# Portfolio

## Takanori Nanahara

### This book contains...

- Curriculum Vitae
- Research Projects

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# Curriculum Vitae

# Takanori Nanahara

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| **EDUCATION** | 2023. 3 | **Bachelor of Engineering**<br>Nagoya University, Department of Civil Engineering and Architecture, School of Engineering |
| | 2023. 4 - 2025. 3 | **Master of Architecture**<br>Nagoya University, Graduate School of Environmental Studies |
| | 2025. 4 - Present | Doctoral Student<br>Nagoya University, Graduate School of Environmental Studies |
| **PRESENTATIONS** | 2025. 9 | Nanahara, T., & Lee, S. (2025). Selection between conflicting strategies during indoor wayfinding: An insight into individual differences in the decision making process. 2025 Annual Conference of the Architectural Institute of Japan |
| | 2025. 7 | Hinano, I., Nanahara, T., & Mai, M. (2025). Multimodal Dynamicity in Fictive Expressions: Exploring Co-speech Gestures in Spatial Descriptions. CogSci 2025 |
| | 2024. 12 | Nanahara, T., & Lee, S. (2024). The non-fixed power balance between two navigation strategies; the demonstration by the controlled experiment. The 5th Asia Conference of International Building Performance Simulation Association 2024 |
| | 2024. 8 | Nanahara, T., & Lee, S. (2024). Distance to spatial cue affects strategy selection for wayfinding: the process of decision making and experiment in desktop virtual environment. 2024 Annual Conference of the Architectural Institute of Japan |
| | 2024. 6 | Nanahara, T., & Kitagami, S. (2024). How do differences in spatial depth and perceptual fluency affect route selection? The 22nd Conference of the Japanese Society for Cognitive Psychology |
| | 2023. 9 | Nanahara, T., & Tabata, E. (2023). How differences in the amount of signage effect on route learning in underground spaces. 2023 Annual Conference of the Architectural Institute of Japan |
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| | 2023 | **Grant**<br>Financial Support for Reseach Activities of Students in Graduate School of Environmental Studies: *Graduate School of Environmental Studies* |
| | 2024 | **Grant**<br>Grant-in-Aid for Encouragement of Scientists 2024: *Obayashi Foundation* |
| | 2025. 4 - 2027. 3 | **Grant**<br>Make New Standards Program for the Next Generation Researchers: *Japan Science and Technology Agency (JST), Tokai National Higher Education and Research System (THERS)* |
| | 2024. 6 | **Award**<br>JSCP Distinguished Presentation Award (Technology Evaluation Division), The 22nd Conference of the Japanese Society for Cognitive Psychology, 2024 |
| | 2025. 3 | **Award**<br>Best Performance Award, TMI Qualifying Examination 1, 2025. 3 |
| | 2023. 11 | **Award**<br>Best Presentation Award, “Exprolation of Space and behavior”, The 3rd TMI Symposium |
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## MEMBERSHIPS

- Architectural Institute of Japan
- Japanese Society for Cognitive Psychology

## TECHNICAL SKILLS

- Rhinoceros + Grasshopper
- Unity
- Python
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## REFERENCES

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# Research Projects

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### Non-fixed balance of influence between two navigation strategies (P. 5)

Studies in various fields such as spatial cognition, urban and architectural studies, and cognitive or environmental psychology have identified several strategies that people use during the wayfinding process. While the requisites for these strategies have been explored, much remains unknown about the hierarchy or activation priorities of these strategies. We began our investigation by comparing two well-known startegies: the floor strategy and the direction strategy. We observed participants' strategy choices in situations where these two strategies directed them toward opposing directions. Our finding revealed that the power balance between the two strategies is not uniform. Instead, there appears to be an interaction between the strategies, mediated by looking-around behavior.

Publications and presentations
*Takanori, N., & Sihwan, L. (2024a) (in Japanese.)*
*Takanori, N., & Sihwan, L. (2024b). This conference paper is available in the end of this document.*

### Perceptual Fluency and Route Selection (P. 10)

Spatial elements such as the width and length of a corridor, and the height of a ceiling are known to influence people's spatial decision-making. Some studies have reported that when presented with two alternative corridors, people tend to choose the longer one, while others have shown a preference for the shorter option. We hypothesized that this tendency can be influenced by how easily the length of the corridors can be perceived, a concept known as perceptual fluency. Our results indicate that people tend to prefer a shorter corridor when the lengths of the corridors are difficult to be recognized. Additionally, we figured out a possibility that the depth of the corridors influences our selection onloy when we are motivated to explore the environment.

Publications and presentations
*Takanori, N., & Shinji, K. (2024) (in Japanese.)*

### Amount of Information and Route Learning (P. 11)

Two types of signage are installed in underground stations in Japan. One is installed during the construction stage and the other is added later by station employees in response to user feedbacks. Of course the primary purpose of these additional signages is to make it easier for users to navigate the stations, and it feels like it works that way. However, counterintuitively, increasing the amount of information through additional signages seems to hinder the users' navigation performance. Also, it has been suggested that a lack of the signages might motivate people to seek out more information from navigation space itself.

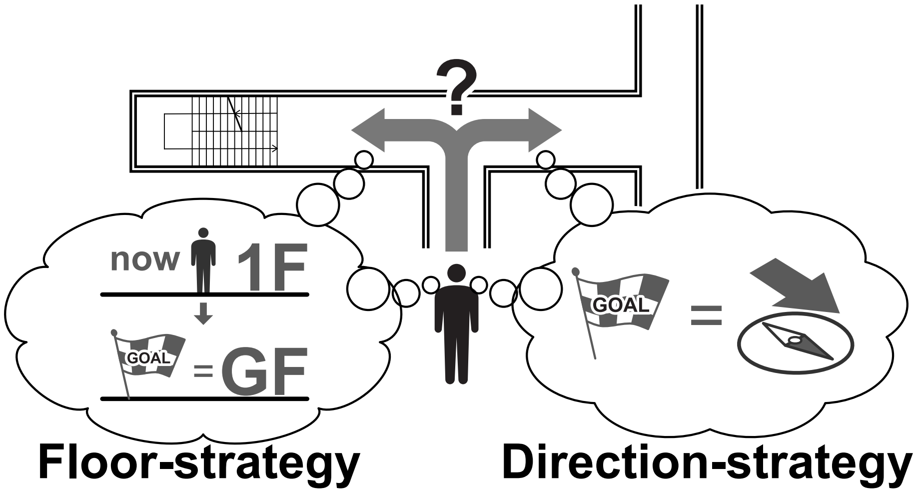
Publications and presentations
*Graduation Paper (in Japanese)*
*Takanori, N., & Eisuke, T. (Under Review; 2023) (in Japanese)*

# The non-fixed balance of influence between the two navigation strategies

## The direction strategy vs. the floor strategy: What leads to the alternative decision?

*The conference paper about this topic is available at the end of this document. Please refer it for more detailed information.

## Background




In the field of navigation and wayfinding, several strategies are known, such as central-point strategy, direction strategy, and floor strategy.

It has been revealed that each strategy has specific requirements for activation. For example, people must know the direction of their goal to use the direction strategy, while the floor strategy requires that an instrument allowing movement between levels, such as a staircase or elevator, be visible. The former relies on an internal cue, while the latter depends on an external cue.

This difference in the nature of these requirements might  alter the psychological activation pathway. Therefore, it can be hypothesized that the hierarchy between these two navigation strategies is not fixed. However, it is often implicitly assumed to be static or at least probabilistic. Through a systematically controlled experiment, we explicitly unveiled that the power balance between the direction strategy and floor strategy is not uniform. We also analysed the individual differences among the subjects.

## Experiment

A total of 120 subjects participated in the experiment.

Figure 2 shows the flow of the experiment. Subjects explored six buildings shown in Figure 1 in random order. They first entered a building from the entrance on the ground level, and navigated themselves to room "R" on the 1st level by following arrows installed on the floor. After entering the room, subjects were asked to select one panel corresponding to the direction of the entrance from eight options, indicating directions such as "front", "back", "left", "right", and intermediate directions (e.g., "left-front", "right-back"). They also received feedback on the correct answer. Following this orientation task, they were instructed to exit the room and navigate back to the entrance without any navigation aids. During this navigation task, subjects had to choose one corridor out of two at the intersection just after leaving room "R", depicted as the "Decision point" in Figure 1.

In buildings A, B, and C, the floor strategy was not available because subjects could not see a staircase from the decision point. In buildings D, E, and F, subjects could use the floor strategy.

## Results and discussion

We analysed which strategies were used by how many subjects in each building. We also evaluated how much subjects looked around in the intersection area when making their decision.

Horizontal bar graphs in Figure 1 illustrate the proportions of subjects' strategy preferences. For example, in building B, 88.9% of subjects used the direction strategy, while 11.1% used the opposite strategy. For buildings D, E, and F, "Conditions" represents the distance conditions shown in Figure 2.

To categorize every selection made by subjects, we formally named two additional strategies: "Opposite strategy" for selections contrary to the direction strategy, and "Nothing strategy" for selections that did not align with any of the direction, floor, or opposite strategies.

From the results of buildings A, B, C, and D, we confirmed that our virtual buildings are suitable for evaluating subjects' strategy selection. There was no left-right bias in building A, and subjects preferred the direction strategy in buildings B and C, where the direction strategy was the only plausible option. In building D, the majority of subjects applied the floor strategy, and the proportion correlated with the distance between the intersection and the staircase.

Our main focus was on the proportion of selections in building F, where the direction strategy and floor strategy led subjects to opposing directions. If the balance of influence between the two strategies were static, we could expect the following results: (1) overall, the direction strategy would be preferred over the floor strategy, with the prevalence of the direction strategy declining as the distance to the staircase decreased; (2) overall, the floor strategy would be preferred over the direction strategy, with the prevalence of the floor strategy declining as the distance to the staircase increased; or (3) the proportions of strategy selection would be balanced in the middle-distance condition, with the floor strategy and direction strategy being more prevalent in the short-distance and long-distance conditions, respectively. However, the actual results did not aligned with any of these expectations. Instead, the two strategies seemed to be balanced in the short- and long-distance

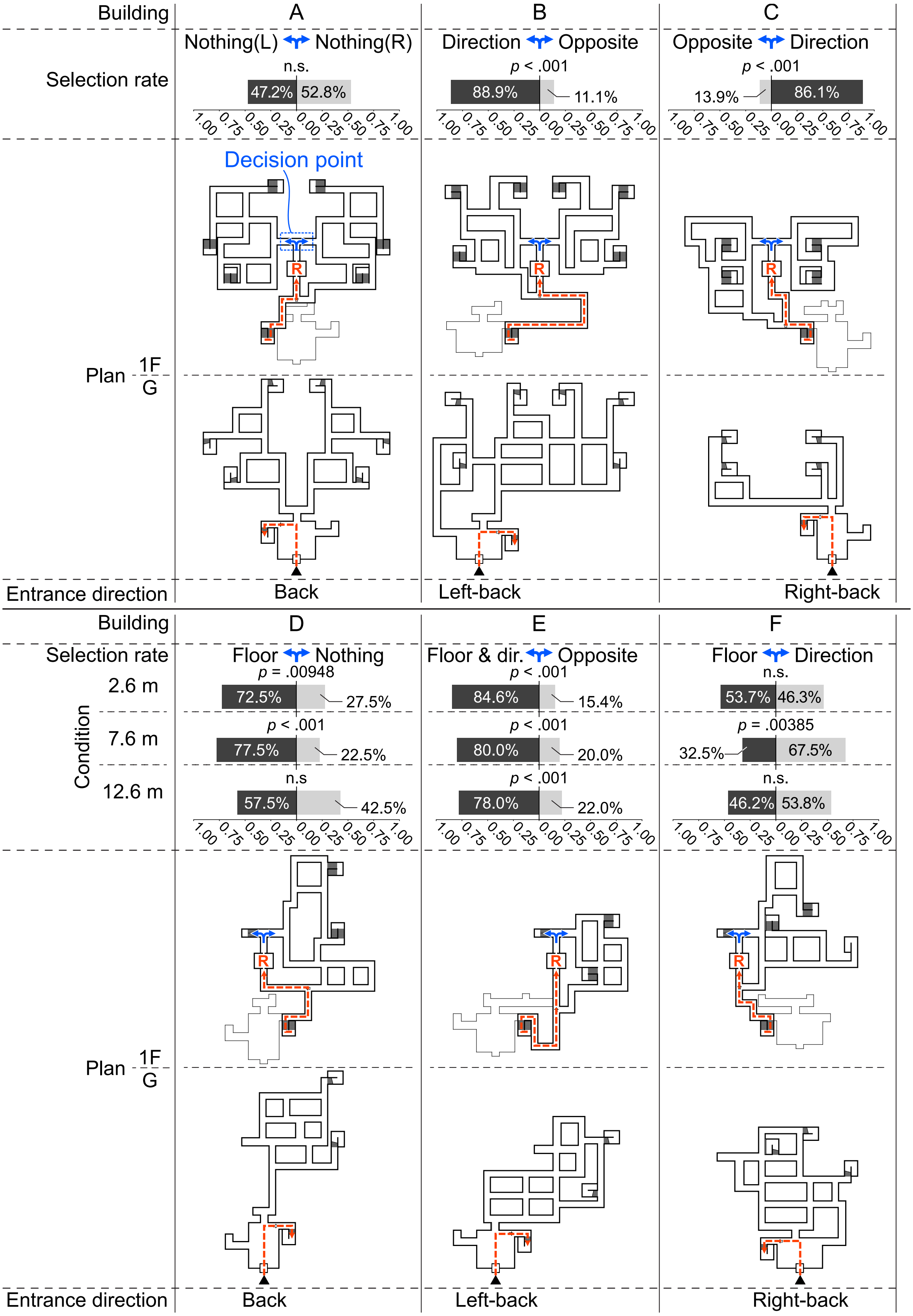
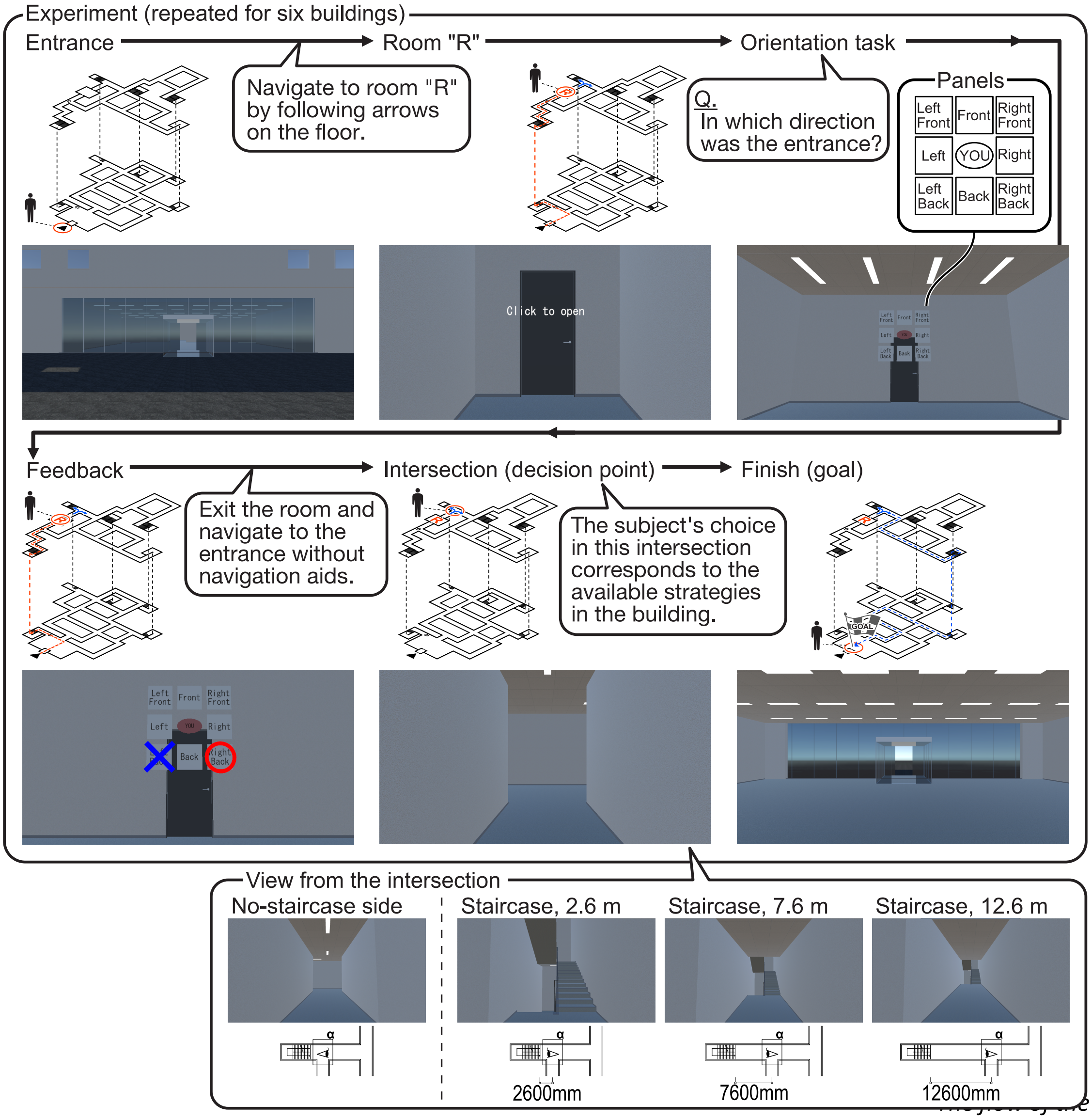



***Figure 1.*** *Overview of the experiment. Bar graphs display the proportions of strategy selection among subjects for each building. The orange dotted lines on the floor plans represent the routes that subjects navigated by following arrows installed on the floor.*




*e experiment.*

conditions, while the direction strategy was prevalent in the middle-distance condition. So, what determined the subjects' strategy selection?

We evaluated how much subjects looked around in the intersection area, i.e., the decision point. Figure 3 shows the grouped plot of look-around behavior. The *U*-test indicated that subjects who used the floor strategy in building F looked around more than those who used the direction strategy. Catching sight of the staircase might be a principal trigger for activating of the floor strategy.

## Conclusion

We pointed out that the balance of influence between the direction strategy and floor strategy might not be static or uniform. The analysis of look-around behavior provided two plausible interpretations: (1) the floor strategy is stronger than the direction strategy, as catching sight of the staircase might override the activation of the direction strategy, and (2) the direction strategy is stronger, as one's awareness of the fact that the one knows the direction of the destination might lower the one's motivation to seek out other information by looking around. However, we were unable to further investigate why the subjects especially who chose the floor strategy looked around, even though they actually knew the direction of their goal.

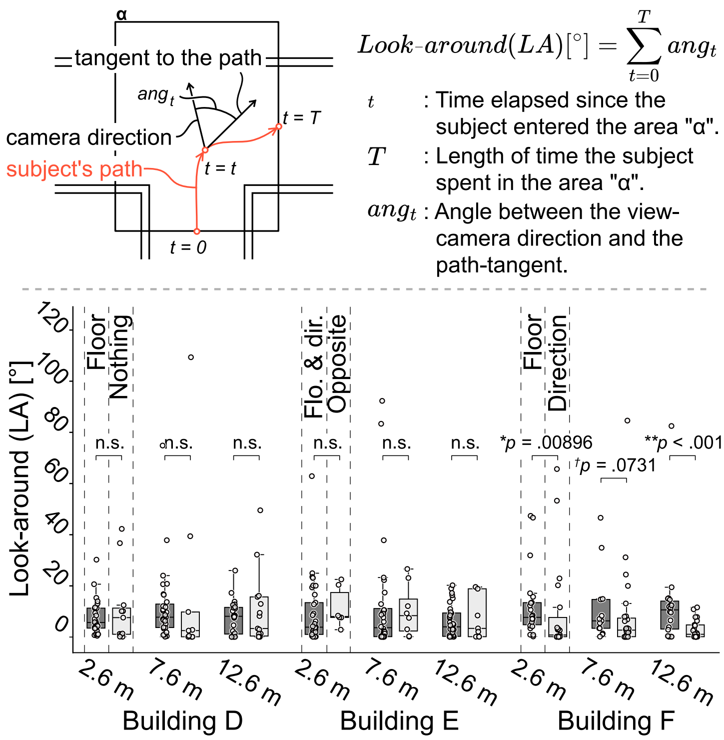
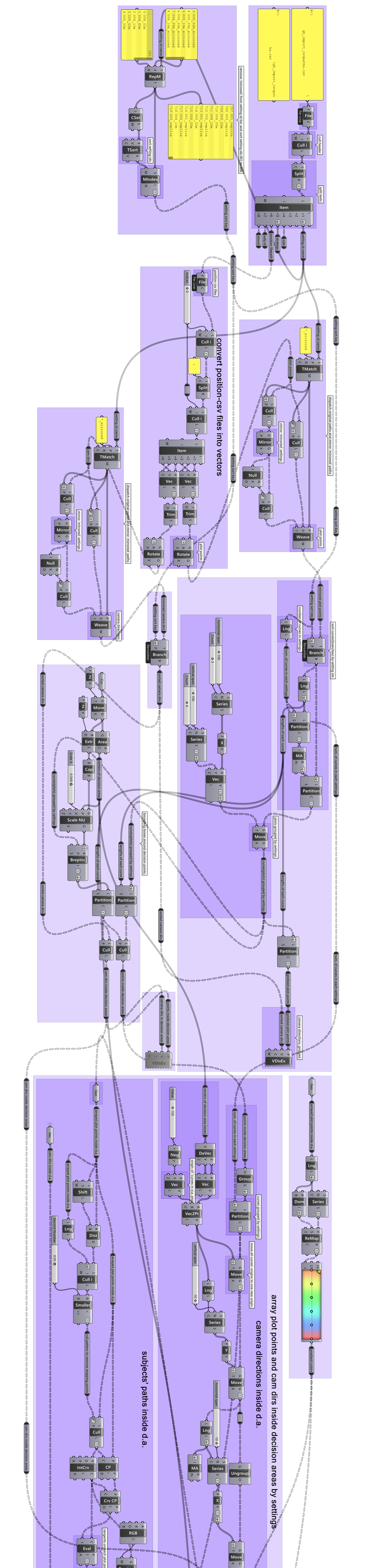


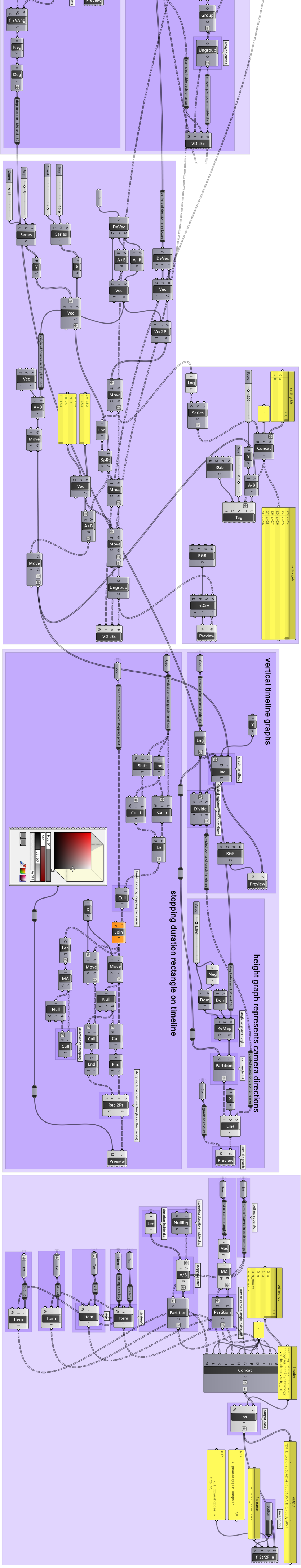

***Figure 3.*** *Definition and plots of look-around behavior.*




## Appendix

# Data visualization and look-around behavior analysis using Grasshopper

The experiment software I made with Unity recorded subjects' position and camera direction at each point in time. The visualization of these data was carried out using Grasshopper. Also, the look-around value explained in Figure 3 was calculated by the GH script. Some examples of path plots are given below.


vertical timeline graphs
stopping duration rectangle on timeline
height graph represents camera directions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# Perceptual Fluency and Route Selection

## What makes us choose longer/shorter routes?

## Background

The spatial configuration of environments is known to influence our choices during wayfinding and navigation. Several studies have highlighted the types of configurational elements that affect our navigational behavior and the mechanisms behind these effects. Regarding corridor length, some studies suggest that when two alternative routes are available, people tend to choose longer one, while others have found that a significant proportion of people prefer the shorter corridor in the same situation. What causes this discrepancy?

Perceptual fluency, the subjective experience of how easily the physical attributes of a stimulus can be discriminated, influences the decision-making process in many ways. For instance, Reber and Schwarz (1999) demonstrated that perceived truth of a proposition written in text can be altered by perceptual fluency of the text itself, which is affected by the contrast between the text and its background. Given this functional characteristic of perceptual fluency, it might also impact our route choice decisions during wayfinding and navigation. The discrepancy mentioned above could potentially be attributed to the differences in the perceptual fluency of the stimuli used in these studies.

## Experiment

We modeled a decision point in a virtual environment where two corridors of different lengths can be seen (Figure 4). Subjects wore a head-mounted display and were instructed that their task was to find a reward somewhere in the virtual environment, which branched out one after another. At each decision point, they were to select one of the two corridors. After each selection, a subsequent branching scene was presented, with the corridor lengths randomly changed. Subjects were informed that if they found the reward within a certain number of selections, they would be paid 200 yen. However, the reward was actually presented after a randomly determined number of selections—either 8, 10, or 12 (Figure 5). Subjects completed six blocks of this “treasure digging” task, with stimuli presented in high fluency in three blocks (Figure 4, left), and low fluency in the other three blocks (Figure 4, right). The order of the fluency conditions was counterbalanced between subjects. In total, each subject made 60 selections during the experiment.

## Result

24 subjects were participated ($M_{age}$ = 23.96, *SD* = 1.92).

Nine subjects reported using one or more conscious strategies when choosing corridors (referred to as the strategic group), while the remaining 15 did not (non-strategic group).

For each group, the independence between the selection of the longer corridor and the fluency condition was examined using the *McNemar* test. The results showed no significant dependency for the non-strategic group ( $\chi^2(1, N = 884) = .15, p = .70$ ). On the other hand, a significant dependency was found in the strategic group ($\chi^2(1, N = 527) = 21.92, p < .001$ ).

For the strategic group, where the preference for the longer routes was related to the fluency condition, we conducted a logistic regression analysis taking absolute length

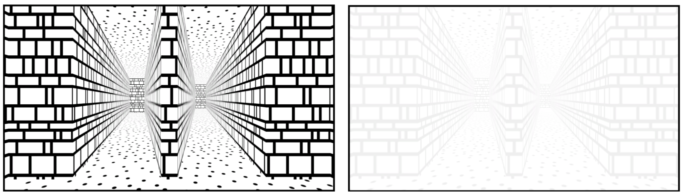


***Figure 4.*** *Presented images of decision points.*

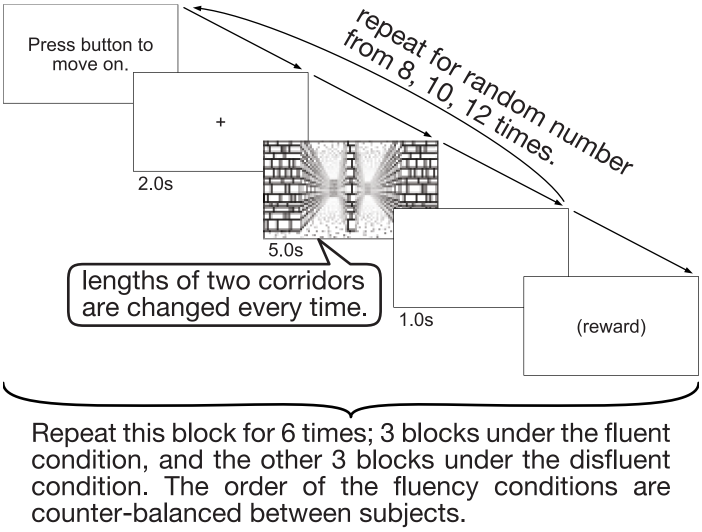



***Figure 5.*** *Flow of the experiment.*

***Table1.*** *Logistic regression analysis of route selection on strategic group.*

| | *Coef.* | *SE* | *OR* | *p* | *CI* (95%) |
|---|---|---|---|---|---|
| (Intercept) | -.483 | .188 | .617 | .009 | .247 - .891 |
| Absolute difference in depth | -.073 | .183 | .929 | .005 | .883 - .978 |
| Fluency | .609 | .183 | 1.840 | < .001 | 1.280 - 2.630 |

difference between the two corridors in each stimulus and fluency (coded as 0 for disfluent and 1 for fluent) as explanatory variables, and the selections (0/1 for shorter/longer corridor) as a the response variable (Table1). The results indicated that subjects preferred shorter routes when the stimulus was disfluent and the absolute length difference between the two corridors was larger.

## Discussion and conclusion

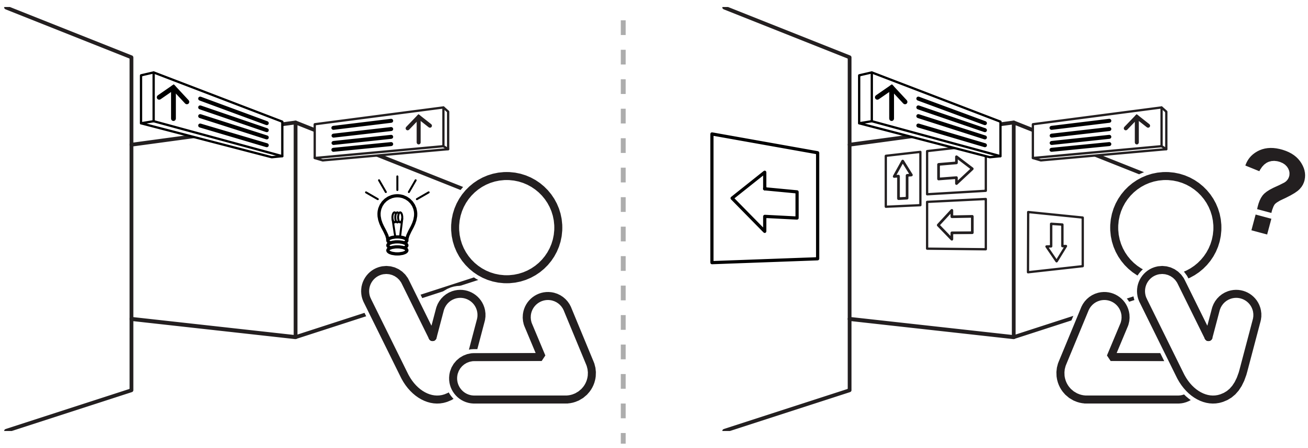
The results of the logistic regression analysis for the strategic group suggest that perceptual fluency influences people’s route selection. When the environment is disfluent, people may prefer shorter routes.

On the other hand, no significant selection trend regarding corridor length was observed in the non-strategic group. We assume that route selection might be influenced only when individuals have a conscious motivation or purpose. Although many studies have examined how the configurational characteristics of space influence decision-making during wayfinding and navigation, little is known about how motivation affects navigational benaviour. Further research on this topic is anticipated in the future.

# Amount of Information and Iterative Route Learning

## The more signages, the more legible the station?

*This project was for my graduation paper.



### Background: increase in number of signages in complicated stations

Two types of signage are installed in underground stations in Japan. One type is installed during the construction stage, and the other is added later by station employees in response to user feedback (Figure 6).

Particularly in major urban transfer stations, employees often install additional signages to make the station more understandable for users. While providing abundant navigation information may seem user-friendly, extracting the desired information from an excess of signage can be challenging. This is because individuals can only process a limited amount of information at one time. In some cases, these additional signages may even offer redundant or confusing information. Consequently, rather than helping, the additional signages might unintentionally increase the cognitive load on users, whether they are conscious of it or not.

In this project, an experiment using head-mounted display revealed that redundant navigation information can decrease navigation performance. Also, counterintuitively, partially missing information might actually be beneficial for understanding spatial configuration.

***Figure 6.***
*A view of an underground station where signages have been over-installed by station employees. Redundant information can be found almost everyehre in these complex stations in Japan.*

## Experiment

### Environment and task conditions

We designed a virtual underground station as shown in Figure 8a, with a platform on the B3 level, passageways on the B2 and B1 levels, and exits on the B1 level.

Subjects were asked to navigate from the start point to Exit 10B using signages. In the decision area (Figure 8b), subjects had to carefully choose their route because selecting the wrong side (i.e., stairs on the right hand) will prevent them from reaching Exit 10B without returning to the decision area. We established following three conditions with different amounts of signage.

● *Insufficient Condition (Figure 8b, top left):*

One signage indicating the direction to Exits 1A-9B is installed on the right side. Since the subjects' destination was Exit 10B, they had to infer that their destination was in the opposite direction of what the signage showed. This setup was designed to direct the subjects' attention not only to the information on the signage but also to the spatial configuration of the environment.

● *Construction Condition (Figure 8b, middle left):*

Two signages are installed. The left one indicates Exits 10A and 10B, and the right one is the same as in the insufficient condition. This arrangement mirrors the typical signage installation method used during standard construction phases.

● *Excessive Condition (Figure 8b, bottom left):*

In addition to the signages in the construction condition, additional signages are installed, indicating exit directions and transfers. These additional signages are designed identically to those used in actual stations.

## Procedure

The experiment included two different tasks:

*Main task:*

Subjects were asked to navigate themselves from the start point to Exit 10B. They were randomly assigned to one of the three conditions mentioned above. The task was repeated three times under the same condition, meaning that a subject assigned to the insufficient condition navigated three times under that condition.

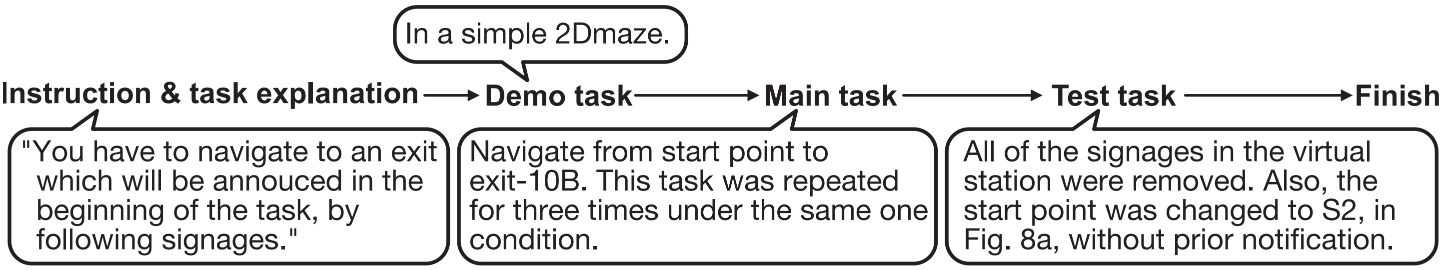



***Figure 7.*** *Overall flow of the experiment.*

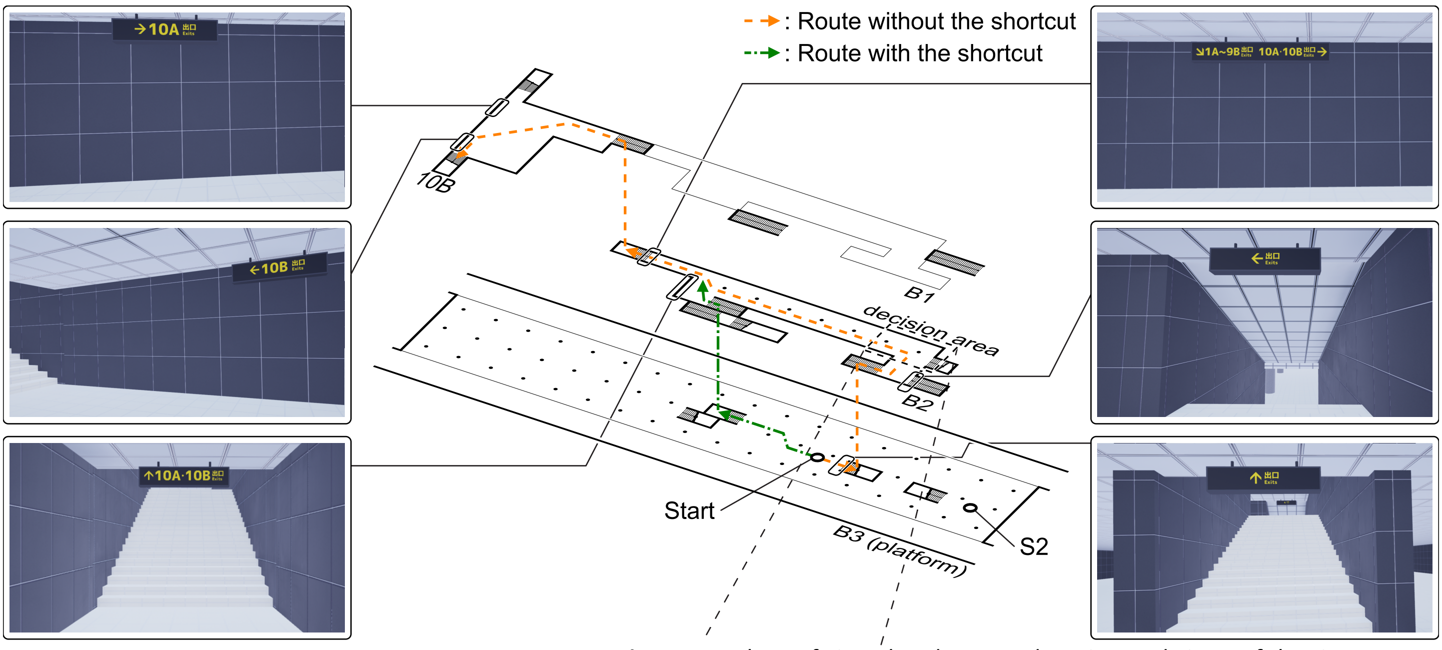
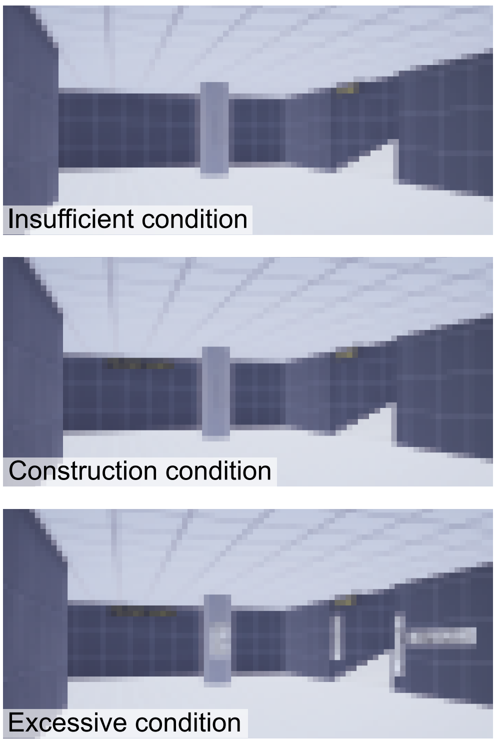



***Figure 8a.*** *Plans of virtual underground station and views of the signages.*



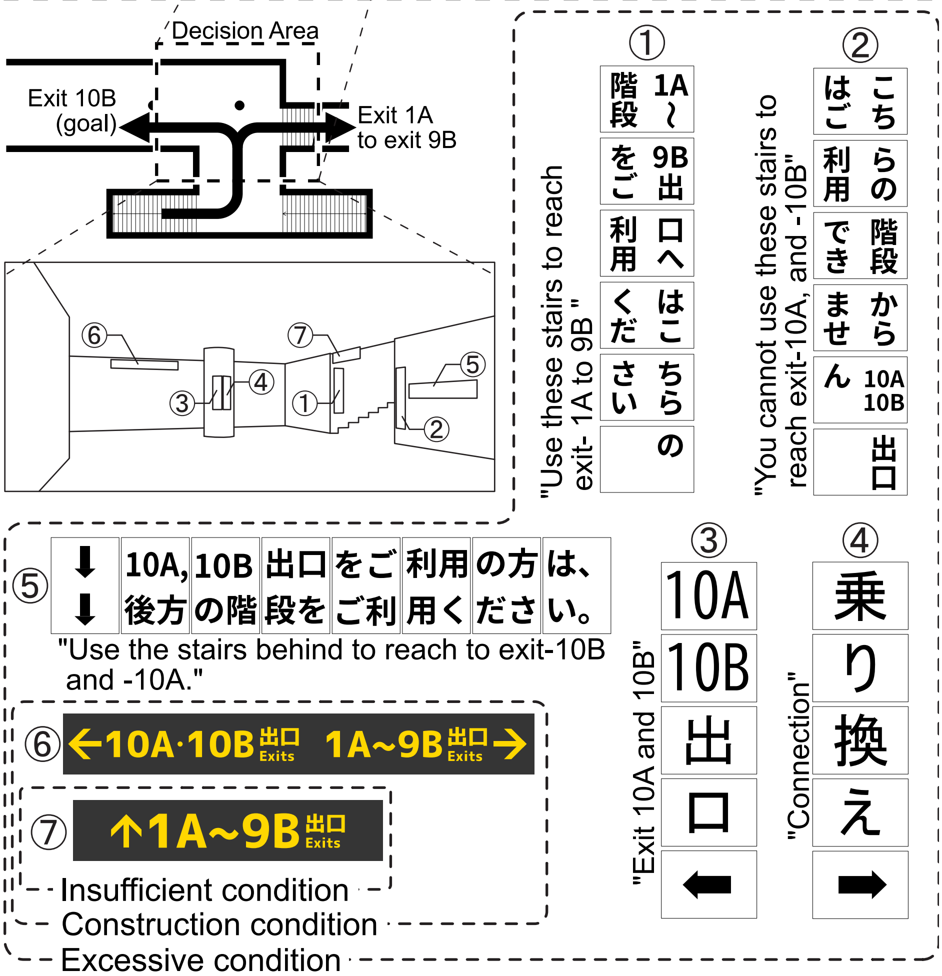




***Figure 8b.*** *Detailed information around the decision area. The screenshots depict views of the decision areas for each condition. Signages ① - ⑦ are located within the decision area. Depending on the condition, different signages are installed within this area. All signages outside the decision area, shown in 8a are identical across the conditions.*

large in the $1^{st}$ trial but converged during the $2^{nd}$ and $3^{rd}$ trials. As for the excessive condition, although the variation did not fully converge across trials, overall instability declined from the $1^{st}$ trial to the $2^{nd}$ trial and remained stable in the $3^{rd}$ trial. In contrast, in the insufficient condition, instability seems remained relatively constant, and the variation in the instability also did not converge.

## Discussion and conclusion

Counterintuitively, installing additional signages may not always help station users. Subjects in the excessive condition took longer time to navigate in the $1^{st}$ trial compared to those in the construction condition. Additionally, the instability of the movement did not converge from $2^{nd}$ to $3^{rd}$ trial in the excessive condition, whereas it did converge to a small value throughout the trials in the construction condition. These results imply that over-installing signages might reduce the usability of the station, contrary to its intended purpose.

Regarding the insufficient condition, it also offers an interesting perspective. Given that there was no significant difference in navigation time between the $1^{st}$ trial of the insufficient condition and that of the construction condition, it can be assumed that people can quickly gather the information from the available signages and the space itself, and infer the correct path to the goal. Furthermore, although the numbers were small, only subjects in the insufficient condition found the shortcut after leaving the decision area in the $1^{st}$ trial. It is possible that the lack of information motivated subjects to explore the spatial environment more thoroughly, which may

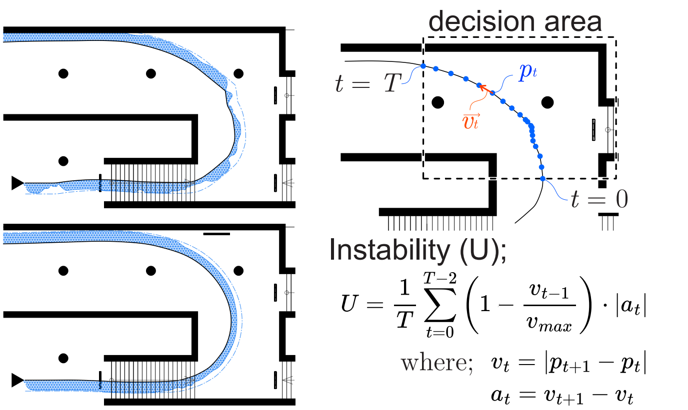



***Figure 10.*** *Left; examples of path and walking speed at each point in time. Right; definition of the instability of movement.*

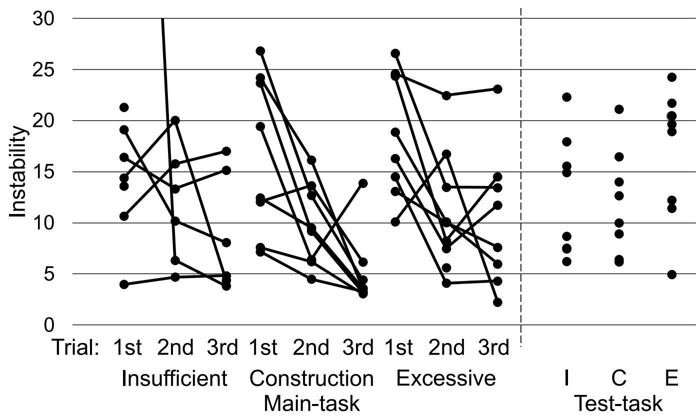



***Figure 11.*** *Instability of movement.*

*__Test task:__*

After learning the route in the main task, subjects were asked to navigate to the Exit 10B once more. In the test task, unlike the main task, all signage was removed, and the start point was changed to the red S2 in plans in Figure 8a without informing the subjects. The existence of the test task was also not disclosed to prevent them from consciously learning the spatial configuration.

First, subjects practiced how to move within the virtual environment. After they became sufficiently accustomed to the control system, they proceeded with the main task and the test task.

## Results

**Shortcut**

Two out of eight subjects in the insufficient condition found the shortcut (the green line in Figure 8a) during the $1^{st}$ trial and used it in the following trials. One subject out of nine in the excessive condition also used the shortcut in the $1^{st}$ trial but did not use it in the $2^{nd}$ or $3^{rd}$ trial. None of the eight subjects in the construction condition found the shortcut.

**Navigation time**

Two-way ANOVAs were conducted to compare the navigation time to reach Exit 10B between the different conditions and across the trials for the main task. The results showed a significant main effect of the condition, as well as a significant interaction between the condition and the number of trials (Figure 9). A Tukey-Kramer test revealed significant differences between the following pairs: the $1^{st}$ trial of the insufficient condition and the $3^{rd}$ trial of the construction condition, the $2^{nd}$ trial of the insufficient condition and the $2^{nd}$ trial of the excessive condition, the $1^{st}$ trial of construction condition and the $1^{st}$ trial of the excessive condition, the $1^{st}$ trial of the excessive condition and the $2^{nd}$ trial of the excessive condition, and the $1^{st}$ trial of the excessive condition and the $3^{rd}$ trial of the excessive condition.

**Instability of movement**

Figure 10 illustrates the definition of movement instability and Figure 11 shows the data for all subjects, with each subject's plot points connected across trials.

Subjects under different conditions exhibited distinct trends. In the construction condition, the variation in instability was

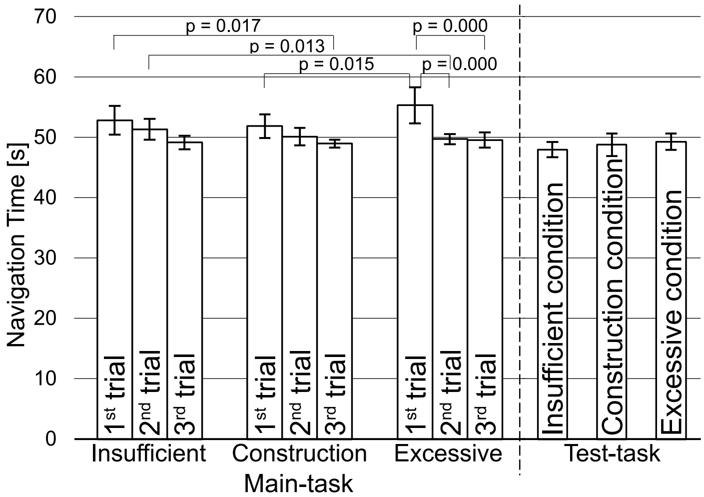



***Figure 9.*** *Task completion times.*