An Analysis of the Psychological Impacts of Collaborative Exploration Activities in Group Travel Contexts on Well-being

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ABSTRACT

Group sightseeing sometimes fails to promote active interaction among participants and improve their well-being. This study investigated how collaborative exploration activities affect group tourism participants' well-being, using a photo-spot quiz as an experimental task to induce cooperative behavior. We developed a group tourist well-being support system using iPhones and Apple Watches that presents a partial photo of a tourist site as a task, verifies completion through photo similarity and GPS, and provides different hints to each participant to encourage discussion. A field experiment was conducted in Kyoto, Japan, with six groups of three visiting sightseeing locations across two conditions (with vs. without the system) on separate days. Personality traits were collected before the experiment; emotional states were collected in three phases (arrival, mid-visit, exit); movement distance and heart rate were recorded throughout the tour. Results showed that groups with more participants high in extraversion and openness exhibited increased positive affect during collaborative exploration, and their heart rate synchronization remained more stable even in highly crowded locations. These findings suggest that collaborative exploration can enhance group tourism experiences, depending on participant characteristics and environmental context.

Keywords: *Cooperative behavior, Photo-spot quiz, Personality traits, Heart Rate Synchronization*

1 INTRODUCTION

More than 80% of overnight trips in Japan are conducted in groups rather than individually (Recruit LifeStyle, 2025). However, simply being together at the same place does not necessarily guarantee active interaction or improved well-being among participants, and few studies have directly examined this relationship. Existing destination recommendation systems for group tourism (Alatiyyah, 2025) optimize which spots a group should visit but do not address how members can enjoy the experience together on-site.

Game-based tourism can influence participants' emotions and enhance engagement (Xu et al., 2017), but has not focused on improving on-site stays. Behavioral and physiological data

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such as movement and heart rate have been used to examine how engaging in activities together at a tourist spot affects enjoyment (Ogino et al., 2022), but without considering the personality traits of group members. To investigate how personality differences affect enjoyment and emotions during group exploration, we developed a well-being support system for group tourists using an iPhone and Apple Watch.

2 METHOD

2.1 System

We developed a group tourism well-being support system using iPhones and Apple Watches for a group of three participants. Each participant carried an iPhone, which recorded GPS-based routes, and wore an Apple Watch, which measured heart rate. The photo-spot quiz application was installed on only one of the iPhones because the system aimed to help the group work together through active conversations at tourist destinations (Figure 1). The application presented a partial photo of a tourist spot as an exploration task and encouraged participants to find the location together. Task completion was judged based on similarity between the participants' photo and the correct photo, computed with a machine-learning library (Core ML) on the iPhone, together with GPS information to verify the location. The app provided three types of hints; to facilitate group discussion, each participant could only see hints different from the others, so they needed to share information and collaborate to solve the task. The application also provided a detailed screen for each tourist spot (Figure 2). From this screen, participants can check the quiz photo, access questionnaires, view hints, and verify the photos they took.

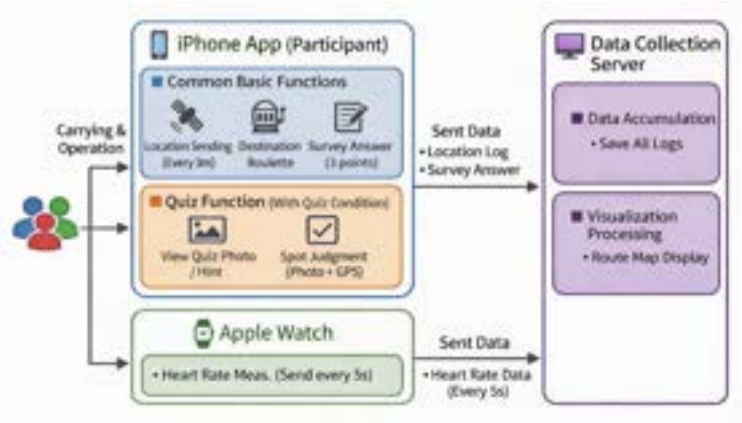


Figure 1. Overview of the group tourism well-being support system



Figure 2. Example of the photo-spot quiz application interface

2.2 Participants

A total of 17 participants (10 males and 7 females; mean age = 21.67 years, SD = 1.38) participated in the experiment. They were divided into six groups, each consisting of three close friends. However, one participant was included in two different groups.

2.3 Experiment Procedure

We conducted the experiment over two days to evaluate whether the photo-spot quiz application made group sightseeing more fun and enjoyable for the participants. Each group of three conducted two conditions of the experiment: sightseeing with and without the photo-spot quiz application. In the quiz application condition, the participants collaboratively performed a photo-spot quiz task while sightseeing. In contrast, in the non-quiz application condition, the participants explored tourist spots without performing any collaborative tasks.Each condition was tested on separate days (Figure 3). The group visited three tourist spots in one day. They chose these spots from a list of 12 in Kyoto, Japan. The participants in a group discussed and decided together where to go before each day's tour. Importantly, the three spots visited on the day with the system and the three spots visited on the day without the system were entirely different even for the same group, because each group newly selected the spots from the list of 12 before each day's tour. This design was adopted to avoid carryover effects from revisiting identical spots. At each location, they filled out surveys three times: upon arrival, at a mid-visit checkpoint, and upon departure. The mid-visit checkpoint was defined differently across conditions—immediately after quiz completion in the with-system condition, and seven minutes after arrival in the without-system condition—a design choice discussed further in the Limitations section. During the experiment, each participant used their iPhone to track their route and moving distance during their tour using the GPS. They also recorded their heart rates using Apple Watches while sightseeing. These measurements were taken in both situations to compare the emotional, behavioral, and physical responses.

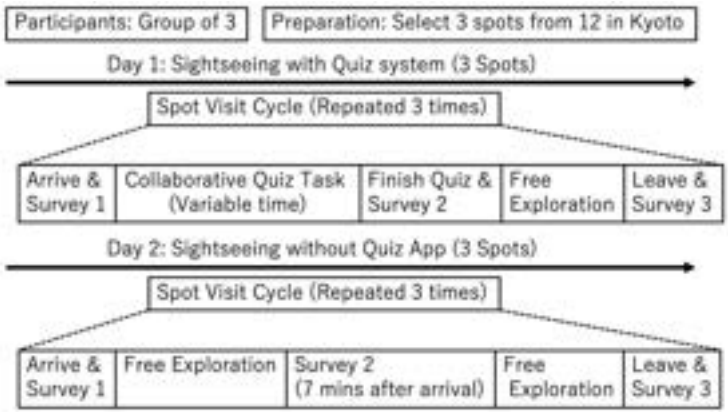


Figure 3. Overview of the Experimental Procedure

2.4 Measures

2.4.1 Emotional Measures

Emotional changes were assessed with the Multidimensional Mood Scale (MMS; Terasaki et al., 1992) and the Japanese version of the Positive and Negative Affect Schedule (PANAS; Sato et al., 2001). The MMS comprises eight mood scales (Depression/Anxiety, Hostility, Boredom, Liveliness, Well Being, Friendliness, Concentration, Startle), each with five items rated on a four-point Likert scale (score range: 5–20). The PANAS measures positive affect (PA) and negative affect (NA), each with eight items on a six-point Likert scale (score range: 8–48). At the exit survey, participants additionally rated perceived crowding (1–5) and quiz difficulty (1–4).

2.4.2 Personality Traits

Participants' personality traits were assessed prior to the experiment using a questionnaire based on the Big Five Personality Model. The five dimensions (extraversion, agreeableness, conscientiousness, neuroticism, and openness) were measured to examine how individual differences influenced the effectiveness of collaborative exploration during group tourism.

2.4.3 Behavioral Measures

Behavioral data were collected using GPS data obtained from the participants' iPhone devices. During sightseeing, GPS data were transmitted from the iPhone application to a server each time a participant moved more than three meters. This approach enabled the continuous tracking of participants' locations while minimizing redundant data transmission. Using the collected GPS data, movement routes and total movement distances within each tourist spot were recorded during the experiment.

2.4.4 Physiological Measures

Physiological data were collected by continuously measuring the participants' heart rates using Apple Watch devices during sightseeing. Heart rate data were recorded throughout the experiment under both quiz and non-quiz conditions. The collected heart rate data were used to examine changes in physiological arousal during sightseeing activities. In addition, heart rate synchronization among group members was analyzed as an indicator of shared engagement and

coordinated activity during the collaborative exploration, following previous research on group mood estimation using wearable devices (Ogino & Ikematsu, 2022). Heart rate synchronization was evaluated by examining the temporal similarities in heart rate fluctuations among group members at each tourist spot.

3 RESULTS

3.1 Group Classification Based on Personality Traits

Non-metric multidimensional scaling (NMDS) was applied to the Big Five Questionnaire data (Wada, 1996) to examine similarities and differences in participants' personality traits. Figure 4 shows the participants in NMDS space, and Table 1 shows how each NMDS axis relates to the Big Five traits. Participants in the upper region scored higher on extraversion and openness; those in the lower region scored lower on these traits.

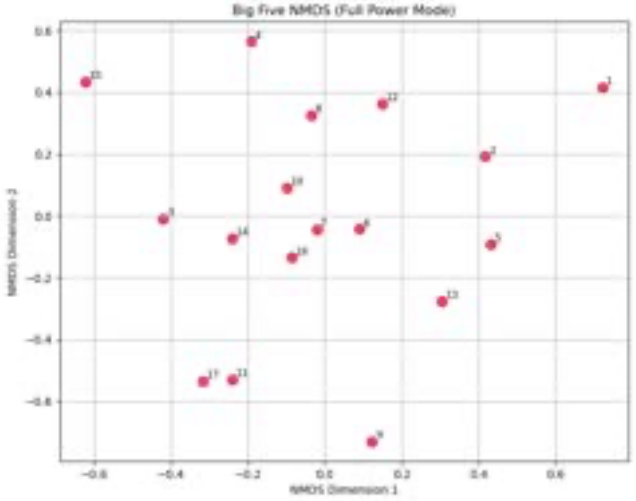


Figure 4. NMDS plot of participants based on Big Five personality traits.

Table 1. Correlations between NMDS dimensions and Big Five personality traits

	Extraversion	Neuroticism	Openness	Conscientiousness	Agreeableness
NMDS1 (Horizontal axis)	-0.35	0.82	-0.50	-0.51	0.21
NMDS2 (Vertical axis)	0.86	0.33	0.58	-0.27	0.42

Participants were divided into two groups. Group A consisted of groups with two or more of three members relatively high in extraversion and openness, and Group B was defined by the opposite pattern. In small groups of three, the personality traits shared by most members are

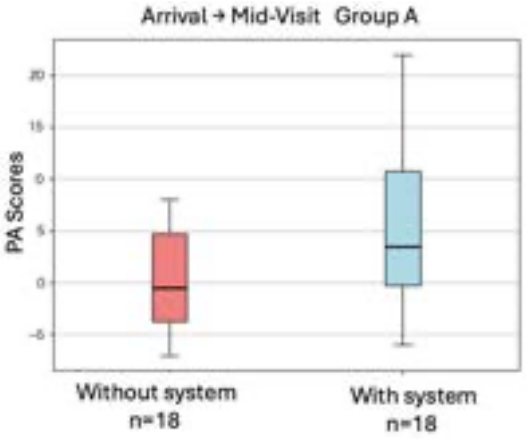
likely to shape how the group behaves, interacts, and feels during sightseeing. All subsequent analyses compared Group A and Group B.

3.2 Effects of Collaborative Exploration on Emotional States Across Personality Groups

Change scores in PANAS and MMS were calculated across three intervals (Arrival→Mid-visit, Mid-visit→Exit, Arrival→Exit) and compared between conditions using the Wilcoxon signed-rank test ($p < 0.05$), visualized with box plots.

As shown in Figure 5, in Group A, PA scores significantly increased from the arrival to the mid-visit phase under the photo-spot quiz application condition (With system) compared with the non-quiz application condition (Without system). Similarly, the “Liveliness” scores were significantly higher in the quiz application condition than in the non-quiz application condition. This indicates that the participants experienced a more energetic and active emotional state during collaborative exploration. In contrast, no significant changes were observed in Group B.

In contrast, no significant changes were observed in Group B. Furthermore, in Group A, NA scores significantly increased from arrival to exit under the "With system" condition compared with the "Without system" condition. A closer inspection of the individual NA scores revealed that this increase was primarily driven by higher scores on the items “worried” and “upset.” Regarding the "startle" item, a significant increase from arrival to mid-visit was observed in the photo-spot quiz condition. This increase was consistently observed across groups, regardless of personality composition. In contrast, no comparable increase was observed in the "Without system" condition.



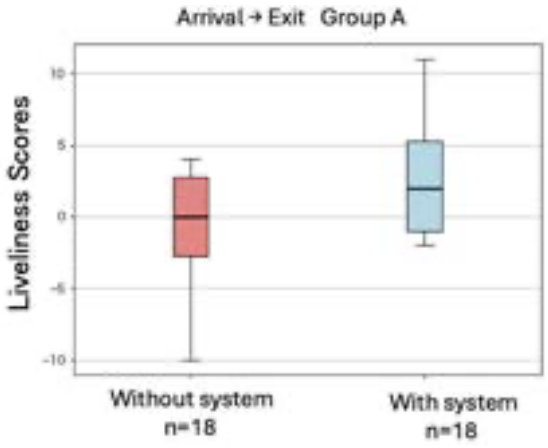


Figure 5. Changes in PA scores (left) in PANAS and Liveliness scores (right) in the MMS from Arrival to Mid-Visit in Group A

Furthermore, in Group A, NA scores significantly increased from arrival to exit under the "With system" condition compared with the "Without system" condition. A closer inspection of the individual NA scores revealed that this increase was primarily driven by higher scores on the items “worried” and “upset.” Regarding the "startle" item, a significant increase from arrival to mid-visit was observed in the photo-spot quiz condition. This increase was consistently observed across groups, regardless of personality composition. In contrast, no comparable increase was observed in the "Without system" condition.

3.3 Effects of Perceived Crowding on Emotional Changes

Tourist spots were categorized into high- and low-crowding locations based on questionnaire responses, and emotional changes were compared using the Mann-Whitney U test.

As shown in Figure 6, during the Arrival to Mid-Visit interval at high-crowding spots, the “Liveliness” scores were significantly higher under the "With system" than under the "Without system" ($p = 0.049 < 0.05$). This pattern indicates that collaborative exploration enhances energetic and active emotional states, even in crowded environments.

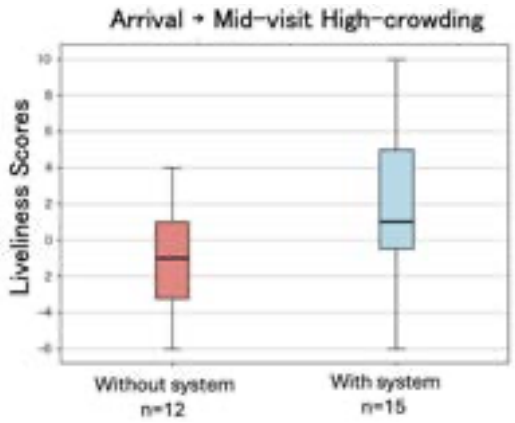


Figure 6. Change in Liveliness Scores from Arrival to Mid-Visit at High-Crowding Spots

Table 2. Mean and Standard Deviation of Heart Rate Synchronization Scores for Each Group

	Condition	SD	Mean
G1	Without System	0.11	0.52
	With System	0.07	0.40
G2	Without System	0.24	0.45
	With System	0.06	0.60
G3	Without System	0.10	0.58
	With System	0.08	0.48
G4	Without System	0.06	0.34

	With System	0.09	0.39
G5	Without System	0.31	0.29
	With System	0.03	0.62
G6	Without System	0.12	0.62
	With System	0.02	0.54

3.4 Heart Rate Synchronization

Heart rate synchronization was quantified as the number of matched heart-rate peaks among group members within a ±5 s window, using standardized signals from Apple Watches (sampled every 5 s).

Table 2 presents the mean values and standard deviations of the heart rate synchronization scores for each group under both the "With system" and "Without system" conditions. No remarkable differences in mean values were observed between the conditions. However, the standard deviations tended to be smaller under the "With system" condition, suggesting that synchronization was more stable during collaborative exploration.

4 DISCUSSION

Groups with more participants high in extraversion and openness showed significantly greater increases in Positive Affect (arrival to mid-visit) and Liveliness (arrival to exit), while groups lower in these traits did not. This shows that the photo-spot quiz application works well-being for people who are more "extraversion" and "openness." These people like social activities and new experiences, which might be why they enjoy the quiz more. This interpretation is consistent with prior work showing that extraversion is dispositionally associated with heightened positive affect (Costa & McCrae, 1980), and that openness predicts a preference for novel and exploratory experiences (McCrae, 1996). An alternative account, however, is that individuals high in extraversion report higher positive affect in general (Costa & McCrae, 1980). This baseline tendency could contribute to the Group A effect independently of the task; distinguishing these accounts would require designs that separate trait-level baseline affect from task-induced changes. However, they also increased the "Negative affect" score by increasing the scores in the “worried” and “upset” items. This indicates that temporary tension was experienced while searching for the correct location during the task.

The result indicated that the environmental context also affects people using the photo-spot quiz application. In very crowded places, people felt more "Liveliness" from the Arrival phase to the Mid-Visit phase when using the photo-spot quiz application. In less crowded places, there was no significant change. This implies that collaboration on tasks can be highly effective in crowded environments. The tasks provide people with a clear goal, making the crowded environment feel like part of the activity rather than a source of stress. This interpretation is consistent with the attentional focusing that characterizes flow states, in which engagement with a goal-directed task reduces the perceived cost of environmental stressors (Csikszentmihalyi, 1990). Importantly, the same crowded spots did not produce a comparable

rise in emotional state under the without-system condition, which argues against a purely site-attractiveness explanation and supports the interaction between crowding and the collaborative task. An alternative account is that crowded spots may make the quiz itself more difficult, so that a stronger sense of achievement upon task completion contributes to the observed rise in Liveliness. In less crowded places, people can move around easily and enjoy the view, which lowers their stress. In these places, the photo-spot quiz may not be as effective. To improve the experience in these places, it may be more helpful to focus on ways to enjoy the scenery more deeply or improve the quality of the experience rather than on activities with strict goals.

"Startle" scores increased significantly during the Arrival to Mid-Visit phase only under the with-system condition, likely reflecting the moment participants found the answer and enjoyed it.

5 LIMITATIONS

5.1 Sample size and non-independent observations

The study included 17 participants across six groups of three, and one participant took part in two different groups. Both of these groups were classified as Group B, so no participant contributed data to both sides of the Group A versus Group B comparison, and that comparison is not confounded by the repeated participant. Their responses do, however, carry slightly more weight within the Group B statistics. The within-condition Wilcoxon signed-rank comparisons are unaffected, since each participant serves as their own control across conditions. Given the small number of groups, we treat these findings as preliminary and await replication with a larger, fully independent sample.

5.2 Choice of personality inventory

We measured the Big Five using Wada's (1996) scale, a standard Japanese-language instrument that keeps our results comparable with earlier Japanese personality research. Item loadings can vary frozm one Big Five scale to another, so administering a second inventory in parallel would give a firmer basis for the group classification we relied on.

5.3 Unmeasured within-group relational characteristics

Each group consisted of three close friends, but we did not record how close they were, or in what way. Length of acquaintance, frequency of interaction, prior shared travel, and whether one member tended to lead were all left uncollected. Two groups that both count as “close friends” could differ on any of these, and that hidden variation may have added noise to the outcomes. Including a validated closeness scale in future rounds would let us treat these factors as moderators rather than leaving them uncontrolled.

5.4 Design-driven timing difference in the mid-visit questionnaire

The mid-visit questionnaire was administered at different moments in the two conditions: immediately after quiz completion in the with-system condition, and seven minutes after arrival in the without-system condition. This was intentional. In the with-system condition we wanted to capture the emotional state right after task completion, and fixing a specific elapsed time

would have interrupted many groups mid-task. The without-system condition has no equivalent task-completion event, so we used a fixed elapsed time to approximate the moment after an initial round of free exploration. The gap between the two was nevertheless large—10.3 ± 2.4 minutes without-system versus 21.8 ± 13.2 minutes with-system (Wilcoxon signed-rank test, $p = 0.003$)—so part of the increase in Positive Affect and Liveliness may reflect longer time spent at the location rather than collaborative exploration itself. Adding a few time-based checkpoints alongside the functional one used here would help separate the two.

5.5 Physical versus psychological contributions to heart rate synchronization

Heart rate synchronization was used as an indicator of shared engagement, but heart rate reflects physical activity as much as psychological state. The standardization procedure applied here does not separate synchronization arising from shared movement (e.g., walking together) from synchronization arising from shared psychological engagement with the task. The results should be read as a combination of both. A physiological signal less confounded by movement—electrodermal activity, for example—would help isolate the psychological component in future work.

6 CONCLUSION

This study investigated how a photo-spot quiz system affects well-being in group tourism experiences. The system was most effective for groups higher in extraversion and openness, who reported greater positive affect and liveliness during collaborative exploration. In crowded environments, the system enhanced emotional engagement. Physiologically, heart rate synchronization remained more stable under the system across most groups. Together, these findings suggest that collaborative exploration can enhance group tourism experiences, contingent on participant personality and environmental context.

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