

## Effects of an indoor plant on creative task performance and mood

SEIJI SHIBATA<sup>1</sup> and NAOTO SUZUKI<sup>2</sup>

<sup>1</sup>*Bunkyo Gakuin University, Japan*

<sup>2</sup>*Doshisha University, Japan*

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In this study, we investigated the effect of an indoor plant on task performance and on mood. Three room arrangements were used as independent variables: a room with (1) a plant, or (2) a magazine rack with magazines placed in front of the participants, or (3) a room with neither of these objects. Undergraduate students ( $M = 35$ ,  $F = 55$ ) performed a task of associating up to 30 words with each of 20 specified words in a room with one of the three room arrangements. Task performance scores showed that female participants performed better in view of the plant in comparison to the magazine rack ( $p < 0.05$ ). Moreover, mood was better with the plant or the magazine rack in the room compared to the no object condition ( $p < 0.05$ ). However, the difference in task performance was highly influenced by the evaluation about the plant or the magazine rack. It is suggested that the compatibility between task demand and the environment is an important factor in facilitating task performances.

*Key words:* Indoor plant, task performance, association task.

*Seiji Shibata, Department of Human Studies, Bunkyo Gakuin University, 1196 Kamekubo, Oimachi, Iruma-gun, Saitama 356–8533, Japan. Fax: +81 49-261-6496; E-mail: sshibata@hum.u-bunkyo.ac.jp*

In recent years, there have been an increasing number of studies on the effect of natural environments on humans. There is much evidence that being in natural environments, or just looking at nature, promotes recovery from stress (e.g., Bell, Greene, Fisher & Baum, 2001; Hartig, Mang & Evans, 1991; Hartig, Böök, Garvill, Olsson & Gärling, 1996; Herzog, Black, Fountaine & Knotts, 1997; R. Kaplan, 2001; S. Kaplan, 2001; Ulrich, 1984; Ulrich, Simons, Losito, Fiorito, Miles & Zelson, 1991). For example, inpatients assigned to a room with a view of nature recovered faster than those assigned to a room with windows facing a brick building (Ulrich, 1984). In the workplace, Heerwagen and Orians (1986) found that the lack of a window in the office is associated with the quantity of decor containing nature-dominant visual materials, substituting for the view from the window, suggesting that visual contact with nature may be important to the room occupants' well-being. In the residential context, it has also been suggested that views of nature from windows enhances residents' sense of well-being (R. Kaplan, 2001). One study suggests that even an exposure to photos or films of natural scenes may have similar effects. Viewing a 10-minute video dominated by natural elements (trees, vegetation, or water) after the participants were stressed by a video of industrial accidents facilitated recovery from stress, as indicated by lowered blood pressure, lowered muscle tension, and skin conductance (Ulrich *et al.*, 1991). In addition, Hartig *et al.* (1996) found that the photographic simulation of natural environments affected participants' emotional self-reports in a positive direction. Moreover, Shibata and Suzuki (2001) have suggested that even a few indoor plants can accelerate recovery from mental fatigue. In their study, the recovery rate of participants' task score after a five-minute break was

greater when there were plants in the room than without any plants. Similarly, it has been demonstrated that the presence of indoor plants reduced eye fatigue caused by operating visual display terminals (Asaumi, Nishina, Nakamura, Masui & Hashimoto, 1995; Kondo & Toriyama, 1989). The rating scale measures of the restorative components of nature and city environments were developed by Laumann, Gärling, and Stormark (2001).

Although viewing nature generally improves mood and facilitates physiological recovery from stress, in some cases, it may have a negative effect on performance, or on task perception (Stone & Irvine, 1993, 1994; Stone, 1998). For example, though a room with a window results in more positive perceptions regarding creative tasks, a room without windows led to more positive perceptions regarding a simple repetitive task (Stone & Irvine, 1994). A similar finding was reported related to the presence of indoor plants. Larsen, Adams, Deal, Kweon, and Tyler (1998) examined the relationship between the quantity of indoor plants and participants' task performance. They found that the performance of a letter identification task decreased as the quantity of indoor plants increased, though mood evaluations were more positive when indoor plants increased. In another study, however, the scores of an association task – generating up to 30 items associated with a specified word – were lower with no indoor plant compared to when a plant was placed in the room (Shibata & Suzuki, 2002). These studies suggest that the effects of viewing plants on task performance may be task dependent. One possible explanation of task dependence might be the role of attention. According to the attention restoration theory (ART) proposed by Kaplan (Kaplan & Kaplan, 1989; Kaplan, 1995; Tennessen & Cimprich, 1995),

natural scenes contain many interesting characteristics that effortlessly attract attention. When participants are engaged in a computation task or a sorting task, which requires much attention, the view from the window may be a distraction (Stone & Irvine, 1994). When engaged in a creative task, however, a view of nature may facilitate the generation of more diverse response (Shibata & Suzuki, 2002). Positive mood promoted by the view of nature may be another possible explanation of the task dependent effect of natural scenes. A number of studies have suggested that viewing nature causes a positive affective state in people (Kaplan & Kaplan, 1989; R. Kaplan, 1993, 2001; Korpela, Klemettilä & Hietanen, 2002; Larsen *et al.*, 1998; Ulrich, 1981; Ulrich *et al.*, 1991). It is also known that creativity increases when people are in a positive mood (Hirt, Levine, McDonald & Melton, 1997; Isen, 2000; Knez, 1995). In explaining their results, Larsen *et al.* (1998) hypothesized that as the amount of indoor plants increased, the more positive the participants feel. The more positive were the participant's feelings, the more task irrelevant materials were recalled, which interfered with the assigned task.

In this study, we investigated the effects of an indoor plant on the performance of an association task, and on mood. We were especially interested in whether the plant affected task performance by facilitating information, or by facilitating positive mood. In this study we used three different room environments. In the first condition, the room contained a potted plant. In the second condition the room contained a magazine rack with magazines and books to control for the effect of information. If the facilitative effect of the plant on performance was due to the information it contained (e.g., colors and shapes), then the magazine rack would show a similar effect on task performance. Otherwise, if the effect were caused by the positive mood facilitated by the view of nature, participants' task performance with the plant should be better compared to the magazine rack condition. The third condition with no plant or magazine rack was designed to control for the presence of an object.

## METHOD

### Participants

Ninety undergraduate students (male 35, female 55) who volunteered by signing a roster for extra credit for participation took part in the study.

### Task

We used an association task that required participants to generate and note up to 30 words associated with a given word.

### Task environment

The room used in this study was 278 cm (W) × 581 cm (D) × 235 cm (H), and contained one 89.5 cm × 89.5 cm desk and a chair. It

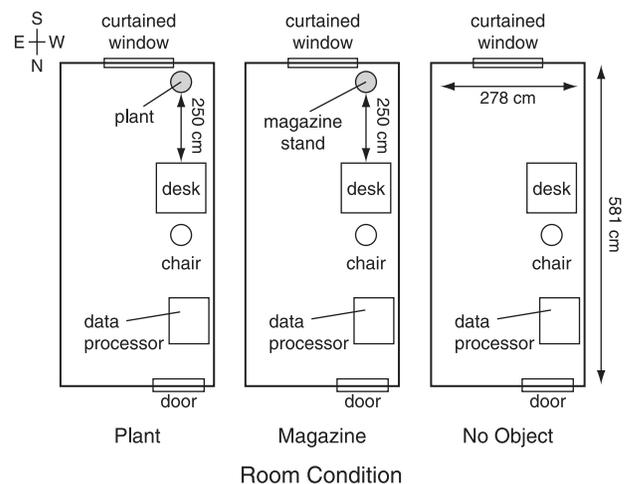


Fig. 1. Room arrangement for each condition.

had one window in the south and one door in the north side. The window was curtained and covered with blinds so that participants could not see outside. The desk was placed 250 cm from the south wall and 180 cm from the east wall. The participants were seated on the north side of the desk, facing south. We employed the three conditions shown in Fig. 1. In the *plant condition*, a 1.5 m high, potted *Massangeana Dracaena* (*Dracaena fragrans* cv. *Massangeana*) was placed in front of the participant, near the south wall. A *Massangeana* was chosen because it is a commonly available. In the *magazine condition*, a 26 cm (W) × 35 cm (D) × 135 cm (H) magazine rack with magazines and catalogues was placed in front of the participant instead of the plant. The magazines were chosen because of their colorfulness and diversity of information. In the *no object condition*, no plant or rack was present in the room.

### The questionnaire

To assess the participants' mood state, we used a questionnaire with a seven-point scale: 1 (*strongly disagree*) to 7 (*strongly agree*). We used nine terms: happy, tired, calm, confident, tense, concentrated, at-ease, energized, and distracted. In addition, eight more terms were used to assess participants' feelings regarding the task: amusing, tiresome, easy, monotonous, boring, distracting, difficult, and focusing. The questionnaire also assessed the participants' subjective performance evaluation and self-confidence regarding performance. We used 12 items to assess feelings regarding the task environment: sober, energetic, distracting, spacious, tense, bright, tranquil, familiar, noisy, dark, concentrating, and small. The questionnaire also assessed participant's feelings regarding the effect of the environment on task performance. In the plant and the magazine conditions, eight more terms were used to assess the participants' feelings regarding the plant or the magazine rack: calm, lively, distracting, natural, familiar, tranquil, artificial, and liking. In addition, participants were asked to evaluate the degree of distraction caused by the plant or the magazine rack.

### Procedure

Participants ( $n = 30$ ) were randomly assigned to each of the three conditions (11 males and 19 females in the magazine condition, and 12 males and 18 females in the plant and no object conditions) and tested individually. After the participants entered the room and were seated, they were asked to wait in the room for 5 minutes while the

experimenter went out. Five minutes later, the experimenter came back into the room and the participants were asked to evaluate their mood. Upon completion of the evaluation, they were given the following instructions: "generate up to 30 words associated with each of the listed adjectives. There is no particular order to follow in this task, so if you get stuck with a particular adjective, you can go on to the next one." The participants were given 10 minutes for the task. After giving the participants a signal to start the task, the experimenter left the room. After 10 minutes, the experimenter came back into the room. The number of associations the participants had made were recorded and used as the task score. After completing the task, the participants were again asked to evaluate their mood, the tasks, and the indoor environment. The participants also evaluated the plant or the magazine rack placed in front of them, except in the "no object" condition.

## RESULTS

### Task score

The total number of words the participants generated was regarded as the task score. Figure 2 shows the mean task scores under each of the room conditions. An analysis of variance (ANOVA) with Room  $\times$  Gender as the main terms indicated that the main effect of gender was significant ( $F(1, 84) = 14.00, p < 0.01$ ). The task scores were higher in females than in males. Moreover, a weak Room  $\times$  Gender interaction was noted ( $F(2, 84) = 2.87, p < 0.10$ ). A post hoc analysis of the Room  $\times$  Gender interaction showed that the simple effect of gender was significant ( $F(1, 84) = 16.40, p < 0.01$ ). Also, the simple main effect of room on female participants was significant ( $F(2, 84) = 4.57, p < 0.05$ ). The results of Tukey–Kramer's HSD test showed that the female

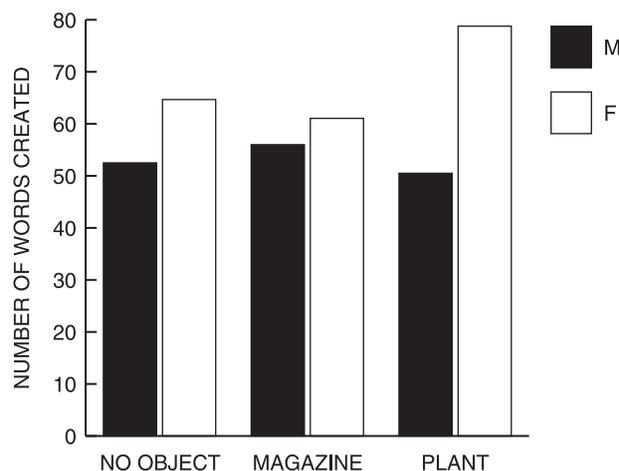


Fig. 2. Task scores under each environment.

participants under the plant condition achieved higher task scores than under the magazine condition ( $HSD = 14.77$ , alpha level = 0.05).

### Questionnaire

**Mood evaluation.** Table 1 shows the mean pre and post-task mood evaluation scores. A Room  $\times$  Gender  $\times$  Time (pre and post-task) multivariate analysis of variance (MANOVA) was conducted on the mood evaluation scores. Evaluation scores for all nine items were entered into a MANOVA as dependent

Table 1. Mean evaluation scores for each variables (SDs are in parentheses)

Variables	No object		Magazine		Plant	
	Pre-task	Post-task	Pre-task	Post-task	Pre-task	Post-task
<i>Females</i>	<i>n</i> = 18		<i>n</i> = 19		<i>n</i> = 18	
Happy	3.72 (1.13)	3.44 (1.42)	3.42 (1.30)	3.79 (1.03)	3.94 (0.94)	3.94 (1.06)
Tired	4.00 (1.41)	4.44 (1.25)	4.21 (1.69)	4.47 (1.07)	4.94 (1.26)	4.89 (1.57)
Calm	4.61 (1.38)	3.67 (0.77)	4.68 (1.49)	4.21 (1.18)	4.61 (1.20)	4.22 (0.88)
Confident	2.89 (1.41)	2.56 (1.04)	3.21 (1.23)	3.26 (1.05)	3.39 (1.20)	3.50 (1.54)
Tense	3.50 (1.10)	3.50 (1.38)	3.68 (1.53)	3.47 (1.47)	3.89 (1.60)	3.06 (1.00)
Concentrated	3.28 (1.23)	4.11 (1.02)	3.68 (1.45)	4.42 (1.26)	3.44 (1.29)	4.83 (1.25)
At ease	4.22 (1.22)	3.39 (1.24)	3.89 (1.33)	3.95 (1.13)	4.56 (1.10)	4.11 (1.08)
Energized	3.28 (1.60)	3.39 (1.24)	2.95 (1.22)	3.11 (1.29)	3.50 (1.20)	3.56 (1.29)
Distracted	3.17 (1.42)	3.44 (1.46)	3.11 (1.49)	3.05 (1.22)	3.50 (1.25)	2.67 (1.08)
<i>Males</i>	<i>n</i> = 12		<i>n</i> = 11		<i>n</i> = 12	
Happy	3.42 (1.44)	3.08 (1.51)	4.09 (1.22)	4.27 (1.19)	3.50 (1.24)	3.42 (1.62)
Tired	3.92 (2.19)	4.33 (2.31)	4.27 (0.65)	4.18 (1.33)	4.00 (1.21)	4.75 (1.22)
Calm	4.75 (1.91)	3.33 (1.37)	4.45 (1.44)	3.27 (1.01)	5.17 (0.94)	3.58 (1.31)
Confident	3.33 (1.44)	2.42 (1.31)	4.00 (0.63)	3.73 (0.79)	3.67 (0.98)	2.92 (1.16)
Tense	3.00 (1.81)	3.08 (1.78)	4.18 (1.54)	3.91 (1.14)	3.92 (1.44)	4.08 (0.79)
Concentrated	3.42 (1.24)	4.33 (1.67)	3.64 (1.21)	4.82 (1.66)	4.50 (1.09)	4.58 (1.44)
At ease	4.50 (1.24)	3.00 (1.60)	4.36 (1.29)	3.91 (1.14)	4.25 (1.14)	3.75 (1.14)
Energized	2.50 (1.62)	2.58 (1.44)	4.00 (1.10)	3.64 (1.29)	3.58 (1.38)	3.42 (0.90)
Distracted	2.33 (1.15)	3.08 (1.44)	3.27 (1.49)	3.27 (0.90)	2.92 (1.38)	3.17 (1.19)

Table 2. Canonical variate correlations for each variables on the main effects of Time and Room and the interaction of Room  $\times$  Gender

	Time	Room	Room $\times$ Gender
Happy	0.017	0.379	0.438
Tired	-0.167	0.278	0.003
Calm	0.681	0.208	-0.232
Confident	0.252	0.698	0.244
Tense	0.109	0.458	0.370
Concentrated	-0.559	0.461	-0.008
At ease	0.432	0.350	0.140
Energized	0.013	0.528	0.700
Distracted	-0.043	0.103	0.346

variables. The MANOVA indicated that the main effect of Time ( $F(9, 160) = 6.09, p < 0.01$ ) and the Room  $\times$  Gender interaction ( $F(18, 320) = 1.73, p < 0.05$ ) were significant. Moreover, a weak main effect of Room was noted ( $F(18, 320) = 1.54, p < 0.10$ ). Table 2 shows the canonical variate correlations (CVCs) of the main effect of Time and Room, and Room  $\times$  Gender interaction. It indicates that the evaluation scores for "Calm" and "Concentrated" represent the difference between pre and post-task mood evaluations. Also, the scores of "Confident" and "Energized" represents the difference between mood evaluations under each of the Room conditions. A multivariate multiple comparison test using Hotelling's  $T^2$  showed that mood evaluations were significantly different between the plant condition and no object condition ( $F(9, 160) = 2.14, p < 0.05$ ). Also, comparison of the magazine condition and no object condition showed a weakly significant difference ( $F(9, 160) = 1.93, p < 0.10$ ). The evaluations scores of "Confident" and "Energized" under no object condition were lower than under the other two conditions (the weighted means of the mood evaluation scores were 5.15 ( $SD = 1.05$ ) under the no object condition, 5.79 ( $SD = 1.10$ ) under the magazine condition, and 5.95 ( $SD = 0.83$ ) under the plant condition). The evaluation score of "Energized" represents the Room  $\times$  Gender interaction. In the Room  $\times$  Gender interaction, evaluations by males were significantly different between the magazine condition (weighted mean of evaluation scores was 3.66,  $SD = 0.89$ ) and no plant condition (weighted mean was 2.06,  $SD = 1.19$ ;  $F(9, 56) = 2.84, p < 0.01$ ). There was no significant difference in the evaluation score between the plant condition (weighted mean was 2.76,  $SD = 0.80$ ) and the other two conditions. Evaluations scores by females showed no significant difference between the three room conditions.

To identify the contribution of individual items in the Room and Time main effects, and Room  $\times$  Gender interaction,  $F$ -to-remove values (Bray & Maxwell, 1985; Huberty, 1984; Huberty & Morris, 1989) were also calculated for each nine items by partialing out the other items. The  $F$ -to-remove values showed that "Calm," "Tense," and "Concentrated" were important for the main effect of Time ( $F(1, 165) = 10.42,$

Table 3. Least squares mean evaluation scores and standard errors (in parentheses) of "Calm," "Tense," and "Concentrated" on pre and post-task

	Pre-task	Post-task
Calm**	4.51 (0.12)	3.90 (0.12)
Tense*	3.89 (0.15)	3.31 (0.15)
Concentrated**	3.64 (0.13)	4.50 (0.13)

$n = 90$ . \* $p < 0.05$ , \*\* $p < 0.01$ .

Table 4. Least squares mean evaluation scores and standard errors (in parentheses) of "Tired" and "Confident" under each Room condition

	No object	Magazine	Plant
Tired	4.10 (0.20)	4.31 (0.20)	4.71 (0.19)
Confident	3.01* (0.13)	3.47* (0.13)	3.25 (0.13)

$n = 60$ . \* $p < 0.05/3$ .

$p < 0.01$ ;  $F(1, 165) = 7.29, p < 0.01$ ;  $F(1, 165) = 21.16, p < 0.01$ , respectively). Moreover, "Tired" and "Confident" were important for the main effect of Room ( $F(2, 165) = 3.31, p < 0.05$ ;  $F(2, 165) = 3.58, p < 0.05$ , respectively), and "Energized" was important for the Room  $\times$  Gender interaction ( $F(2, 165) = 4.26, p < 0.05$ ). Also, weak significance of "Calm" for the Room  $\times$  Gender interaction was noted ( $F(2, 165) = 2.69, p < 0.10$ ).

Table 3 shows the least squares means (LS Means) and the standard errors of pre and post-task evaluations under "Calm," "Tense," and "Concentrated." The results of a post-hoc test showed that evaluations of "Calm" and "Tense" were higher for the pre-task than for the post-task condition, and evaluation of "Concentrated" was lower for the pre-task than for the post-task condition.

Table 4 shows the least squares means and the standard errors of "Tired" and "Confident" under each Room condition. Multiple comparisons with Tukey-Kramer's adjustment showed that the difference between the least squares means of the evaluation scores of "Confident" under the magazine condition and under the no object condition was significant ( $t(160) = 2.52, p < 0.05$ ). Also, the difference between the least squares mean of the evaluation scores of "Tired" under the plant condition and under no object condition had a weak significance ( $t(160) = 2.20, p < 0.10$ ).

Simple main effects of Gender on each Room condition were calculated for "Calm" and "Energized" respectively (Figs. 3 and 4). The result of the post-hoc test shows that in males, evaluation scores of "Calm" were significantly lower than in females under the magazine condition ( $F(1, 165) = 7.52, p < 0.01$ ) and that in males evaluation scores of "Energized" were significantly lower than in females under the no object condition ( $F(1, 165) = 8.36, p < 0.01$ ).

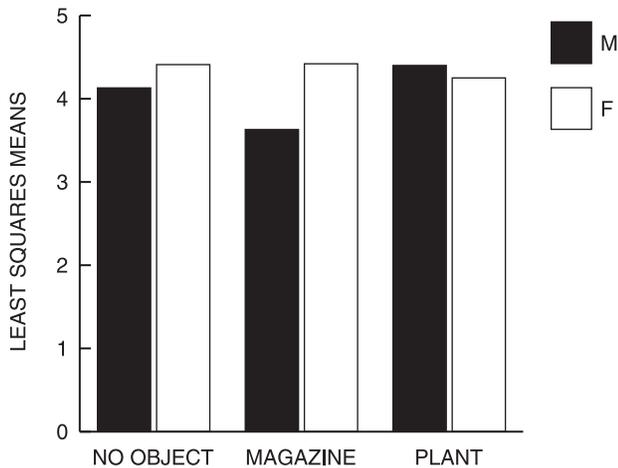


Fig. 3. Least squares means of "Calm" under each condition.

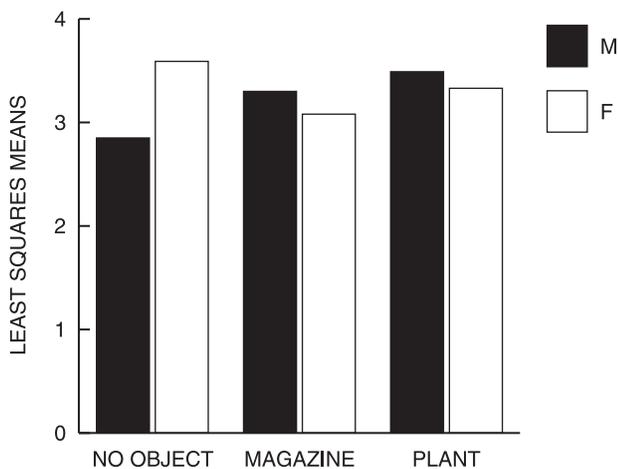


Fig. 4. Least squares means of "Energized" under each condition.

To examine the effects of pre-task to post-task mood changes on task score under the three Room conditions, an analysis of variance (ANOVA) was performed on task scores after removing the covariates of "Calm," "Tense," and "Concentrated." The results indicated that the main effect of Gender remained significant ( $F(1, 78) = 21.25, p < 0.01$ ) and that the Room  $\times$  Gender interaction had a weak significance ( $F(2, 78) = 3.05, p < 0.10$ ). A multiple comparison with Tukey–Kramer adjustment showed that the difference in task scores between the magazine and the plant conditions in females remained weakly significant ( $t(80) = 2.81, p < 0.10$ ). Next, scores of "Tired" and "Confident" were removed from the analysis to examine the effect of differences in mood evaluation between each room condition. Results indicated that the main effect of Gender and the Room  $\times$  Gender interaction were significant ( $F(1, 80) = 16.12, p < 0.01$ ;  $F(2, 80) = 3.15, p < 0.05$ ). The result of multiple comparison analysis indicated that the difference in task scores between the magazine condition and the plant condition in females

was significant ( $t(80) = 3.01, p < 0.05$ ). Moreover, scores of items "Energized" and "Calm" with a significant Room  $\times$  Gender interaction were removed in the analysis. Results indicated that the main effect of Gender and the Room  $\times$  Gender interaction remained significant ( $F(1, 80) = 21.30, p < 0.01$ ;  $F(2, 80) = 3.22, p < 0.05$ ). The multiple comparisons indicated that in females the difference in task scores between the magazine condition and the plant condition was significant ( $t(80) = 2.82, p < 0.10$ ).

**Task evaluation.** Table 5 shows the mean evaluation scores for each task item. Table 6 also shows the participant's self-evaluations regarding their performance (self-confidence and task accomplishment). A MANOVA with gender and room as the main terms was conducted with task evaluation scores and self-evaluation scores. These analyses indicated no significant effects of Gender or Room.

**Room evaluation.** Table 7 shows the participants' mean evaluation scores regarding their task environment. A MANOVA with gender and room as the main terms was conducted with room evaluation scores. This analysis indicated no significant effects of Gender or Room.

Table 8 shows participant's evaluation of the extent to which they were affected by the room environment. A Gender  $\times$  Room ANOVA revealed that the main effect of Room was significant ( $F(2, 84) = 4.94, p < 0.01$ ). A multiple comparison using Tukey–Kramer's HSD test showed the evaluation under the no object condition was significantly higher than under other conditions ( $HSD = 1.06$  at the level of  $\alpha = 0.05$ ).

**Object evaluation.** Table 9 shows participants' mean evaluation scores of the plant and magazine stand. A Gender  $\times$  Room MANOVA indicated that the main effect of Room was significant ( $F(8, 49) = 4.86, p < 0.01$ ). *F*-to-remove values of each item showed that "Tranquil" was important for the main effect of Room ( $F(1, 49) = 7.09, p < 0.01$ ). Moreover, *F*-to-remove values of "Calm" and "Distracting" indicated a weak significance for the main effect of Room ( $F(1, 49) = 3.27, p < 0.10$ ;  $F(1, 49) = 3.06, p < 0.10$ , respectively). As can be seen in Table 9, mean evaluations of "Calm" and "Tranquil" were higher under the plant condition than under the magazine condition, and the mean evaluation of "Distracting" was lower under the plant condition than under the magazine condition in both sexes.

Table 10 shows the participant's evaluation of the distraction caused by the object in the room. A Gender  $\times$  Room ANOVA indicated a weak main effect of Room ( $F(1, 56) = 3.79, p < 0.10$ ). The evaluation of the magazine stand was higher than that of the plant.

To examine the effects of object evaluations on task performances under each Room conditions, an ANOVA on task score under the plant condition and the magazine condition was performed with object evaluation terms

Table 5. Mean evaluation scores for each task item

	No object		Magazine		Plant	
	Females <i>n</i> = 18	Males <i>n</i> = 12	Females <i>n</i> = 19	Males <i>n</i> = 11	Females <i>n</i> = 18	Males <i>n</i> = 12
Amusing	3.44 (1.34)	3.25 (1.82)	4.00 (1.37)	3.45 (1.13)	3.61 (1.54)	3.50 (1.78)
Tiresome	4.28 (1.49)	4.00 (2.41)	4.11 (1.66)	4.36 (1.43)	4.67 (1.53)	5.00 (0.95)
Easy	3.22 (1.35)	2.83 (1.75)	3.05 (0.91)	2.91 (0.94)	3.44 (1.50)	3.25 (1.22)
Monotonous	3.78 (1.59)	3.92 (1.73)	4.21 (1.13)	4.64 (1.21)	4.72 (1.60)	4.50 (1.51)
Boring	3.67 (1.24)	3.92 (1.62)	3.32 (1.34)	3.82 (1.08)	3.89 (1.71)	3.92 (1.44)
Distracting	3.22 (1.48)	2.75 (2.01)	2.53 (1.39)	3.00 (1.48)	2.33 (1.14)	2.83 (1.40)
Difficult	4.44 (1.50)	4.08 (1.93)	4.37 (1.46)	4.27 (1.35)	4.17 (1.79)	4.33 (1.30)
Focusing	4.61 (1.09)	4.00 (1.21)	4.68 (1.29)	3.64 (1.43)	5.28 (0.96)	4.75 (1.60)

Table 6. Mean evaluations about how confident the participants were

	Gender		No object <sup>a</sup>	Magazine <sup>b</sup>	Plant <sup>a</sup>
To what extent the participants felt they had accomplished the task	Male	<i>X</i>	2.67	2.64	2.92
		( <i>SD</i> )	(1.07)	(1.36)	(0.90)
	Female	<i>X</i>	2.94	2.84	3.11
		( <i>SD</i> )	(1.35)	(0.96)	(1.13)
How confident the participants felt in doing their task	Male	<i>X</i>	3.00	2.27	3.00
		( <i>SD</i> )	(1.28)	(0.90)	(0.85)
	Female	<i>X</i>	2.67	2.79	2.83
		( <i>SD</i> )	(1.37)	(0.98)	(1.04)

<sup>a</sup> *n* = 30 in each cell (M = 12, F = 18).

<sup>b</sup> *n* = 30 in each cell (M = 11, F = 19).

Table 7. Mean evaluation scores for each room item

	No object		Magazine		Plant	
	Females <i>n</i> = 18	Males <i>n</i> = 12	Females <i>n</i> = 19	Males <i>n</i> = 11	Females <i>n</i> = 18	Males <i>n</i> = 12
Sober	5.00 (1.46)	4.75 (1.71)	4.68 (0.75)	4.82 (1.17)	5.17 (1.04)	5.00 (1.13)
Energetic	2.17 (1.15)	2.25 (1.22)	2.16 (1.17)	2.36 (1.21)	2.83 (1.20)	3.17 (1.11)
Distracting	2.89 (1.45)	1.83 (0.83)	2.84 (1.71)	2.45 (1.21)	2.44 (1.29)	2.50 (1.17)
Spacious	3.22 (1.22)	2.08 (1.16)	2.68 (1.20)	2.91 (1.30)	2.56 (1.15)	3.58 (1.16)
Tense	3.78 (1.77)	3.17 (1.75)	3.53 (1.58)	3.36 (1.80)	3.78 (1.63)	4.33 (1.50)
Bright	4.06 (1.59)	4.00 (0.95)	3.63 (1.16)	3.82 (1.17)	4.22 (1.31)	4.33 (0.78)
Tranquil	6.00 (0.84)	6.42 (0.79)	6.37 (0.96)	6.27 (0.79)	5.67 (1.64)	6.42 (0.67)
Familiar	2.72 (1.41)	2.75 (1.48)	2.68 (1.60)	2.82 (1.08)	3.11 (1.08)	3.00 (0.85)
Noisy	1.22 (0.43)	1.08 (0.29)	1.68 (1.49)	1.55 (0.93)	1.56 (0.98)	1.75 (0.97)
Dark	2.94 (1.76)	3.25 (1.22)	3.58 (1.50)	3.09 (1.76)	2.56 (1.46)	2.83 (1.64)
Concentrating	4.61 (0.61)	4.75 (0.87)	4.84 (1.30)	4.82 (1.40)	5.06 (1.11)	5.17 (0.83)
Small	4.17 (1.54)	5.08 (1.51)	4.16 (1.46)	5.36 (0.81)	4.78 (1.40)	3.42 (1.08)

removed as covariates. The results revealed that the main effect of Gender, and the Room × Gender interaction were significant ( $F(1, 46) = 7.60, p < 0.01$ ;  $F(1, 46) = 8.03, p < 0.01$ , respectively). However, a multiple comparison with Tukey–

Kramer adjustment showed that the difference in the task score between the magazine condition and the plant condition in female participants was not significant ( $t(52) = 2.24, n.s.$ ).

Table 8. Evaluation of the extent the participants felt the room environment had affected doing their task

Gender		No object <sup>a</sup>	Magazine <sup>b</sup>	Plant <sup>a</sup>
Male	<i>X (SD)</i>	4.08 (1.44)	2.91 (1.76)	3.33 (2.27)
Female	<i>X (SD)</i>	3.89 (1.60)	2.32 (1.45)	2.56 (1.82)

<sup>a</sup> *n* = 30 in each cell (M = 12, F = 18).

<sup>b</sup> *n* = 30 in each cell (M = 11, F = 19).

Table 9. Mean evaluation scores for the object in the room

	Magazine		Plant	
	Females <i>n</i> = 19	Males <i>n</i> = 11	Females <i>n</i> = 18	Males <i>n</i> = 12
Calm	4.21 (0.85)	4.00 (0.45)	5.17 (1.10)	5.25 (0.87)
Lively	3.16 (1.30)	3.45 (0.93)	4.00 (1.53)	4.50 (1.09)
Distracting	2.74 (1.52)	3.73 (1.85)	2.17 (1.25)	1.75 (0.75)
Natural	3.79 (2.23)	3.64 (1.86)	4.67 (1.91)	5.17 (1.34)
Familiar	3.89 (1.56)	3.18 (1.17)	4.22 (1.52)	4.58 (1.08)
Tranquil	4.37 (1.64)	4.55 (1.04)	5.39 (0.78)	5.58 (0.79)
Artificial	5.53 (1.31)	5.00 (1.73)	4.44 (1.69)	3.83 (1.59)
Liking	4.11 (1.63)	3.91 (0.70)	5.06 (1.26)	5.25 (1.22)

Table 10. Evaluation of how much the participants felt that the object in the room was distracting

		Magazine <sup>a</sup>	Plant <sup>b</sup>
Male	<i>X (SD)</i>	4.36 (1.86)	2.91 (1.83)
Female	<i>X (SD)</i>	3.05 (2.12)	2.50 (1.82)

<sup>a</sup> *n* = 30 in each cell (M = 11, F = 19).

<sup>b</sup> *n* = 30 in each cell (M = 12, F = 18).

## DISCUSSION

In this study, we investigated the influence of an indoor plant placed in a room on participants' performance in an association task, as well as on their mood. The influence of the indoor plant on performance was clear in female participants – who performed better when the plant was in the room, compared to when a magazine stand was in the room. In addition, evaluation scores of participants' mood showed differences between the no object condition and the plant and magazine conditions. Under the no object condition, participants evaluated themselves as less confident and less energized in comparison to the other two conditions.

Larsen *et al.* (1998) has suggested the possibility that the presence of indoor plants made people's mood more positive and that this mood change affected task performance. In our study also, mood evaluations were more positive under the magazine and the plant conditions, compared to the no object condition. In female participants, a difference in mood under the magazine condition and the plant condition was found. Moreover, the difference in task performance in females

remained significant even when the effect of the mood was removed from task performance. This suggests that differences of task performances between each room condition were independent of the participants' mood state.

Difference in task performance under each room condition disappeared when the effects of evaluations of the magazine rack or the plant were removed. Therefore, it is suggested that differences in task performance were mainly affected by the object placed in the room. The magazine rack and the potted plant used in this study were about the same size (magazine rack was 135 cm in height, the potted plant was about 150 cm in height). Though the shape of the plant was more complex than the magazine rack, which was a rectangle, the magazines on the rack contained many more colors and a variety of figures. Therefore, the rack with magazines was a better source of information for the association task used in this study. However, magazines were evaluated as less calm and more distracting than the plant, and there were no differences in task performances between the magazine condition and the no object condition. These results suggest that task-related information does not necessarily facilitate task performance. This is despite Shibata and Suzuki's (2002) suggestion that a plant might be a facilitative source of information for association tasks. Participants' task performance was better when they felt more active and confident, and when the object in the room was perceived as calm and not distracting. These findings suggest that a plant in the room was more suitable for the association task used in this study. Compatibility between an environment and its function is important for the restorative effect of the environment (S. Kaplan, 1983, 2001; Korpela & Hartig, 1996; Korpela, Hartig, Kaiser & Fuhrer, 2001; Hartig, Kaiser & Bowler, 2001; Laumann *et al.*, 2001). Compatibility between the task and the environment is also considered to be very important. Our results, however, do not clarify which aspects of the plant that were compatible with the task in this study.

In this study, only female participants showed a difference in task performance between the different conditions. Similar gender differences in the evaluation of mood or affect have been reported in other studies (Brody & Hall, 2000; Knez, 1995, 2001; Knez & Enmarker, 1998). Knez and Enmarker (1998) suggested that females are more expressive regarding an affective source (indoor lighting) compared to males. Moreover, Knez and Kers (2000) reported that females appraised a room light as more accentuated than did males. In our study, it is possible that female participants showed a more extreme reaction to the plant as an affective source. However, our results showed no difference in the evaluation of the plant, or the room environment between males and females. Rather, differences in the overall mood evaluation were found in male participants. Male participants evaluated their mood as less energized than female participants in the no object condition, and there was no difference in female participants mood evaluations under different room conditions. In other words, in male participants, mood evaluations were

affected by the room condition, but in female participants, task performance was affected by the room condition. It is difficult to explain the reason for this difference based exclusively on the results of the current study. It is suggested that further investigations of this phenomenon should be undertaken in the future.

We found clear gender difference in the task score. Gender differences have also been found in the study by Knez and Kers (2000). According to the authors of this study, it is unclear why female participants were superior to male participants in a free recall task. In a different study on the effect of room color on task performances, it was also reported that female participants were superior to male participants in doing a proofreading task (Kwallek & Lewis, 1990). Moreover, in a study on the effect of creativity on the ability to build hypothesis, correlations between gender and size of the vocabulary, and gender and fluency of conceptualization were found, and the number of words generated by females was higher than that by males (Lewin, Wolgers & Herlitz, 2001; Hayes & Waller, 1994). There is the possibility that the superiority of females in verbal task may be one reason for the gender difference found in this study.

In this study, we investigated the effects of indoor plants on participants' task performance and mood. The results showed that task performance of female participants was enhanced when the plant was placed in the room compared to the other room settings. This difference was not only due to the mood change of the participant or the availability of facilitative source of information. There is the possibility that the participant's task performance was also affected by the degree of compatibility between the task and the environment. Moreover, gender difference in task performance suggests the possibility that females have a high reactivity to the affective source. Moreover female superiority in verbal tasks may also have led to the gender differences found in this study.

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