

Influence of the Seat Arrangement in Public Reading Spaces on Individual Subjective Perceptions

Jo-Han Chang, Chung-Jung Wu

Abstract—This study involves a design proposal. The objective of is to create a seat arrangement model for public reading spaces that enable free arrangement without disturbing the users. Through a subjective perception scale, this study explored whether distance between seats and direction of seats influence individual subjective perceptions in a public reading space. This study also involves analysis of user subjective perceptions when reading in the settings on 3 seats at different directions and with 5 distances between seats. The results may be applied to public chair design. This study investigated that (a) whether different directions of seats and distances between seats influence individual subjective perceptions and (b) the acceptable personal space between 2 strangers in a public reading space. The results are shown as follows: (a) the directions of seats and distances between seats influenced individual subjective perceptions. (b) subjective evaluation scores were higher for back-to-back seat directions with Distances A (10cm) and B (62cm) compared with face-to-face and side-by-side seat directions; however, when the seat distance exceeded 114cm (Distance C), no difference existed among the directions of seats. (c) regarding reading in public spaces, when the distance between seats is 10cm only, we recommend arranging the seats in a back-to-back fashion to increase user comfort and arrangement of face-to-face and side-by-side seat directions should be avoided. When the seat arrangement is limited to face-to-face design, the distance between seats should be increased to at least 62cm. Moreover, the distance between seats should be increased to at least 114cm for side-by-side seats to elevate user comfort.

Keywords—Individual Subjective Perceptions, Personal Space, Seat Arrangement.

I. INTRODUCTION

THIS study adopts a post-proposal design regarding seat arrangement in public reading spaces. The purpose of the design project is to create seat arrangement methods that can be adjusted freely without disturbing the users. The settings consider the desirable seat position for users to read in a comfortable personal space when staying with strangers in a room. Through the experimental results, this study facilitates the understanding of personal acceptable seat arrangement psychologically when reading with a stranger in a space. The results can provide a reference for designing public seats.

Individuals read in a public space may choose to be seated one or two seats away from a stranger who sits on the same row of seats. This is because each person adjusted their distance between others according to their personal space [1]. The

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scholars proposed the concept of personal space to represent the areas surrounding the body of a person [2], which is composed based on interpersonal distance and may change, extend, dwindle, or move according to the situation [3], [4]. The study tested the interpersonal distances and found that the interpersonal distance increased when familiarity between people decreased [5], [6]. This finding indicated that the range of personal space changes with the surroundings.

Previous studies had indicated that when interacting with a stranger in an open space, individuals tended to take seats in face-to-face or side-by-side seats. When interaction was not involved, individuals preferred back-to-back seats [7]. This result showed that in addition to distance between seats, the directions of seats influence individual psychological perceptions.

Based on the previously stated background and motivations, the objectives of this study are shown as follows:

- (1) Whether directions of and distances between seats influence the individual subjectively perceived comfort in a public reading space.
- (2) Acceptable seat arrangement for two strangers in a public reading space.

Another study suggested that interpersonal distances of women were shorter compared with men. The distance between men was largest [8]. To minimize the seat dimensions in a public reading space in this study in response to an insufficient public space, the research participants were men.

II. LITERATURE REVIEW

This study investigated whether direction of seats and distance between seats influence individual subjectively perceived comfort. Thus, we compiled directions of and distances between seats recommended by literature to establish the standard variables for experimental directions of and distance between seats in this study.

The personal space concept was proposed [2]. The scholars defined personal space as the invisible region surrounding a person's body that allowed no encroachment by other people [3], [4]. A cultural anthropologist compared this invisible region as a bubble-like space, which surround individuals like a doughnut [9]. Another scholar considered that personal distance represents an invisible bubble [4].

Personal space is an invisible space that surrounds individuals and changes in range with individual cognition [10]. Through personal space, we can control the distance in staying close or away from other people in sight, facilitating adjustment of interpersonal emotional responses [11], [12]. For example, when people take escalators, they intentionally choose keep a

distance from others to avoid contact and preserve personal space.

A scholar proposed the concept of personal space in "The Hidden Dimension" [9]. The distance between individuals is a nonverbal communication method. People use different space ranges according to contextual conditions. Hall contended that interpersonal interactions include four distances: intimate, personal, social, and public distances. In addition, the four distances were specified as 0-45cm (intimate distance), 45-120 cm (personal distance), 120-350cm (social distance), and 360 cm or above (public distance). Because the public reading space is limited, seat arrangement cannot reach the recommended value for public distance at 360cm or above, we included the public seat size (42cm) and the distance between seats (10cm) and set the distance variables in the experiments as 10, 62, 114, 166, and 208cm. We proposed three directions for seats, namely, face-to-face, side-by-side, and back-to-back, as the experimental variables of seat directions [7].

III. RESEARCH METHODS

A. Participants and Test Time

1. Participants: 30 men aged 20 to 65 years who did not know each other.
2. Test time: January 2014.

B. Experimental Variables

1. Independent Variable

- (1) Seat Directions: Three criteria comprising face-to face, side-by-side, and back-to-back directions, shown in Fig. 1.
- (2) Distance between Seats: Five criteria comprising distances of 10, 62, 114, 166, and 208 cm between two individuals, shown in Fig. 2.

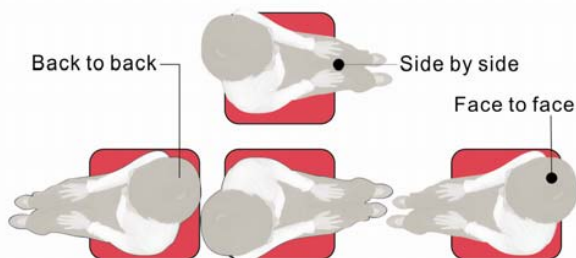


Fig. 1 Seat directions

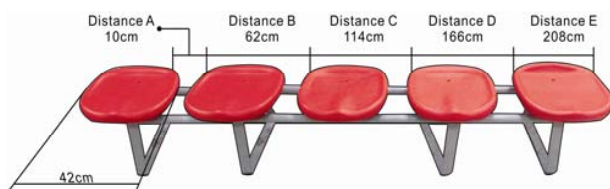


Fig. 2 Distance between seats

1. Control Variable: Participants were all men; the environment (Taipei Railway Station) and seats were set to be identical.

2. Dependent Variables: A subjective perception scale based on a 7-point Likert scale (extremely uncomfortable: 1 point; extremely comfortable: 7 points). We requested the participants to read during the experiment and recorded their subjective perception subsequently.

C. Experimental Steps

3. We explained the experimental procedure and methods to the participants.
4. We installed seats of three directions in a public space and assigned the first participant to be seated on Seat A.
5. The second participant was assigned to be seated based on three seat directions and five distance between seats, totaling 15 combinations of seat arrangement for the experiment. The experiment was conducted for 1 to 2 min reading for each parameter setting. The overall experiment time was 15 to 20 min.
6. After completion of reading in each arrangement, the participant was asked to complete a subjective perception scale.
7. The experiment ended.

D. Statistical Analysis

1. Descriptive Statistics: Subjectively perceived comfort under different arrangement of seat directions and distance between seats.
2. Two-Way ANOVA
 - (1) Whether the direction of seats influences the participant's subjectively perceived comfort when reading with a stranger.
 - (2) Whether the distance between seats influences the participant's subjectively perceived comfort when reading with a stranger.
 - (3) Whether the interaction between seat directions and distances influences the participant's subjectively perceived comfort when reading with a stranger.

IV. EXPERIMENTAL RESULTS

This study recruited 30 male adults aged 20 to 65 years.

A. ANOVA Results

1. Test of Homogeneity:

Levene test for equality of error variance is also known as the test for variance homogeneity. The F value was 1.241 and p value was $.242 > .05$, accepting the null hypothesis. This result represented that the error variances of dependent variables were identical, exhibiting homogeneity.

2. ANOVA:

Table I shows the two-way ANOVA result, which tested the effect terms between participants. The result indicated that significant difference existed in the five seat distance variables ($F = 291.028$, $p = .000 < .05$) and the three seat direction variables ($F = 13.921$, $p = .000 < .05$). The interaction between seat distances and directions also exhibited significant difference ($F = 6.405$, $p = .000 < .05$).

TABLE I
TEST RESULTS FOR THE EFFECT TERMS BETWEEN THE PARTICIPANTS

Source	Type III sum of squares	F	Significance
Seat distance	1073.819	291.028	.000
Seat direction	25.682	13.921	.000
Seat distance * Seat direction	47.265	6.405	.000

Subsequently, we conducted ANOVA of seat directions with differing seat distances. All variables passed the test of homogeneity, where Distances A ($p = .000 < .05$) and B ($p = .006 < .05$) exhibited significant difference, but Distances C ($p = .248 > .05$), D ($p = .959 > .05$), and E ($p = .468 > .05$) did not show significant difference.

B. Analytic Results of Multiple Comparisons

1. Analytic Results of Multiple Comparisons (Scheffe) Regarding Seat Distances

Table II shows the analytic results of multiple comparisons regarding seat distances. Significant differences were observed among all criteria ($p < .05$), indicating that the distance of seat arrangement installed in this experiment influenced personal psychological perceptions.

TABLE II
MULTIPLE COMPARISON RESULTS REGARDING SEAT DISTANCES

(I) Seat distance	(J) Seat distance	Significance
Distance A	Distance B	.002
	Distance C	.000
	Distance D	.000
	Distance E	.000
	Distance A	.002
Distance B	Distance C	.000
	Distance D	.000
	Distance E	.000
	Distance A	.000
	Distance B	.000
Scheffe Distance C	Distance D	.000
	Distance E	.000
	Distance A	.000
	Distance B	.000
	Distance C	.000
Distance D	Distance B	.000
	Distance C	.000
	Distance E	.000
	Distance A	.000
	Distance D	.000
Distance E	Distance B	.000
	Distance C	.000
	Distance D	.000
	Distance E	.000

2. Analytic Results of Multiple Comparisons Regarding Seat Directions

Table III shows the analytic results of multiple comparisons regarding seat directions. Significant differences existed between side-by-side and face-to-face variables ($p = .013 < .05$) and between side-by-side and back-to-back variables ($p = .00 < .05$). However, no significant difference existed between back-to-back-and face-to-face variables ($p = .071 > .05$).

TABLE III
ANALYTIC RESULTS OF MULTIPLE COMPARISONS REGARDING SEAT DIRECTIONS

(I) Seat direction	(J) Seat direction	Significance	
Scheffe	Face-to-face	Side-by-side	.013
		Back-to-back	.071
	Side-by-side	Face-to-face	.013
		Back-to-back	.000
	Back-to-back	Face-to-face	.071
		Side-by-side	.000

3. Analytic Results of Multiple Comparisons Regarding Seat Directions within a Given Distance Between Seats

We organized the analytic results of multiple comparisons regarding seat directions within Distances A and B, which had passed the test of homogeneity. The results are shown in Tables IV and V.

- (1) Significant difference existed between the three seat directions in Distance A.
- (2) In Distance B, only side-by-side and back-to-back directions exhibited significance, whereas multiple comparison results of other seat directions showed no significant differences.

TABLE IV
MULTIPLE COMPARISON RESULTS OF PERCEPTIONS IN DISTANCE A

(I) Seat direction	(J) Seat direction	Standard error	Significance	
Distance A	Face-to-face	Side-by-side	.04804	.001
		Back-to-back	.04804	.001
	Side-by-side	Face-to-face	.04804	.001
		Back-to-back	.04804	.000
	Back-to-back	Face-to-face	.04804	.001
		Side-by-side	.04804	.000

TABLE V
MULTIPLE COMPARISON RESULTS OF PERCEPTIONS IN DISTANCE B

(I) Seat direction	(J) Seat direction	Standard error	Significance	
Distance B	Face-to-face	Side-by-side	.248	.120
		Back-to-back	.248	.505
	Side-to-side	Face-to-face	.248	.120
		Back-to-back	.248	.007
	Back-to-back	Face-to-face	.248	.505
		Side-by-side	.248	.007

C. Descriptive Statistics Results

The analytic results shown above indicate that seat distance, direction, and interaction between distance and direction influenced the participants' subjective perceptions. Descriptive statistics results are shown in Table VI.

TABLE VI
RESULTS OF DESCRIPTIVE STATISTICS

Direction	Face-to-face	Side-by-side	Back-to-back	Total
Distance	Mean (SD)	Mean (SD)	Mean (SD)	Mean (SD)
A	2.26(.930)	1.45(.723)	3.39(1.202)	2.37(.974)
B	3.03(1.110)	2.52(.926)	3.32(.871)	2.96(.405)
C	4.68(1.013)	4.39(1.174)	4.81(.792)	4.63(.215)
D	5.65(1.112)	5.65(.915)	5.58(.992)	5.63(.040)
E	6.42(.923)	6.42(.765)	6.19(.792)	6.43(.132)
Mean (SD)	4.41(1.861)	4.08(2.076)	4.66(1.483)	

- (1) The ANOVA results showed that seat distances influenced individual subjective perceptions. Table VI shows that smaller distance yielded lower average scores, representing decreased comfort. By contrast, larger distance yielded higher average scores, representing increased comfort.
- (2) The ANOVA results indicated that seat directions influenced individual subjective perceptions. Regarding the average scores of the three directions in various distances, the back-to-back direction was the highest (mean = 4.66 ± 1.483 SD), followed by face-to-face (mean = 4.41 ± 1.861 SD) and side-by-side directions (mean = 4.08 ± 2.076 SD). This result shows that the back-to-back seat direction provided the greatest perceived comfort, the side-by-side direction the least.
- (3) In Distances A, B, and C, the average scores were the lowest for the side-by-side direction and the highest for the back-to-back direction. However, in Distances D and E, the averages scores for face-to-face and side-by-side directions were higher than that of the back-to-back direction.
- (4) The analytic results of multiple comparisons showed that significant distance existed in Distances A and B, whereas no significant difference was observed in Distances C, D, and E. The three seat directions in Distance A showed significant difference, where the average scores from high to low in order were observed in back-to-back, face-to-face, and side-by-side directions. In Distance B, only side-by-side and back-to-back directions showed significant difference; the average score for the back-to-back direction was higher than that of the side-by-side direction.

V. CONCLUSION AND DISCUSSION

A. Different Seat Directions and Distances May Influence Personal Perceptions

1. Distances influenced personal perceptions. Regardless of the distance between the participants, their perceived comfort was significantly influenced.
2. Seat directions influenced personal perceptions, especially in Distances A (10cm) and B (62cm). We suggest back-to-back directions to be used for seats with a distance of 10cm (Distance A), back-to-back or face-to-face direction for seats with a distance of 62cm (Distance B); yet, back-to-back direction is a superior choice. However,

when the distance exceeds 114cm (Distance C, D, and E), no difference exists among the three directions.

B. Acceptable Personal Space Range between Two Strangers

1. As the distance between seats increased from Distances A to E, the participants' subjectively perceived comfort increased. This result is identical to literature that proposed by Hall [9], arguing that longer distance yielded higher comfort.
2. Overall, the back-to-back direction was superior to the face-to-face direction, which was superior to the side-by-side direction. In particular, the difference in perceptions of the three directions was significant in Distance A (10cm). This result is identical to the conclusion provided in the study by Okada and Takahashi [7], stating that back-to-back positions were preferred when interaction was not involved. We also found that the side-by-side direction caused the greatest discomfort to the participants when reading with a stranger in a space.
3. Based on the results of this study, we proposed the following suggestions. When distance between seats is 10 cm in a public reading space, a back-to-back arrangement is recommended to provide high comfort to users. In addition, face-to-face, and side-by-side arrangement should be avoided. When face-to-face arrangement is the only choice, the distance between seats should be increased to at least 62cm. When the side-by-side arrangement is the only option, the distance between seats should be increased to at least 114cm to increase user comfort.

The design proposal based on the conclusion of this study is shown in Fig. 3. Considering the limitations of public spaces and differing reading habits of users in the public space, the design enables users to select their positions and sitting directions according to their familiarity with other readers. When the number of readers increases, the users may not be able to choose positions at will and be seated between two other readers. The design enables the users to turn the seat to the back-to-back direction, allowing two strangers to be seated with comfort and reducing the waste of space.



Fig. 3 Seat design in a public reading space

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