus could not satisfy the psychological sense of security. In view of "Tree", it met the functional demands of shading in a subtropical climate; meanwhile, the surrounding feeling and shadow formed by its crown created a visual concealment effect, meeting the need for a sense of security and became the most preferable waiting space.

This study clarified the corresponding relation between spatial elements and the subjects' psychological perception. The results indicated that, a good waiting space could meet the functional demands, and more importantly, satisfy the subjects' psychological sense of security. In the future, designers may create more desirable open spaces based on this principle.

References

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