〔**Articles**〕

The Effects of Caffeine Ingestion on the Activeness of Group Conversation

Miko Maeda
Yosuke Egawa

Abstract

This study examined the effects of caffeine ingestion on the activeness of group conversation. Four healthy male university students participated in three experimental conditions: water, placebo, and caffeine (4 mg/kg body mass).

Under each condition, the participants took part in a 30-min group discussion. Speech behavior was evaluated using four indices: total number of utterances, number of speaker changes, frequency of overlapping utterances, and sound pressure level.

The results showed that the total number of utterances and speaker changes in the caffeine condition were similar to those in the water and placebo conditions. No significant differences were found in overlapping utterances or sound pressure level. However, the Profile of Mood States (POMS) showed a significant decrease in fatigue 90 min after caffeine ingestion ($p < .01$).

These findings suggest that caffeine ingestion may reduce subjective fatigue, but does not increase the activeness of group conversation one hour after ingestion.

Keywords：Caffeine, Group Conversation, Conversational Activeness, Speaker Change, Overlapping Utterance, Sound Pressure Level, Fatigue, Profile of Mood States

1. Introduction

Caffeine is one of the most widely consumed psychoactive substances in the world(1) and is known to exert a variety of psychological and physiological effects(24). Generally, low to moderate doses of caffeine intake (37.5–450 mg per day) have been reported to enhance concentration and attention(5,7,16), improve physical performance and endurance, elevate mood(17,18), reduce fatigue(16), and increase overall performance efficiency(2,5).

Kurihara (2016) suggested that the consumption of two to five cups of coffee per day may elevate positive mood and reduce anxiety. Similarly, Zabelina and Silvia (2020) demonstrated that caffeine intake facilitates convergent problem-solving and enhances cognitive function. Thus, beyond its arousing effect, caffeine may influence an individual's psychological state through emotional and cognitive pathways, potentially affecting social interactions and interpersonal behavior.

Recently, researchers have begun to explore the effects of caffeine from the perspective of social interaction. Yokomitsu and Fujiwara (2019) reported that consuming caffeinated beverages can facilitate dyadic communication, increase trust, and enhance vigor. In their study, pairs who conversed for 15 minutes while drinking coffee exhibited significantly higher levels of trust, friendship, and vigor compared to those who did not drink coffee.

However, in that study, the conversation was completed before the physiological effects of caffeine could manifest. Therefore, the influence of caffeine's physiological activation on communication and speech behavior remains largely unexplored. The physiological effects of caffeine are known to peak approximately 30–60 minutes after ingestion[(24)], during which arousal level and mood are most strongly modulated.

In contrast, several studies have examined environmental and social factors that promote verbal activity. Tomita et al. (2010) demonstrated that observing others' discussions prior to engaging in one's own can enhance conversational activeness. Shibuya (2008) found that round-table seating arrangements diminish hierarchical perceptions and promote participation. Likewise, Gilbert (1993) reported that in counseling sessions, conversations become more active when the therapist and client are seated at a 90-degree angle. Furthermore, Nakamura and Miura (2014) revealed that concurrent eating or drinking during dialogue increases smiling behavior, fosters positive affect sharing, and elevates speech frequency.

Collectively, these findings indicate that psychological, social, and environmental factors jointly contribute to the activation of verbal behavior. Nevertheless, the extent to which physiological changes induced by caffeine consumption influence speech behavior has not yet been sufficiently clarified.

Accordingly, the present study aimed to elucidate how group conversation becomes more active after the onset of caffeine's physiological effects.

2. Methods and Material

2.1 Subjects

The subjects were four healthy male university students (mean ± SD: age, 20.5 ± 0.5 years; height 176.8 ± 2.9 cm; body mass, 72.8 ± 9.4 kg). They know each other and go to the same university, where they regularly talked in daily life. All subjects were fully informed of the study's aims and procedures, assured that their personal information would remain confidential, and informed that participation was voluntary and that refusal would not result in any disadvantage.

Written and verbal informed consent was obtained from each subject prior to participation.

The study protocol was conducted in accordance with the regulations of the Ethics Committee of Kokushikan University.

2.2 Experimental Protocol

Participants were instructed to abstain from all caffeine containing beverages (e.g., cola, coffee, tea, green tea) for 24h before and after each experimental session. A double-blind design was used, with caffeine and placebo powders prepared such that their identity could not be distinguished by appearance or taste. Participants were also instructed to finish their last meal at least 3 h prior to caffeine ingestion.

At baseline, participants completed the first Profile of Mood States (POMS) assessment. At the scheduled time, they ingested either caffeine powder or placebo powder dissolved in 200 mL of water. One hour after ingestion, participants gatherd in a designated room and completed the second POMS assessment. A discussion topic was then presented, and a 30-min group conversation, the third POMS assessment was conducted. The water-only condition followed the same procedure as the powder conditions.

During the preliminary stage, discussions were conducted using several different topics. Among these, topics related to relationships with the opposite sex led to the most active discussions. Therefore, in the present study, topics related to the opposite sex were selected.

Just before the start of the discussion, several topics related to the opposite sex were presented, and the participants were asked to choose the topic they were easiest for them to discuss. The topic selected by the largest number of participants was used for the discussion in the present study.

For the discussion topics, the theme under the water condition was “whether romantic relationships should prioritize physical appearance or personality,” the theme under the placebo condition was “whether friendship between men and women can exist,” and the theme under the caffeine condition was “whether one would bring a romantic partner or a friend to a deserted island.” Just before the discussion began, multiple topics were presented, and participants were allowed to select the topic they found easiest to discuss. All topics were standardized as closed-ended questions related to relationships with the opposite sex.

In this study, a conversation was defined as “active” when the total number of utterances, number of speaker changes, and number of overlapping utterances were high, and the overall sound pressure level was elevated. In addition, POMS assessments were used to examine changes in psychological states associated with caffeine ingestion.

In this study, the water, placebo, and caffeine conditions were conducted on separate days: however, the order of the conditions was not randomized and was identical for all participants. Consequently, potential order effects, such as habituation or fatigue associated with repeated participation, could not be fully controlled. This limitation should be considered when interpreting the results of the present study.

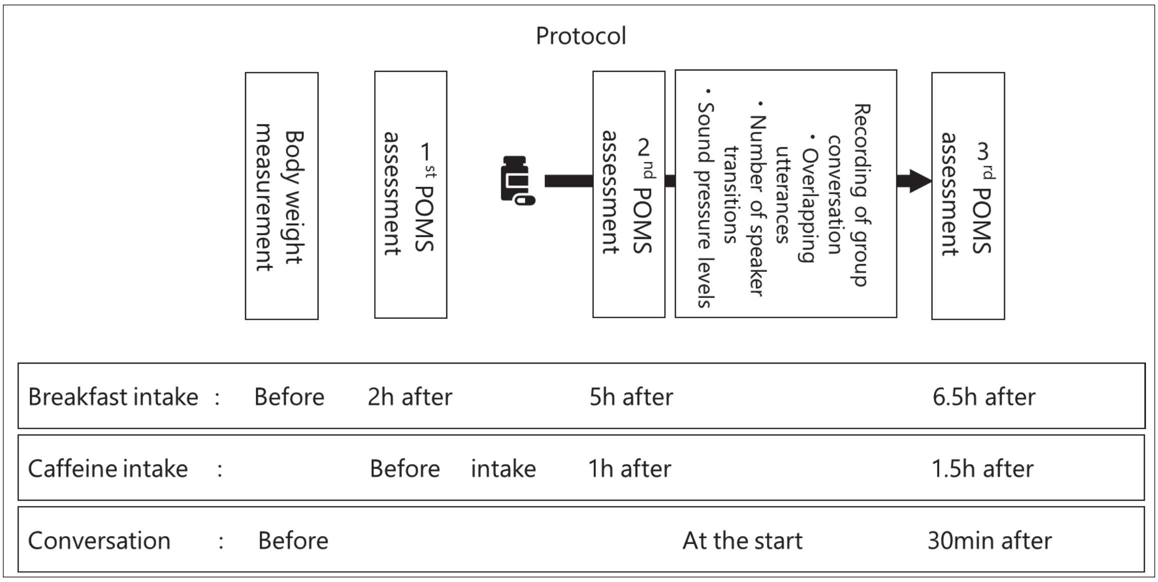

Figure1. Experimental Protocol

2.3 Speech Data and Physiological Measurements

An “active conversation” is defined as a situation in which speaker changes occur frequently and all members of the group participate in the conversation[13]. In addition, Mizukami et al. (2009) identified the amount of speech as an indicator of discussion activity, while Kubota and Nishida (2004) and Yokoyama (2012) reported that conversations are more likely when overlapping utterances (simultaneous speech by multiple speakers) occur more frequently.

Furthermore, Nishida et al. (2018) demonstrated that sound pressure level is an acoustic indicator reflecting the degree of speech activity.

Based on these previous studies, the present study used the total number of utterances, number of speaker changes, rate of overlapping utterances, and sound pressure level as indices of speech activity, and defined higher values of these indices as indicating “active speech.”

These indices were not intended to determine speech activity based on any single measure alone, but were used in combination to capture different aspects of speech behavior, including its quantity and interaction between speakers. Accordingly, “active speech” in this study was defined based on whether specific absolute threshold values were met, but was operationally defined to examine relative differences in speech activity among the ingestion conditions.

Speech data were recorded using a video camera (SONY HDR-CX680) equipped with a wireless microphone (SONY ECM-W1M), a voice recorder (SONY Li-ion) with an external microphone (SONY ECM-CQP1), and a sound level meter (SNDWAY SW-525A), From the video and audio recordings, the total number of utterances, number of utterances per participant, number of speaker changes, and number of overlapping utterances were extracted. From these, each participant’s proportion of speech and the overlap rate were calculated.

Overlapping utterances were defined, based on previous research[9], as instances in which a subsequent speaker began speaking before the preceding speaker had completed their utterance.

Instances in which a subsequent utterance began immediately after the preceding one, with no discernible pause, were also classified as overlapping.

The number of overlapping utterances was determined by listening to the voice recordings while checking verbatim transcripts, and each instance in which the second utterance overlapped with the first was counted as one occurrence.

The total number of utterances was obtained from the verbatim transcripts of the 30-min conversation. When the same participant spoke again after a pause of 3 seconds or longer, the utterance was counted as a single utterance, even if the content differed.

The number of speaker changes was calculated by identifying the speaker for each utterance in the transcript and counting each instance in which the speaker changed.

Sound pressure level (dB) was measured with the sound level meter placed at the center of the conversation table to ensure equal distance from all participants. The device recorded sound pressure at 0.5-s intervals. These values were extracted from the video recordings and compiled for analysis.

The POMS assessments were conducted three times per condition: before ingestion, 1 h after ingestion, and 1.5 h after ingestion.

2.4 Materials

The caffeine condition consisted of powdered caffeine (Caffeine 200, Harumi's Co., Ltd.) administered at a dose of 4 mg/kg body mass dissolved in 200 mL of water. The placebo condition used a powdered placebo (Placeplus 30, Placebo Pharmaceutical Co., Ltd.) prepared in the same manner.

2.5 Statistical Analysis

Data are presented as mean ± standard deviation (SD). POMS scores were analyzed using one-way ANOVA. The total number of utterances and the mean sound pressure level (aggregated in 5-min intervals) were analyzed using the Kruskal-Wallis test. The level of statistical significance was set at $p < 0.05$.

3. Results

3.1 Number of Utterances

Table 1 shows the total number of utterances per participant, the overall total number for all four participants, each participant's proportion of speech, the number of speaker changes, and the number and rate of overlapping utterances.

The total number of utterances was highest in the caffeine condition (922) compared with the water (918) and placebo (872) conditions, slightly higher. The number of speaker changes was also greatest in the caffeine condition (921) compared with the water (917) and placebo (871) conditions.

The highest overlap rate was in the water condition (86.7%), followed by caffeine (84.7%) and placebo (82.1%). However, none of these differences were statistically significant.

Table1. Total number of utterances, proportion of speech, number of speaker changes, and number and rate of overlapping utterances for each participant.

	water	placebo	caffeine
Student A: Total utterances (n)	343	313	296
Student B: Total utterances (n)	189	268	294
Student C: Total utterances (n)	240	189	174
Student D: Total utterances (n)	146	102	158
Total utterances (all participants, n)	918	872	922
Student A: Speech proportion (%)	37.4	35.9	32.1
Student B: Speech proportion (%)	20.6	30.7	31.9
Student C: Speech proportion (%)	26.1	21.7	18.9
Student D: Speech proportion (%)	15.9	11.7	17.1
Number of speaker transitions (n)	917	871	921
Overlapping utterances (n)	796	716	781
Percentage of overlapping utterances (%)	95.0	84.5	90.9

3.2 Sound Pressure Level (dB)

Sound pressure levels were classified based on the criteria described in the Noise Survey Subcommittee report. Analysis of the distribution of sound pressure levels showed that the caffeine condition showed a higher proportion of quieter speech (40-49.9 dB) compared with the water and placebo conditions. However, the mean sound pressure level was similar across conditions (caffeine: 62.8 dB; water: 62.8 dB; placebo: 60.0 dB), and no significant differences were found in maximum sound pressure levels.

Analysis over time showed a transient drop in sound pressure level during the caffeine condition, but by the end of the 30-min session, levels had converged with those observed in the other conditions. These findings suggest that caffeine ingestion did not have a clear effect on sound pressure level during group conversation.

Table 2. Percentage of utterances at each sound pressure level.

	Sound Pressure Level						
	40.0~49.9	**50.0~59.9**	**60.0~69.9**	**70.0~79.9**	**80.0~89.9**	**90.0~99.9**	**100.0~109.9**
Water (%)	16.6	24.4	30.8	21.7	5.3	1.2	0.0
Placebo (%)	22.8	28.7	28.9	14.8	3.5	1.3	0.0
Caffeine (%)	31.6	25.1	26.2	13.2	3.1	0.8	0.0

Table3. Changes in sound pressure level by intake condition (every 5 minutes)

Water	Mean (dB)	SD (dB)	Max (dB)	Min (dB)	Mode (dB)
0:00~5:00	61.8	11.0	96.2	44.2	63.2
5:01~10:00	66.2	11.0	93.5	43.8	62.2
10:01~15:00	62.3	11.2	96.6	44.0	44.3
15:01~20:00	61.6	9.6	94.6	44.3	63.2
20:01~25:00	61.4	10.2	95.3	44.4	64.2
25:01~30:00	63.8	13.8	101.0	44.5	44.6
Placebo	Mean (dB)	SD (dB)	Max (dB)	Min (dB)	Mode (dB)
0:00~5:00	60.9	11.7	98.5	42.4	43.7
5:01~10:00	58.5	11.7	97.3	43.3	43.5
10:01~15:00	58.0	10.8	96.2	42.8	43.3
15:01~20:00	58.8	11.3	97.2	42.8	43.5
20:01~25:00	60.6	10.4	98.5	43.2	58.9
25:01~30:00	63.5	11.0	97.4	43.5	55.8
Caffeine	Mean (dB)	SD (dB)	Max (dB)	Min (dB)	Mode (dB)
0:00~5:00	59.3	10.4	95.8	43.4	44.0
5:01~10:00	60.7	10.8	87.0	43.5	43.7
10:01~15:00	57.1	14.0	99.8	43.3	43.6
15:01~20:00	52.0	8.1	80.7	43.4	43.6
20:01~25:00	60.4	11.7	98.7	43.7	44.0
25:01~30:00	59.7	10.8	94.1	43.6	44.2

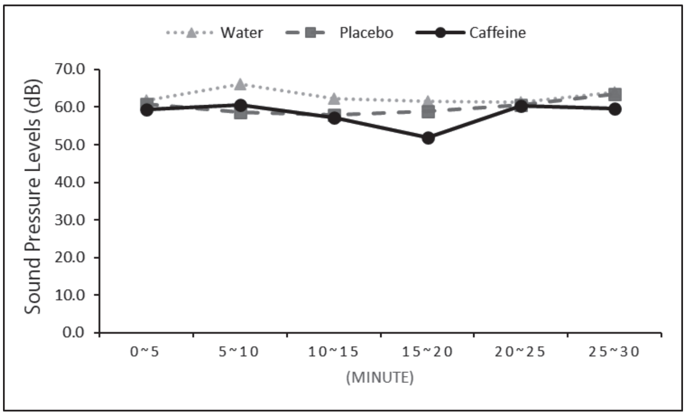

Figure2. Temporal Changes in Mean Sound Pressure Levels at 5-min Intervals

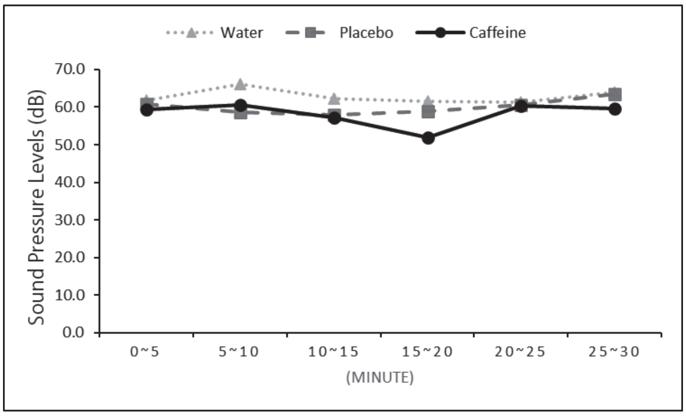

Figure3. Temporal Changes in Maximum Sound Pressure Levels at 5-min Intervals

3.3 Profile of Mood States (POMS) Scores

Mean POMS T-scores for each condition are shown in Table 4, with individual changes shown in Figures 3-5. No changes before and after ingestion were found in tension, depression, anger, vigor, or confusion scores in either the water or placebo conditions. In contrast, the caffeine condition showed a significant reduction in fatigue scores, from 48.6 at baseline to 44.1 at 1 h and 40.7 at 1.5 h after-ingestion ($p < .01$; Figure 6). No significant differences were found in any of the other subscales.

Table 4. Changes in POMS T-scores by condition.

Water	Before	1h after intake	1.5h after intake
Tension	50.4 ± 10.7	47.95 ± 8.6	45.5 ± 7.0
Depression	49.1 ± 10.1	48.43 ± 11.7	46.4 ± 12.3
Anger	45.8 ± 11.8	45.18 ± 10.8	43.9 ± 12.5
Vigor	46.7 ± 10.7	45.43 ± 16.4	40.5 ± 10.3
Fatigue	52.3 ± 13.2	46.55 ± 8.8	48.9 ± 3.7
Confusion	46.1 ± 12.1	49.45 ± 8.6	46.1 ± 12.1
Placebo			
Tension	51.7 ± 13.0	49.2 ± 7.4	48.0 ± 5.0
Depression	46.4 ± 10.6	45.68 ± 14.8	50.5 ± 16.8
Anger	53.1 ± 7.9	49.13 ± 13.7	46.5 ± 15.3
Vigor	50.4 ± 12.4	47.93 ± 16.4	54.1 ± 20.1
Fatigue	46.6 ± 5.9	55.73 ± 9.5	53.5 ± 5.3
Confusion	54.4 ± 1.0	44.48 ± 12.6	46.1 ± 9.4
Caffeine			
Tension	58.1 ± 14.9	55.7 ± 12.7	50.0 ± 8.2
Depression	48.2 ± 9.1	48.2 ± 17.2	47.5 ± 15.3
Anger	49.9 ± 14.8	49.85 ± 11.5	50.4 ± 12.8
Vigor	46.7 ± 12.4	51.43 ± 14.0	57.3 ± 19.2
Fatigue	48.2 ± 10.4	43.53 ± 7.1	40.0 ± 0.0
Confusion	58.5 ± 13.8	46.8 ± 11.1	46.8 ± 12.4

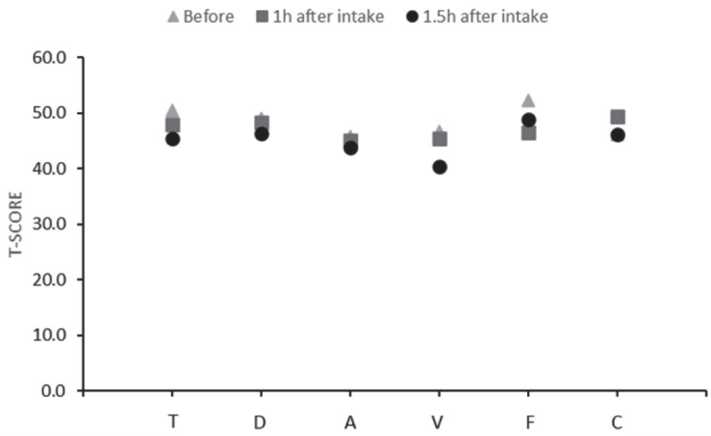

Figure.4 Changes in Mean POMS Scores during the Water

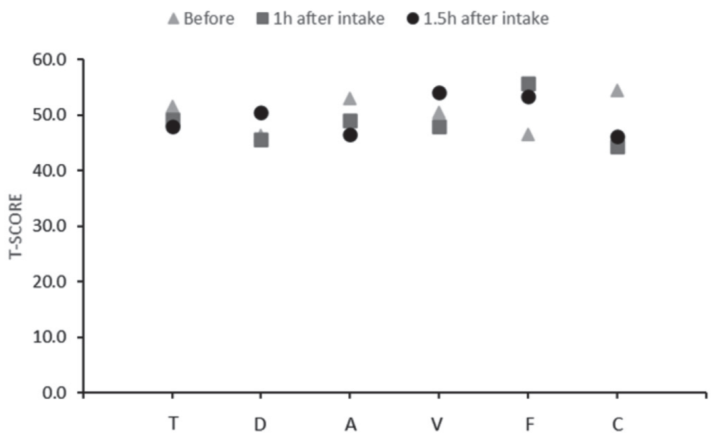

Figure.5 Changes in Mean POMS Scores during the Placebo

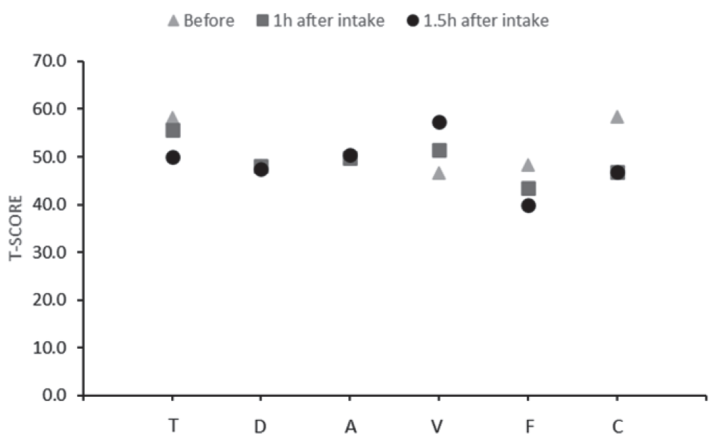

Figure.6 Changes in Mean POMS Scores during the Caffeine

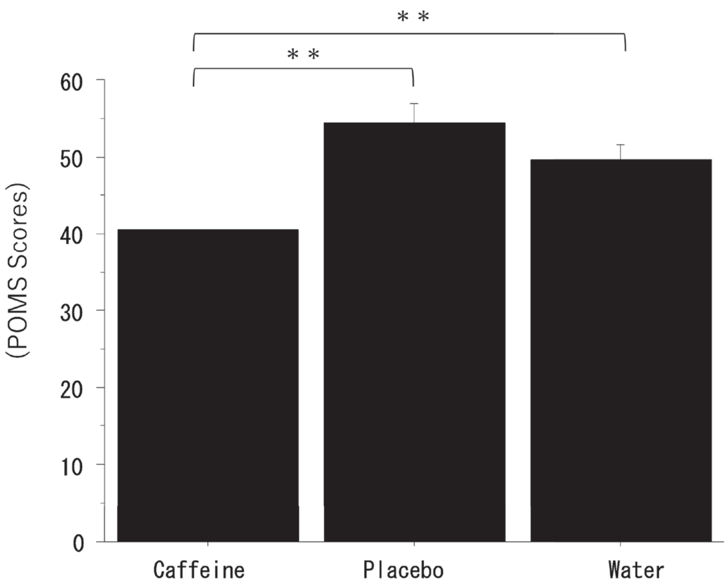

Figure.7 ANOVA results for POMS Fatigue Scores at 1.5h post-ingestion(**p<.01)

4. Discussion

The present study examined the effects of caffeine ingestion on the activeness of speech during group conversation. Four indices of speech behavior (total number of utterances, number of speaker shifts, frequency of overlapping utterances, and sound pressure level) as well as psychological states assessed by the Profile of Mood States (POMS) were analyzed.

Regarding speech behavior, both the total number of utterances and the number of speaker shifts were slightly higher in the caffeine condition than in the water and placebo conditions; however, these differences were not statistically significant. Analysis of sound pressure levels showed that relatively quiet utterances (40–49.9 dB) occurred more frequently during the caffeine condition than during the water or placebo conditions, while no differences were observed in mean or maximum sound pressure levels. These findings suggest that caffeine ingestion does not clearly aggect the physical aspects of speech such as loudness or intensity. Interestingly, sound pressure levels tended to be higher in the water condition than in the caffeine condition,suggesting that situational factors such as conversation content or social atmosphere may have a greater impact on vocal intensity than physiological arousal alone. Moreover, the temporary decline in sound pressure observed around the midpoint of the session under the caffeine condition suggests that the arousing effects of caffeine do not directly translate into elevated vocal energy or volume.

In contrast, psychological assessment indicated a significant reduction in the POMS Fatigue score only 90 minutes after caffeine ingestion. This finding supports the notion that caffeine’s central nervous system-stimulating properties contribute to a subjective reduction in fatigue, consistent with previous reports (16). However, no significant changes were observed in other affective dimensions such as tension–anxiety, depression–dejection, anger–hostility, vigor–activity, or confusion–bewilderment.

Taken together, these results suggest that although caffeine ingestion may reduce subjective fatigue, it does not substantially improve the behavioral activeness of group conversation within approximately one hour after intake.

5. Future Directions

In the present study, a decrease in the Fatigue score of the POMS was observed 90 minutes after caffeine ingestion, whereas no changes were found in behavioral indices related to speech activeness, such as the total number of utterances and sound pressure level. Based on these findings, several points should be considered for future research.

First, increasing the number of participants is needed. Because the present study included only four participants, the statistical power was limited. Increasing the sample size and collecting a larger dataset would allow for more robust statistical analyses and improve the reliability of the findings.

Second, controlling the relationships among participants should be controlled. In the present study, all participants were acquainted with one another and talked with each other on a daily basis, which may have influenced speech activeness through interpersonal familiarity or group dynamics. Future studies should control the level of familiarity among participants in order to more precisely examine the effects of caffeine ingestion on conversational behavior.

Third, improvement in the selection of discussion topics is necessary. In this study, conversation themes were determined based on participant preference and consisted mainly of closed-ended questions. However, differences in topic characteristics—such as whether they reflect familiar or unfamiliar contexts—may affect the amount and liveliness of speech. Therefore, future studies should carefully select conversation themes that reduce topic-related bias and do not influence speech activeness.

6. Conclusion

The present study aimed to clarify the effects of caffeine ingestion on the activeness of group conversation.

・During the 30-min group conversation conducted from 1h after caffeine ingestion, no clear effects of the experimental conditions were observed on speech behaviors such as the total number of utterances and sound pressure level.

・In the POMS assessment, only the Fatigue score decreased 90 min after caffeine ingestion, while no changes were detected in the other mood dimensions under the present experimental conditions.

In addition, the present study was limited by a small sample size, which resulted in insufficient statistical power, and by the lack of randomization in the order of the experimental conditions, making it difficult to exclude potential order effects. Taking these limitations into account, future studies should use a larger sample size and a randomized study design to further examine the effects of caffeine ingestion.

References

(1) Bastia, E., & Schwarzschild, M. A. (2003). DARPP chocolate: a caffeinated morsel of striatal signaling. Science’s STKE, 2003(165), pe2.

(2) Fine, B. J., et al. (1994). Effects of caffeine or diphenhydramine on visual vigilance. Psychopharmacology, 114, 233–238.

(3) Gilbert, D. A. (1993). Reciprocity of involvement activities in client-nurse interactions. Western Journal of Nursing Research, 15, 674–689.

(4) Glade, M. J. (2010). The beneficial effects of human caffeine consumption deserve clarification. Nutrition, 26(10), 932–938.

(5) Hewlett, P., & Smith, A. (2007). Effects of repeated doses of caffeine on performance and alertness: new data and secondary analyses. Human Psychopharmacology: Clinical and Experimental, 22(6), 339–350.

(6) Kibayashi, R. (2023). Overlapping speech and collaborative utterances in conversation. Keiwa Gakuen University Bulletin, 32, 121–135.

(7) Kurihara, H. (2016a). Coffee/caffeine consumption and daily life: psychomotor stimulant effects and behavioral performance. Tokyo University of Social Welfare Bulletin, 7(1), 5–17.

(8) Kurihara, H. (2016b). Caffeine consumption in daily life: mechanisms of action and safety evaluation. Tokyo University of Social Welfare Bulletin, 6(2), 109–125.

(9) Kubota, Y., & Nishikawa, J. (2004). Construction of scientific meaning in small group learning: from overlapping speech in small groups. Journal of Science Education Research, 44(3), 1–11.

(10) Mizukami, E., et al. (2009). Examination of evaluation parameters for evaluating discussions (1). Proceedings of the 15th Annual Meeting of the Association for Natural Language Processing, 769–772.

(11) Nakamura, S., & Miura, M. (2014). Effects of eating behavior on communication behavior and subjective evaluation in group discussions: does eating sweets improve discussions? Kwansei Gakuin University Repository, 6(2), 59–77.

(12) Nakaya, A., & Okamoto, M. (2022). Overlapping speech in online conversation: focusing on interference with prior utterances. JSAI Research Report, SIG-SLUD-094-13, 70–77.

(13) Nishida, Y., et al. (2018). Extraction of acoustic features at speaker change for creating a simple unsupervised conversation activity classifier. Forum on Information Technology, J-040, 301–304.

(14) Ministry of Agriculture, Forestry and Fisheries (2024). Excessive caffeine intake. https://www.maff.go.jp/j/syouan/seisaku/risk_analysis/priority/hazard_chem/caffeine.html (Accessed May 24, 2025).

(15) Ruxton, C. H. S. (2008). The impact of caffeine on mood, cognitive function, performance and hydration: a review of benefits and risks. British Nutrition Foundation Nutrition Bulletin, 33, 15–25.

(16) Shibuya, M. (2003). Psychologists know: people with and without leadership. PHP Institute.

(17) Smith, A. (2002). Effects of caffeine on human behavior. Food and Chemical Toxicology, 40(9), 1243–1255.

(18) Smith, A., et al. (1999). Effects of a low dose of caffeine given in different drinks on mood and performance. Human Psychopharmacology: Clinical and Experimental, 14(7), 473–482.

(19) Smith, A., et al. (2005). Effects of caffeine in non-withdrawn volunteers. Human Psychopharmacology: Clinical and Experimental, 20(1), 47–53.

(20) Sueoka, S., et al. (2009). Results of survey on creation of ”noise guidelines”. Journal of the Japan Environmental Society, 34(4), 254–261.

(21) Tomita, E., et al. (2010). Exploration of learning environments that promote spontaneous growth of university students' dialogue skills: analysis of self-rating values for discussions. Japan Journal of Educational Technology, 33(4), 431–440.

(22) Une, K., & Imai, S. (2001). The effect of caffeine on computational ability. Bulletin of Okinawa Prefectural College of Nursing, 2, 51–57.

(23) Yokomitsu, K., & Fujiwara, K. (2019). The Communicative Effects of a cup of coffee on dyadic conversation. Psychology, 10, 1361–1370.

(24) Yokoyama, T., et al. (2012). Determining liveliness of multiparty conversation using linguistic and non-linguistic information. Proceedings of the 18th Annual Meeting of the Association for Natural Language Processing, 291–294.

(25) Zabelina, D. L., & Silvia, P. J. (2020). The effects of caffeine on thinking and problem solving. Consciousness and Cognition, 79.