applied sciences

Article

A Psychological Evaluation Model of a Good Conversation in Knowledge Creative Activities by Multiple People

Sohei Tsujimura [1,*], Motoki Yairi [2] and Takayoshi Okita [2]

[1] Graduate School of Science and Engineering, Ibaraki University, 4-12-1 Nakanarusawa, Hitachi 316-8511, Ibaraki, Japan
[2] Kajima Technical Research Institute, 2-19-1 Tobitakyu, Chofu 182-0036, Tokyo, Japan; yairi@kajima.com (M.Y.); okitat@kajima.com (T.O.)
* Correspondence: sohei.tsujimura.fifty@vc.ibaraki.ac.jp; Tel.: +81-294-38-5290

Abstract: Japanese companies have been focusing on enhancing the knowledge creative activities of older office workers in recent years. In addition, the way of working in the office has been shifting from traditional divisional routine work to collaborative or creative work, and office spaces are becoming quieter, with an increasing number of extremely quiet spaces (noise level < 40 dB). A sound environment that is too quiet gives workers the impression that it is difficult to converse with others, because they are worried about what people around them may think. The appearance of the knowledge creative society in recent years has led to a desire for changes in the workplace environment to improve the productivity of intellectual activities. To realize a sound environment that encourages knowledge creative activities, study outcomes need to be accumulated. Therefore, to clarify what kind of sound environment would be appropriate for knowledge creative activities by multiple people, we conducted psychoacoustic experiments to examine the effects of sound pressure level (signal-to-noise ratio), type of sound, and reverberation time in conference rooms on the impression of a "good conversation". In addition, we considered a causal model for the psychological evaluation of a "good conversation" by conducting a multiple regression analysis of psychological evaluations of the experimental participants. The results indicated that a sound environment considered too quiet for multiple people to have discussions about knowledge creative activities lowers the impression of a "good conversation", whereas high levels of relaxation lead to the impression of a "good conversation".

Keywords: workplace; knowledge-creative activity; sound environment; psychological evaluation model

check for updates

Citation: Tsujimura, S.; Yairi, M.; Okita, T. A Psychological Evaluation Model of a Good Conversation in Knowledge Creative Activities by Multiple People. *Appl. Sci.* **2022**, *12*, 2265. https://doi.org/10.3390/app12052265

Academic Editor: Masayuki Takada

Received: 8 December 2021
Accepted: 19 February 2022
Published: 22 February 2022

1. Introduction

With the development of computer technology and financial engineering and the spread of the Internet, industry has shifted from manufacturing to information and technology, telecommunications, and services. Thus, the transformation from an industrial to a knowledge based society is currently underway [1], which means that intellectual productivity in the office is a major factor influencing economic competition. Changes in the workplace environment to improve the productivity of intellectual activities are needed because of the recent appearance of the knowledge creative society. Creativity is a critical factor of cognition that underpins innovative product design, the advancement of science and technology, and effective advertising and marketing communications. As Japanese companies are increasingly focusing on promoting the knowledge creative activities of office workers, the mode of working in the office is shifting from traditional divisional routine work to creative and collaborative work [2]. Creative work performed in the office involves knowledge creative activities carried out both independently and by multiple people, such as meetings for proposing ideas. Knowledge creative activities have traditionally been divided into convergent and divergent thinking [3]. Convergent thinking is a process that enables connecting different ideas to achieve a single solution to a problem, whereas divergent thinking is a process in which many creative ideas are created and evaluated in a short period to find latent solutions to a provided task.

Several previous studies have focused on knowledge creative activities and examined the influences of the sound environment on intellectual productivity [4–8]. Previous studies examining the effects of noise (white noise and pink noise) on creative cognition tasks have reported that high-intensity white noise (75 dB [4] or 90 dB [5]) impairs the performance of creative tasks compared with no noise. Furthermore, another study involving a poetry writing task found that high-intensity intermittent noise (85 dB) inhibited creativity compared with continuous pink noise [6]. By contrast, in another study, highly creative participants demonstrated greater creativity when exposed to white noise at 80 dB than when exposed to white noise at 60 or 100 dB [7]. Another study that examined more naturalistic ambient noise (combination of distinct construction noise, babble noise, and road traffic noise), similar to restaurant noise, reported that noise of 70 dB improved performance in creative tasks compared with that of 50 dB [8]. In terms of the influence of the sound environment on creative cognitive processes, there have been contrasting findings, some reporting impaired task performance and others improved task performance. In addition, previous studies have focused on creative tasks performed alone using a typical task involving divergent thinking, such as the Remote Associate Test (RAT) [9] and the Compound Remote Associate Test (CRAT) [10]. Moreover, previous studies have examined the influence of the sound environment on creative tasks at high-intensity noise levels; however, office spaces in Japan are becoming increasingly quiet, with the number of extremely quiet spaces (<40 dB) increasing.

Previous studies in Japan on creative task performance and the sound environment have evaluated situations involving conversations between two people, simple calculation tasks, memorization tasks performed alone, and essay writing [11–15]. These tasks require convergent as opposed to divergent thinking. These studies have all found that high noise levels reduce task performance. On the other hand, several previous studies have investigated the influence of the sound environment on knowledge creative activities in group settings, focusing on the relationship between intellectual productivity and the sound environment in interpersonal spaces [16,17]. According to previous studies [18], creativity was defined as “the interaction among aptitude, process, and environment by which an individual or group produces a perceptible product that is both novel and useful as defined within a social context”. The component theory [19] of creativity explains the four components that an individual needs for creative work. They are domain-relevant skills, creativity-related processes, task motivation, and conducive environments. These suggest that creativity is influenced not only by intrinsic factors but also by extrinsic factors, such as workplace environment. Regarding the quietness of the sound environment, it has been reported that subjects start to perceive an environment as being noisy (not quiet) in ambient noise of 50 dB and as having increased listening difficulties at 60 dB [16]. Moreover, the ease of meeting received the highest evaluation in a condition of ambient noise of 50 dB for discussions requiring creative ideas. The results of a multiple regression analysis suggested that a quiet sound environment was not necessarily desirable in discussions requiring creative ideas [17].

These findings suggest that an extremely quiet sound environment reduces the perceived ease of meeting in discussions requiring creative ideas by multiple people. These previous studies have argued primarily that a sound environment perceived as being too quiet gives workers the impression that it is difficult to have a conversation. However, none of these studies have considered the influence of the sound source or the acoustical characteristics of spaces on knowledge creative activities. To promote creative thinking and enhance the workplace environment as a conducive space for knowledge creative activities by multiple people, smooth and active communication is required in meeting rooms and common areas. In recent years, as a result of changes in the physical workspace, office workers are frequently engaged in knowledge creative activities in open areas with high ceilings. Knowledge creative activities are also carried out in general construction companies; opportunities for discussions in common areas of the office are increasing. There are some examples of designing office spaces with a sense of openness in general construction companies. Consequently, the further accumulation of research outcomes is needed to construct a sound environment that can enhance knowledge creative activities.

Therefore, the present study aimed to examine the relationship between intellectual productivity and the sound environment in situations in which multiple people engage in knowledge creative activities. In knowledge creative activities by multiple people, it is important for the participants of the meeting to communicate actively and smoothly with each other. In this study, "good conversation" was used as a comprehensive item to evaluate the degree of active and smooth communication. To investigate the influences of sound pressure level (i.e., the signal-to-noise ratio [SNR]), the kind of sound, and the reverberation time in meeting rooms on the impression of a "good conversation", and to clarify the psychological factors that contribute to this impression, we conducted psychoacoustic experiments and considered a causal model for the psychological evaluation of a "good conversation" by performing a multiple regression analysis of data from psychological evaluations.

2. Psychoacoustic Experiment

We conducted a psychoacoustic experiment on the sound environment in a situation in which multiple people were performing knowledge creative activities in an office setting. In the experiment, 5 groups of participants were created, with 2–4 individuals per group. The experimental participants (n = 17) consisted of 6 office workers (5 men and 1 woman) on the staff of a general construction company in their 20s and 30s (n = 5) and 60s (n = 1) and 11 students (5 men and 6 women) in their teens and 20s. All participants had normal hearing that did not interfere with their daily lives. A participant group was created for the 6 workers working at the company and the 11 younger students. Students and office workers have different individual attributes that can affect the ease of conversation, and so they were divided into separate groups. Then, the groups were instructed to hold a conversation about knowledge creative activities for 30 s in various sound environment conditions within a semi-anechoic chamber at the Kajima Technical Research Institute Nishi-chofu Complex in Tokyo, Japan. In this experiment, one trial examining performance on spatial ability tests was set to 30 s, referring to previous studies that examined whether performance was improved when participants listened to music they rated as "like" [20].

2.1. Sound Environment Reproduction System

Figure 1 shows a diagram of the acoustical reproduction system used in our experiment. Assuming a volume of 3000 m^3 (area 300 m^2, ceiling height 10 m), binaural impulse responses between the adjacent sound source and receiving point were calculated by geometrical acoustic simulation. This spatial scale can be seen as some design examples of a general construction company with a sense of openness in Japan. The distance between the adjacent sound source and receiving point was 0.5 m. CATT-Acoustics software (Acoustic Field Inc., Tokyo, Japan), which is based on the sound line method, was used for the geometrical acoustic simulation. The sound absorption and scattering coefficients in this acoustic simulation were uniformly distributed over the entire wall surface. The reverberation times were 0.6 s, 1.5 s, and 2 s, with average sound absorption coefficients of 0.44, 0.20, and 0.16, respectively. The parts of direct sound were cut from the obtained impulse responses and adjusted in such a way that the delay times matched. The input signal from the microphone was convoluted in real-time and reproduced binaurally based on the 3-channel Optimal Source Distribution Technology (3ch-OPSODIS) principle [21,22].

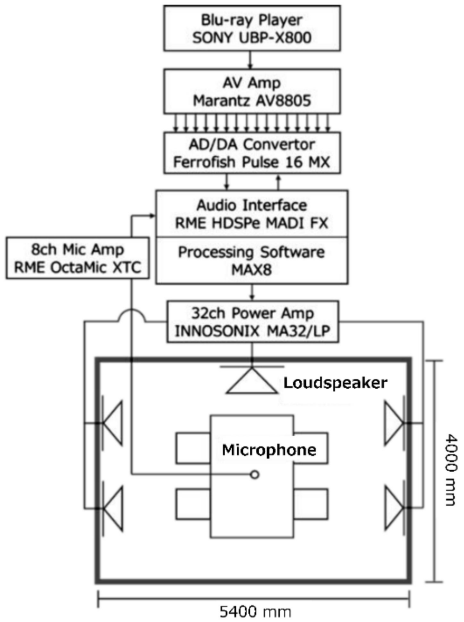

Figure 1. Diagram of the acoustic system used in this experiment.

2.2. Subjective Experiment Procedure

Previous studies have shown that a creative thinking process is intrinsic to normative cognitive functioning and relies on fundamental cognitive processes [23,24]. Traditionally, two kinds of creative thinking (convergent and divergent thinking) have been distinguished [3]. Divergent thinking is defined as a strategy in which many creative ideas are formulated and evaluated in a short period to produce latent solutions for a given problem. A representative task involving divergent thinking is the Alternative Uses Task. In this task, participants are required to think of as many uses as possible for a daily life object, such as a brick or paperclip [20]. A variety of means of increasing creativity, such as brainstorming, have been developed and tested [25,26]. In brainstorming, it is important for participants to have an impression that they can talk easily, because divergent thinking is considered to be promoted when participants can express many opinions. Particularly, a dialogic approach creates the situations in which new ideas are born. It is known that, through a dialogic approach, it leads to the creation and improvement of ideas, the repair of weaknesses in ideas, and the discovery of new ways to avoid stopping ideas [27,28]. In addition, our previous study [17] has shown that the impression of "ease of conversation" has the strongest effect on meetings that require a knowledge-creative process. Therefore, referring to the findings of these previous studies, in our experiment the experimental participants were made to converse, not the actual knowledge-creative task. The experimental participants were instructed to imagine a situation in which they were having a discussion with multiple people that required knowledge creation to propose new ideas in a space with a high ceiling and a feeling of spaciousness. They were instructed to have 30 s conversations in various sound environments. The experimental conditions are shown in Table 1.

Background noise (BGN) recorded at a general construction company office was reproduced at an A-weighted sound pressure level of 40 dB ($L_{\mathrm{Aeq,30s}}$). Different types of sound stimuli were added to the BGN. Four types of sound environment conditions were created in this experiment. The added sound stimuli were set to five kinds of sound pressure levels in SNR from −3 dB to +9 dB for every 3 dB. The experimental conditions for the reverberation times were about 2 s, 1.5 s, and 0.6 s. Our experiment consisted of 63 experimental conditions (4 kinds of sound stimuli × 5 SNR conditions × 3 reverberation time conditions, and 3 levels of conditions with no additional sound stimulus for each reverberation time).

Next, 63 types of sound experimental conditions were presented in random order. The participants evaluated 10 psychological impressions using a five-step rating scale for each acoustical condition. Table 2 shows the psychological evaluation items used in the psychoacoustic experiment. The five-step rating scale used modifiers ("not at all", "slightly", "moderately", "very", and "extremely") proposed by the International Commission on the Biological Effects of Noise [29] and officially adopted by the International Organization for Standardization/Technical Specification (ISO/TS 15666) [30].

Table 1. The sound environment conditions used in the present study.

Background Noise	Type of Added Sound Source	Signal-to-Noise Ratio	Reverberation Time
Background noise recorded at a general construction company office	Urban sound environment Conversation noise ("Human speech-like noise" as babble noise) Brown noise Classical music (Arabesque No. 1, Claude Debussy)	−3 dB to +9 dB every 3 dB	About 2.0 s ($\bar{\alpha}$ = 0.16) About 1.5 s ($\bar{\alpha}$ = 0.20) About 0.6 s ($\bar{\alpha}$ = 0.44)

Table 2. The 10 psychological evaluation items used in the experiment.

Rating Classification	Items of Psychological Evaluation	
Five-step rating scale	Ease of talking Ease of communicating own voice to others Ease of listening Good conversation Distracting to the surroundings	Comfort Quietness Liveliness Mental calmness Relaxation

3. Results

3.1. Results of a Three-Way Analysis of Variance

According to the results of analysis of variance based on the difference in attributes between students and office workers, no statistically significant difference was shown in their evaluations. Therefore, in this study, we conducted statistical analysis with a sample size of 17 without considering the difference in these attributes of experimental participants. To investigate the influence of the sound stimuli, SNR, and reverberation time on the psychological evaluation items used in our experiment, a three-way analysis of variance (ANOVA) was conducted using JMP ver. 14.2 (SAS Institute Inc., Tokyo, Japan). The results are shown in Table 3. The results indicated that the main effect of kinds of sound stimuli was significantly recognized in all psychological evaluation items used in the experiment. The main effect of SNR was significant in nine items, except for "ease of talking". On the other hand, the main effect of reverberation time was not significant except for "distracting to the surroundings". Regarding two-factor interaction, the interaction between the type of sound source and SNR was significantly recognized in "comfort" and "quietness".

Table 3. Results of the three-way analysis of variance; "n.s." in the table represents an abbreviation for "no significant difference".

Rating Classification	Type of Added Sound Stimulus	Signal-to-Noise Ratio	Reverberation Time	Type of Added Sound Stimulus × Signal-to-Noise Ratio	Type of Added Sound Stimulus × Reverberation Time	Signal-to-Noise Ratio × Reverberation Time
Ease of talking	**	n.s.	n.s.	n.s.	n.s.	n.s.
Ease of communicating own voice to others	**	**	n.s.	n.s.	n.s.	n.s.
Ease of listening	**	**	n.s.	n.s.	n.s.	n.s.
Good conversation	**	*	n.s.	n.s.	n.s.	n.s.
Distracting to the surroundings	**	**	*	n.s.	n.s.	n.s.
Comfort	**	**	n.s.	**	n.s.	n.s.
Quietness	**	**	n.s.	*	n.s.	n.s.
Liveliness	**	**	n.s.	n.s.	n.s.	n.s.
Mental calmness	**	**	n.s.	n.s.	n.s.	n.s.
Relaxation	**	**	n.s.	n.s.	n.s.	n.s.

*: $p < 0.01$, **: $p < 0.05$.

3.2. Relationship between Sound Environments and Psychological Evaluations

Figure 2 shows the relationship between SNR and the evaluation of a "good conversation" for each sound environment. The influence of the sound environment on a "good conversation" was greater depending on the type of sound stimulus compared with the SNR. A "good conversation" was as high as 2 out of 5 evaluation grades under any sound environment condition. Regarding the types of sound sources, conversational noise ("human speech-like noise" as babble noise) and classical music resulted in a higher impression of a "good conversation" than did the other sound sources.

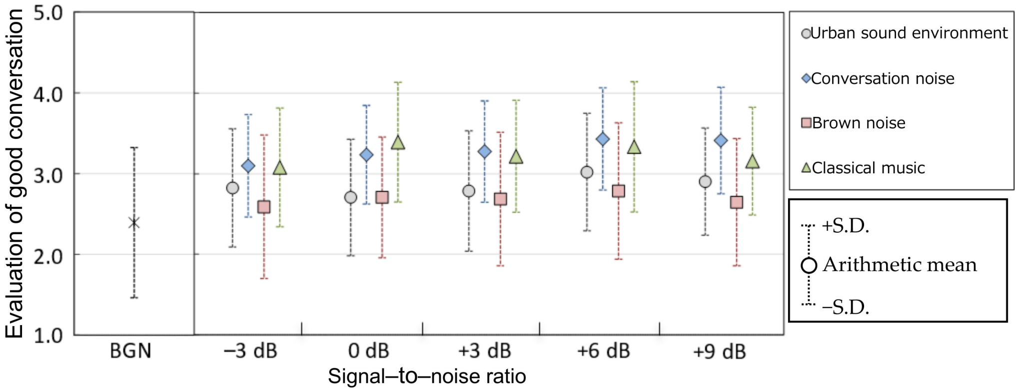

Figure 2. Evaluation of a "good conversation" for each sound environment. The plots in this figure represent the arithmetic mean, and the error bars indicate the standard deviation.

Figure 3 shows the relationship between the SNR and "quietness" for each sound environment. The evaluation of "quietness" tended to decrease with increases in the SNR in all types of sound stimuli. The evaluation of "quietness" declined more slowly in classical music than in the other sound stimuli. In classical music, even with a SNR of +9 dB (under this SNR condition, L_{Aeq} was about 49 dB), it did not fall below "2: slightly quiet", indicating that the impression of "quietness" was not lost. Meanwhile, in conversation noise ("human speech-like noise" as babble noise), the impression of "quietness" tended to be lost under a SNR of +6 dB (under this SNR condition, L_{Aeq} was about 46 dB). In a previous study [17] in which the same conversation noise (babble noise that could not be heard) as that in the present study was used, it was reported that the impression of "quietness" was not lost if the noise level was 45 dB or lower.

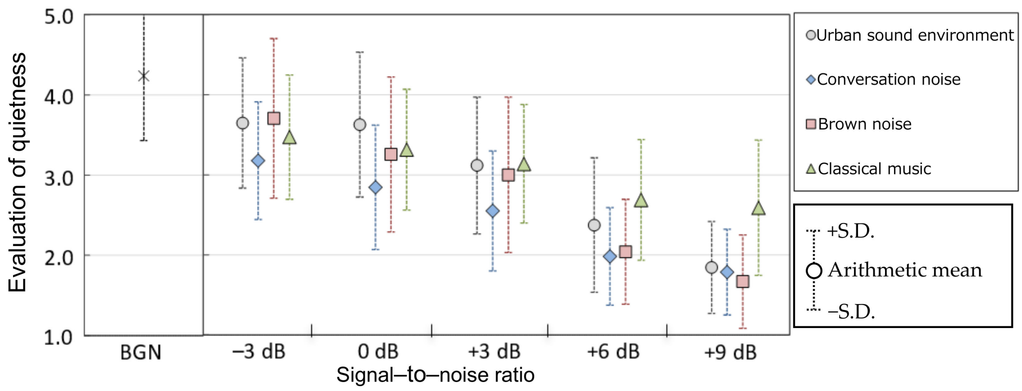

Figure 3. Evaluation of "quietness" for each sound environment condition. The plots in this figure represent the arithmetic mean, and the error bars indicate the standard deviation.

Figure 4 shows the relationship between the SNR conditions and "liveliness" for each sound environment. The impression of "liveliness" was higher than that of the BGN condition under all sound environment conditions and tended to be higher with a larger SNR. Conversation noise ("human speech-like noise" as babble noise) gave the participants a lively impression when the SNR was 0 dB (L_{Aeq} was about 43 dB) or higher. Conversation noise is, therefore, considered easier to convey "liveliness" compared with the other sound stimuli used in our experiment. Meanwhile, regarding classical music and urban noise, under a SNR of +9 dB, the evaluation value was "3: moderately feel liveliness". Conversation noise ("human speech-like noise" as babble noise) is, therefore, considered easier to convey "liveliness" than the other sound stimuli used in our experiment.

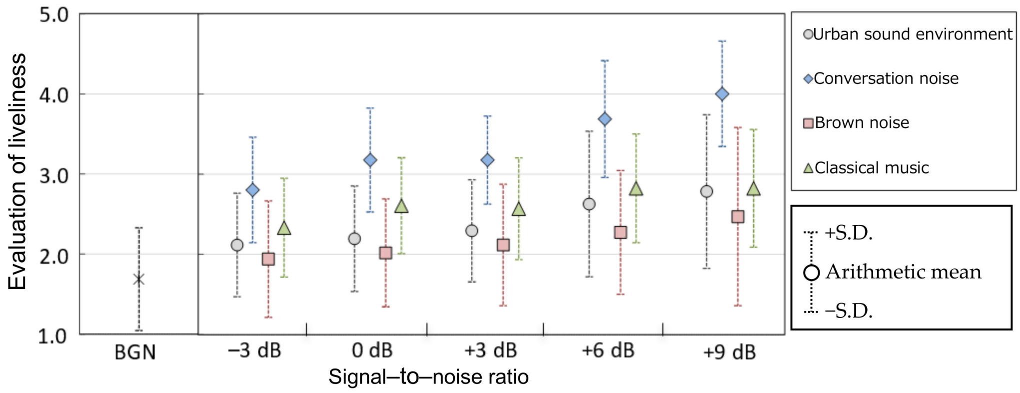

Figure 4. Evaluation of "liveliness" for each sound environmental condition. The plots in this figure represent the arithmetic mean, and the error bars indicate the standard deviation.

Figure 5 shows the relationship between the SNR and "relaxation" for each type of sound stimulus. For all types of sound stimulus, the evaluation of "relaxation" tended to decrease with increases in the SNR. The evaluation was lower than BGN when the SNR was +3 dB or higher, aside from classical music. With regard to classical music, even a SNR of +9 dB was judged higher than "3: moderately feel liveliness."

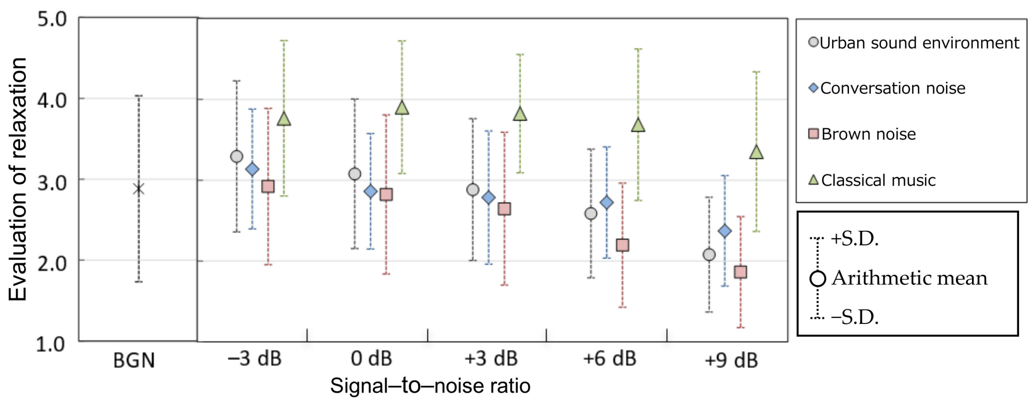

Figure 5. Evaluation of "relaxation" for each sound environment. The plots in this figure represent the arithmetic mean, and the error bars indicate the standard deviation.

3.3. Investigation of the Psychological Evaluation Model Using Multiple Regression Analysis

To clarify the psychological factors that influenced the impression of a "good conversation", a psychological evaluation model using the perception of a "good conversation" as the objective variable was constructed. First, a correlation analysis was conducted for all evaluation items shown in Table 2, and the candidates for explanatory variables to be incorporated into the psychological evaluation model were selected. The correlation coefficient between "relaxation" and "mental calmness", "relaxation" and "comfort", and "mental calmness" and "comfort" were 0.96, 0.94, and 0.94, respectively. These results indicated a strong correlation between "relaxation", "mental calmness", and "comfort".

Additionally, a strong correlation was found between "ease of communicating own voice to others" and "ease of listening" ($r = 0.97$). Considering the effects of multicollinearity, six items ("ease of talking", "ease of communicating own voice to others", "distracting to the surroundings", "quietness", "liveliness", and "relaxation") were selected as candidates for explanatory variables to be incorporated into the psychological evaluation model. Using JMP ver. 14.2 (SAS Institute Japan Ltd., Tokyo, Japan), stepwise selection was conducted with the forward selection method among the candidates for the above six explanatory variables. Next, the evaluation items to be adopted as explanatory variables were extracted. Consequently, the main effects of "quietness", "liveliness", "relaxation", "ease of communicating own voice to others", and "ease of talking" were found to be significant ($p < 0.05$). From the above, a multiple regression model that included these five items as explanatory variables was considered. The results are shown in Table 4. Equation (1) expresses the results in Table 4 by a multiple regression equation. Here, the objective variable y represents "good conversation", and the explanatory variables x_1, x_2, x_3, x_4, and x_5 represent "ease of talking", "ease of communicating own voice to others", "quietness", "liveliness", and "relaxation", respectively.

$$y = 0.183 \cdot x_1 + 0.376 \cdot x_2 - 0.612 \cdot x_3 + 0.438 \cdot x_4 + 0.400 \cdot x_5 \tag{1}$$

Table 4. Results of the multiple regression analysis.

Objective Variable	Adjusted Coefficient of Determination	Explanatory Variable	Standardized Partial Regression Coefficient
Good conversation	0.907	Ease of talking	0.183 *
		Ease of communicating own voice to others	0.376 **
		Quietness	−0.612 **
		Liveliness	0.438 **
		Relaxation	0.400 **

*: $p < 0.01$, **: $p < 0.05$.

The results from calculating the Variance Inflation Factor (VIF) between explanatory variables to examine the effects of multicollinearity on the psychological evaluation model are shown in Table 5. The results show that since the VIF is less than 1.5 among all evaluation items in the model, the effect of multicollinearity was considered to be very small.

Table 5. Variance inflation factors of the evaluation items in the psychological model.

	Ease of Talking	Ease of Communicating Own Voice to Others	Quietness	Liveliness	Relaxation
Ease of talking	-	-	-	-	-
Ease of communicating own voice to others	1.44	-	-	-	-
Quietness	1.00	1.33	-	-	-
Liveliness	1.12	1.00	1.11	-	-
Relaxation	1.18	1.37	1.21	1.01	-

4. Discussion

Based on the results of the ANOVA in Section 3.1 (shown in Table 3), the influence of reverberation time on knowledge creative activities by multiple people was small in the 3000 m^3 space within a reverberation time from about 0.6 s to 2 s (average sound absorption coefficient from 0.16 to 0.44). Claude Debussy's "Arabesque No. 1", which was used as the classical music in our study, has been shown to reduce oxygenated hemoglobin (Oxy-Hb) concentrations in the cerebral bloodstream and to be effective for relieving stress [31].

Considering this and the results shown in Figure 5, the classical music used in our study gave the participants a relaxing feeling.

A previous study examining the impact of classical music (Antonio Vivaldi, Camille Saint-Saëns, Samuel Barber, and Gustav Holston) on creative tasks reported that participants who listened to “happy music” (i.e., classical music that produces arousal and a positive mood) while conducting a divergent creativity task were more creative than those who performed the task silently [20]. In addition, that study concluded that “happy music” had no effect on convergent creativity. Another previous study comparing the music of Mozart and Albinoni [32] reported that participants performed better on a test of spatial abilities after listening to a Mozart sonata than after sitting in a quiet condition and that a slow “sad” musical excerpt from Albinoni had no influence on a creative task. Participants listening to Mozart showed significantly higher positive feelings and arousal (e.g., enjoyment rating, mood rating, Profile of Mood States [POMS] arousal score) and significantly lower negative feelings (e.g., POMS mood score) than did those who listened to Albinoni. As mentioned above, some studies have shown that “happy music” has more of an effect on creative work efficiency compared with a silent condition but that neither “calm” nor “sad” music improves creative work efficiency. By contrast, although Debussy’s “Arabesque No. 1” was used in this study as “calm (relaxing)” music in our experiments, a significant positive effect on knowledge-creative activity was observed. The studies mentioned above examined the influence of classical music on a creative task performed alone, but the present study focused on the effects on knowledge creative activities performed by multiple people; this was considered the reason for the differences in the influence of music. Our findings, therefore, clarified the effectiveness of using an evaluation structural model of the sound environment to examine the effects of different sound stimuli on knowledge creative activities performed by multiple people.

Regarding the urban sound environment, the results for conversational noise (“human speech-like noise” as babble noise) and brown noise were comparable with those of previous studies. It has been shown that high-intensity white noise of 75 dB [4] and 90 dB [5] impairs creative task performance compared with a no noise condition. Furthermore, it has been reported that intermittent noise of 85 dB reduces creativity compared with continuous pink noise as measured in a poetry writing task [6]. By contrast, highly creative participants were shown to exhibit greater creativity in other tasks when exposed to white noise of 80 dB compared with 60 or 100 dB [7]. A previous study using more natural ambient noise reported that noise of 70 dB improved the performance of creative tasks compared with 50 dB [8]. In the present study, conversational noise (babble noise) exceeded a rating of “3: moderately good conversation”, even with a SNR of +9 dB (L_{Aeq} was approximately 49 dB under this condition). Considering this L_{Aeq} level, the noise levels in the present study were 50 dB or less, suggesting that “liveliness” at these noise levels greatly contributes to “good conversation” in knowledge creative activities with multiple people (See Table 4 and Figure 4).

5. Conclusions

The adjusted coefficient of determination in this study was 0.907, indicating that high explanatory power was obtained for the evaluation model. This result suggests that a “good conversation” is most negatively affected by “quietness”. When the evaluation of “quietness” increased, that of a “good conversation” tended to decrease. Meanwhile, the evaluations of “liveliness”, “relaxation”, “ease of communicating own voice to others”, and “ease of talking” had a positive influence on a “good conversation”, and a “good conversation” tended to increase with increases in these evaluations. These findings suggest that the impression of a “good conversation” decreases in a sound environment that is too quiet when multiple people have discussions about knowledge creative activities and that a lively impression enhances the impression of a “good conversation”. Moreover, these results suggest that high “relaxation” also leads to the impression of a “good conversation”.

As many people benefit from creative thinking, we hope that these results can be applied as widely as possible. However, our experimental participants were all Japanese and already engaged in creative work, and about 60% were adult university students. The findings of a previous meta-analysis [25] revealed that enhancing creativity may be more effective in organizational than in academic settings. However, in this study, no statistically significant difference was found in the evaluations because of differences in attributes between students and office workers. Therefore, it seems that the psychological evaluation model of a "good conversation" obtained in this study appropriately represents the evaluation structure of office workers. To enhance the generalizability of our findings, future research will be required to investigate the impact of occupations other than general construction and differences in official position, years of service, and cultural backgrounds. In addition, it is also necessary to investigate the types of sounds that are highly evaluated from the aspects of lively impression and relaxation.

Author Contributions: Conceptualization, S.T. and M.Y.; methodology, S.T. and M.Y.; software, M.Y.; validation, S.T., M.Y. and T.O.; formal analysis, S.T.; investigation, S.T., M.Y. and T.O.; resources, M.Y.; data curation, S.T.; writing—original draft preparation, S.T.; writing—review and editing, M.Y. and T.O.; visualization, S.T.; project administration, M.Y.; funding acquisition, M.Y. and T.O. All authors have read and agreed to the published version of the manuscript.

Funding: This research received no external funding.

Institutional Review Board Statement: Although this study involves humans, it falls under the following items, which are listed as unnecessary criteria by the Bioethics Committee of the Faculty of Engineering, Ibaraki University. (1) Individuals cannot be identified under any conditions. (2) Experiments and surveys that are less invasive, and the principal investigator appropriately notices the risks, intimidation, and protection of personal information of the subjects. (3) Researchers do not request data collection from other institutions or companies (for example, research companies) that are not directly related to research. (4) There is no economic benefit relationship that affects the research results or the protection of the subjects. (5) Video and audio data are not collected. (6) It does not target groups (for example, those who have been bullied, children who do not attend school, persons with disabilities and their families, persons with mental illness, etc.) with characteristics that make them vulnerable to social pressure. (7) Questionnaire surveys, experimental stimuli, etc. do not include all question contents and items that exceed the range that can be experienced in social life or appear in the contents of daily conversation (for example, "Have you ever been bullied?", "Have you had a recent libido?", "Have you ever wanted to die?", etc.). (8) The procedure for deception (procedures using false explanations for research purposes, etc.) is not included.

Informed Consent Statement: For safety reasons and to ensure ethics in research, informed consent was obtained from all study subjects. Written informed consent to publish this paper was obtained from all participants.

Data Availability Statement: Not application.

Conflicts of Interest: The authors declare no conflict of interest.

References

1. Drucker, P.F. The new productivity challenge. *Harv. Bus. Rev.* **1991**, *69*, 69–79. [PubMed]
2. Ministry of Economy, Trade and Industry. *Report of the 7th Study Group on High Value-Added in the Service Industry*; Ministry of Economy, Trade and Industry: Tokyo, Japan, 2014; pp. 3–16.
3. Guilford, J. The nature of human intelligence. *Am. Educ. Res. J.* **1968**, *5*, 249–256. [CrossRef]
4. Martindale, C.; Greenough, J. The differential effect of increased arousal on creative and intellectual performance. *J. Genet. Psychol.* **1973**, *123*, 329–335. [CrossRef] [PubMed]
5. Hillier, A.; Alexander, J.K.; Beversdorf, D.Q. The effect of auditory stressors on cognitive flexibility. *Neurocase* **2006**, *12*, 228–231. [CrossRef]
6. Kasof, J. Creativity and breadth of attention. *Creat. Res. J.* **1997**, *10*, 303–315. [CrossRef]
7. Toplyn, G.; Maguire, W. The differential effect of noise on creative task performance. *Creat. Res. J.* **1991**, *4*, 337–347. [CrossRef]
8. Mehta, R.; Zhu, R.J.; Cheema, A. Is noise always bad? Exploring the effects of ambient noise on creative cognition. *J. Consum. Res.* **2012**, *39*, 784–799. [CrossRef]
9. Mednick, S. The associative basis of the creative process. *Psychol. Rev.* **1962**, *69*, 220–232. [CrossRef]

10. Bowden, E.M.; Jung-Beeman, M. Normative data for 144 compound remote associate problems. *Behav. Res. Methods Instrum. Comput.* **2013**, *35*, 634–639. [CrossRef]
11. Saeki, T.; Fujii, T.; Yamaguchi, S.; Kato, Y. Effects of noise during short-term memory task: Psychological impression of annoyance and performance. *J. Acoust. Sci. Technol. Jpn.* **2003**, *24*, 209–214.
12. Tsujimura, S.; Yamada, Y. A study on the degree of disturbance by meaningful and meaningless noise under the brain task. In Proceedings of the 19th International Congress on Acoustics, Madrid, Spain, 2–7 September 2007.
13. Tsujimura, S.; Yamada, Y. A study on the degree of disturbance by sound under mental tasks using electroencephalogram. *Noise Control Eng. J.* **2008**, *56*, 63–70. [CrossRef]
14. Sakuma, T.; Kaminao, Y. Effect of sound environment on intellectual productivity in workplace. In Proceedings of the 39th International Congress on Noise Control Engineering, Lisbon, Portugal, 13–16 June 2010.
15. Tamesue, T.; Saeki, T. Effects of meaningful or meaningless noise on psychological impression for annoyance and selective attention to stimuli during intellectual task. *J. Acoust. Soc. Am.* **2016**, *140*, 3266. [CrossRef]
16. Tsujimura, S.; Akita, T.; Sano, N. Influence of sound environment on knowledge creative activity in meeting rooms. In Proceedings of the International Congress on Noise as a Public Health Problem, Nara, Japan, 1–5 June 2014.
17. Tsujimura, S.; Akita, T.; Kojima, T.; Sano, N. Influence of sound environment in meeting rooms on knowledge creative activity in a group. *J. Environ. Eng. Archit. Inst. Jpn.* **2015**, *80*, 397–405. [CrossRef]
18. Plucker, J.A.; Beghetto, R.A.; Dow, G.T. Why isn't creativity more important to educational psychologists? Potentials, pitfalls, and future directions in creativity research. *Educ. Psychol.* **2004**, *39*, 83–96. [CrossRef]
19. Amabile, T.M.; Pratt, M.G. The dynamic componential model of creativity and innovation in organizations: Making progress, making meaning. *Res. Organ. Behav.* **2016**, *36*, 157–183. [CrossRef]
20. Ritter, S.M.; Ferguson, S. Happy creativity: Listening to happy, music facilitates divergent thinking. *PLoS ONE* **2017**, *12*, e0182210. [CrossRef]
21. Yairi, M.; Takeuchi, T.; Holland, K.; Morgan, D.G.; Haines, L. Binaural reproduction capability for multiple off-axis listeners based on the 3-channel optimal source distribution principle. In Proceedings of the 23rd International Congress on Acoustics, Aachen, Germany, 9–13 September 2019.
22. Takeuchi, T.; Nelson, P.A. Optimal source distribution for binaural synthesis over loudspeakers. *J. Acoust. Soc. Am.* **2002**, *112*, 2786–2797. [CrossRef]
23. Nijstad, B.A.; Stroebe, W. How the group affects the mind: A cognitive model of idea generation in groups. *Personal. Soc. Psychol. Rev.* **2006**, *10*, 186–213. [CrossRef]
24. Ward, T.B. Structured imagination: The role of category structure in exemplar generation. *Cogn. Psychol.* **1994**, *27*, 1–40. [CrossRef]
25. Scott, G.; Leritz, L.E.; Mumford, M.D. The effectiveness of creativity training: A quantitative review. *Creat. Res. J.* **2004**, *16*, 361–388. [CrossRef]
26. Scott, G.; Leritz, L.E.; Mumford, M.D. Types of creativity training: Approaches and their effectiveness. *J. Creat. Behav.* **2011**, *38*, 149–179. [CrossRef]
27. Montuori, A. The complexity of improvisation and the improvisation of complexity: Social science, art and creativity. *Hum. Relat.* **2003**, *56*, 0237–0255. [CrossRef]
28. Tsoukas, H. A dialogical approach to the creation of new knowledge in organizations. *Organ. Sci.* **2009**, *20*, 941–957. [CrossRef]
29. Fields, J.M.; Jong, R.G.; Gjestland, T.; Flindell, I.H.; Job, R.F.S.; Kurra, S.; Lercher, P.; Vallet, M.; Yano, T.; Guski, R.; et al. Standardized general-purpose noise reaction questions for community noise surveys: Research and a recommendation. *J. Sound Vib.* **2001**, *242*, 641–679. [CrossRef]
30. ISO. *ISO/TS 15666:2021*; Acoustics-Assessment of Noise Annoyance by Means of Social and Socio-Acoustic Surveys. ISO: Geneva, Switzerland, 2021.
31. Sato, S.; Watanabe, S.; Yanagimoto, K.; Shishido, M. Effect of auditory and olfactory stimulation on prefrontal cortex for stress alleviation. *Stud. Sci. Technol.* **2017**, *6*, 25–30. [CrossRef]
32. Thompson, W.F.; Schellenberg, E.G.; Arousal, G.H. Mood, and the Mozart Effect. *Psychol. Sci.* **2001**, *12*, 248–251. [CrossRef]