# Exploring a Screensaver-Based System for Visualizing Health Status to Reduce Presenteeism: A Preliminary Evaluation

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**Abstract**

Presenteeism, a state in which individuals cannot perform optimally due to poor health, has been identified as a major issue, causing greater economic losses than absenteeism. This study proposes a privacy-conscious health visualization system using a screensaver to prevent overwork and facilitate timely support. The study consists of a two-phase experiment. In the first phase, 16 privacy-preserving visualization designs, including flower blooming states and avatar expressions, were evaluated. The results showed that the avatar expression design received the highest evaluation in terms of privacy protection. In the second phase, the system was tested by displaying the highly rated avatar expression design on a screensaver to evaluate its effectiveness. The system was tested over a five-day period, with one visualized subject and feedback collected from 37 participants. On four out of five days, over 70% of participants who viewed the screensaver correctly recognized the subject's health status, demonstrating the system's potential usefulness. Additionally, an analysis of the correlation between recognition accuracy and the Big Five personality traits revealed a weak negative correlation with "openness"; however, statistical significance was not achieved due to the limited sample size. This study highlights the potential of privacy-conscious health visualization systems in workplace health management. Future studies should incorporate diverse visualized subjects and extend the experimental duration to further validate effectiveness and expand applicability. The findings contribute to the development of personalized, privacy-preserving health management tools.

**Keywords**

Presenteeism, Health Care, Well-being, Screensaver, Design, Visualization, Big5, Privacy, Community,



## 1. Introduction

In recent years, health management has gained significant attention as a crucial theme, with increasing focus on presenteeism—a state where individuals remain at work but experience reduced productivity due to health issues. The World Health Organization (WHO) defines presenteeism as a condition in which individuals, despite being physically present at work, are unable to perform optimally due to health problems. In contrast, absenteeism refers to work absences due to illness. Various factors contribute to presenteeism, including workplace cultures that discourage taking leave, concerns about career impact, and a sense of responsibility preventing employees from taking necessary rest [1, 2, 3]. Presenteeism has been linked to decreased work efficiency, deterioration of employee health, and the spread of contagious diseases. Studies have shown that its economic losses exceed those caused by absenteeism [4, 5]. Furthermore, prolonged presenteeism increases the likelihood of long-term sick leave and exacerbates fatigue among employees [6]. When highly contagious illnesses such as influenza are prevalent, presenteeism significantly contributes to infection spread, further disrupting workplace productivity. A 2017 survey in the United States reported that over 40% of respondents attended work while exhibiting flu-like symptoms [7], highlighting the urgent need for interventions to mitigate presenteeism.

Several information visualization approaches have been proposed to address presenteeism in the

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workplace [8, 9, 10, 11]. These methods aim to enhance self-awareness by displaying stress levels and physical activity through graphical interfaces on workplace monitors or personal mobile devices. However, to our knowledge, no prior studies have explored visualizing health conditions within a workplace community to address the cultural barriers that prevent employees from taking leave or openly discussing health concerns.

To address this gap, we explore methods for visualizing individual health status in a shared work environment while maintaining privacy. Our preliminary study investigated the relationship between the location of health visualizations and recognition rates, revealing that computer screen savers are more effective at increasing awareness among colleagues compared to messaging tool icons or wearable devices. However, this approach also raises concerns about unintended exposure of health information to external individuals, necessitating a mechanism that balances visibility within a workplace community with privacy considerations. In this study, we propose a privacy-conscious visualization system that allows only those familiar with its interpretive rules to understand the displayed health information, while obscuring it from external observers. We designed multiple screen saver visualizations with varying levels of interpretability and conducted an experimental evaluation. Participants were divided into groups with and without knowledge of the interpretive rules, and their response times and accuracy were measured. This paper discusses the feasibility of the proposed system using designs that received high preliminary evaluations and explores the relationship between system usefulness and participants' personality traits.

In this paper, Chapter 2 discusses prior research aimed at improving presenteeism and explains the positioning of this study in comparison to previous work. Chapter 3 describes a preliminary experiment that evaluated designs highly regarded for their privacy protection. Chapter 4 introduces the configuration of the visualization system using screen savers proposed in this study, and Chapter 5 provides an explanation of the actual experiment conducted. Chapter 6 presents the results and discusses them in relation to each research question posed. Future perspectives are outlined in Chapter 7, and Chapter 8 concludes the paper.

## 2. Related Work

### 2.1. Institutional Approaches to Addressing Presenteeism

As approaches to improve presenteeism, several systems have been implemented by corporations. Flextime systems and the option for remote work allow employees to adjust their working hours according to their health and personal circumstances, thereby reducing presenteeism [12]. Support for employees' mental health and wellness programs aims to prevent presenteeism by implementing initiatives that promote employee health. These include regular health screenings, counseling support, exercise programs, and the provision of healthy meal options [13]. Article 68 of the Labor Standards Act states that female employees may take menstrual leave if they experience severe menstrual symptoms. Some companies and organizations offer special menstrual leave for female employees suffering from menstrual pain or Premenstrual Syndrome (PMS). The purpose is to avoid the need for employees to attend work while physically unwell, thereby preserving their health and productivity.

However, the implementation and effectiveness of these systems vary by the size of the company, the industry, and the culture, and there are many cases where employees find it difficult to speak up about their deteriorating physical and mental health or menstrual-related symptoms due to a sense of responsibility, guilt, or privacy concerns, thus preventing the systems from having their intended effect[1]. To ensure the effectiveness of internal systems aimed at improving presenteeism, it is necessary to foster a workplace culture that considers privacy and makes it easier for employees to discuss their health issues.

[1]https://www.jri.co.jp/MediaLibrary/file/column/opinion/detail/20210630_tagawa.pdf

### 2.2. Improving Presenteeism through Collective Visualization of Activity-Related Data

Ubifit [10] is a system that enhances users' awareness of physical activity by displaying activity-related data as an animated flower garden on the wallpaper of their mobile phones, thereby supporting a healthier lifestyle. Additionally, Affective Health [11] visualizes users' activity data and biometric information in real-time through a spiral image, aiming to facilitate the users' recognition and management of their stress. Nkem et al. have developed a visualization method that measures stress levels using a galvanic skin response sensor attached to employees' fingertips to detect cortisol levels, and represents the measured stress values as bouncing balls [8]. By displaying this bouncing ball animation on a shared monitor, the system anonymously presents the stress levels of all participants, enabling them to objectively assess their own stress within the group. Wang et al. [14] proposed a method to embed health information, such as heart rate, step count, and calories burned, into data-driven stickers called SnapPI on Snapchat, a platform with high usage rates in the United States. Their study reported that users experienced enjoyment by reflecting their personal information in the design, which promoted behaviors of sharing health information more openly.

### 2.3. Positioning of This Study

Much of the prior research aimed at improving presenteeism has focused on enhancing individual awareness of one's own activity levels and health by displaying users' stress values and activity data in pictures or animations on workplace monitors or personal mobile screens. However, there are no known studies, to our knowledge, that have disclosed mutual health information among users to address workplace cultures that contribute to presenteeism, such as the difficulty in taking leave or reluctance to discuss poor health. This study proposes a novel approach that aims to improve presenteeism by visualizing individual health conditions within a community while considering privacy.

## 3. Preliminary Experiment

For improving presenteeism, it is essential not only that users are aware of their own health conditions, but also that a culture of mutual care and awareness is fostered within the same community. Therefore, we focused on screensavers, which are highly recognizable as a location for visualization. However, visualizing on screensavers poses a challenge because it can disclose sensitive health information to outsiders who should not be privy to it.

In our preliminary experiment, we examined 16 different representations using flowers, weather conditions, and avatars to visualize users' health on screensavers while considering privacy. The health conditions represented were: "good health," "moderately good health," "moderately poor health," and "poor health."

Participants were divided into two groups: those who were informed of the interpretation rules and those who were not. Through a survey, participants were asked to identify the health condition represented by each design. The designs were evaluated based on response time and accuracy rates.

### 3.1. Verification Items

In this study, we have set the following two verification items to validate the effectiveness of the proposed system:

- Is there a significant difference in the accuracy of identifying health condition information represented by the designs between the group of participants who knew the interpretation rules and those who did not?
- Among both groups of participants, which designs resulted in shorter response times and a larger difference in accuracy rates between the group that knew the interpretation rules and the group that did not?

### 3.2. Experiment Overview

In this preliminary experiment, a questionnaire survey was conducted to evaluate how well 16 design types, inspired by motifs such as flowers, weather, avatars, and computer screens, conveyed health condition information. The survey also measured response times for each question. The questionnaire was conducted between October 11, 2023, and October 19, 2023, with 37 participants, comprising students and staff. The participants were divided into two groups: 18 participants in Group A, who were provided with interpretation rules before responding, and 19 participants in Group B, who were not given any interpretation rules. Group A consisted of 17 males and 1 female, aged 21 to 49 years, with an average age of 24.89 years (SD=6.46). Group B consisted of 17 males and 2 females, aged 21 to 55 years, with an average age of 26.42 years (SD=9.15). Designs that achieved short response times across both groups and significant differences in accuracy between groups were evaluated as more privacy-preserving.

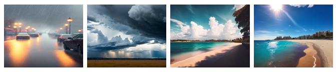
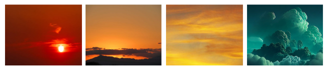
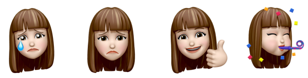
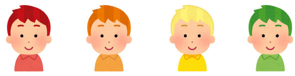
### 3.3. Health Visualization Design

A total of 16 designs were created to visualize users' health conditions while maintaining privacy. These designs were based on four motifs: flowers, weather, avatars, and computer screens, each incorporating four visualization rules. Table 1 summarizes the designs and their corresponding visualization rules. The first visualization rule associates the motif's imagery with health conditions. For example, in the flower motif, a fully bloomed flower with a vase filled with water represents "good health," while a wilted flower with little water represents "poor health." This rule has the lowest interpretation complexity. The second rule arranges four designs horizontally, representing "good health," "moderately good health," "moderately poor health," and "poor health," with the far-right design being the correct one. Compared to the first rule, it increases interpretation complexity as the user must determine which design corresponds to their health condition. The third and fourth rules utilize four colors—red, orange, yellow, and green—to represent health conditions. The third rule uses universally recognized color associations (e.g., green for "good health" and red for "poor health"). For the flower motif, the sequence green, yellow, orange, and red corresponds to "good health," "moderately good health," "moderately poor health," and "poor health." This rule's interpretation complexity is low due to the shared understanding of color meanings. Conversely, the fourth rule assigns colors randomly to health conditions (e.g., yellow = "good health," red = "moderately good health," green = "moderately poor health," orange = "poor health"). As a result, understanding the health condition requires prior knowledge of the color mappings, making this rule highly complex. The same four rules were applied to other motifs. In weather designs, the first two rules use imagery such as clear skies, partly cloudy, overcast, and rainy weather, while the latter two use sky colors. For avatar designs, the first two rules depict avatars with expressions such as joy, a thumbs-up gesture, sadness, or crying. The latter two use avatars with hair and clothing in corresponding colors. Finally, for computer screen designs, the first two rules show screens with varying levels of cracks to represent health conditions, while the latter two use desktop screen colors. Designs were labeled as A for flowers, B for weather, C for avatars, and D for computer screens. The interpretation rules were numbered as follows: Rule 1 used imagery, Rule 2 displayed four images horizontally with the far-right being correct, Rule 3 utilized universally recognized color meanings, and Rule 4 assigned colors randomly. Each design is identified by a combination of a letter and a number (e.g., A-1, B-3).

### 3.4. Results and Discussion

All 37 responses were deemed valid. The evaluation and discussion were conducted based on quantitative data derived from the accuracy rates of the questionnaire results and qualitative data gathered from participants' comments at the end of the questionnaire.

**Table 1**
Designs that represent physical condition

| | Design | Description |
|---|---|---|
| A-1,2) |  | Represents health conditions using flower imagery. |
| A-3,4) |  | Represents health conditions using flower colors. |
| B-1,2) |  | Represents health conditions using weather imagery. |
| B-3,4) |  | Represents health conditions using sky colors. |
| C-1,2) |  | Represents health conditions using avatar expressions. |
| C-3,4) |  | Represents health conditions using colors of avatars. |
| D-1,2) |  | Represents health conditions via screen cracks. |
| D-3,4) |  | Represents health conditions using screen colors. |

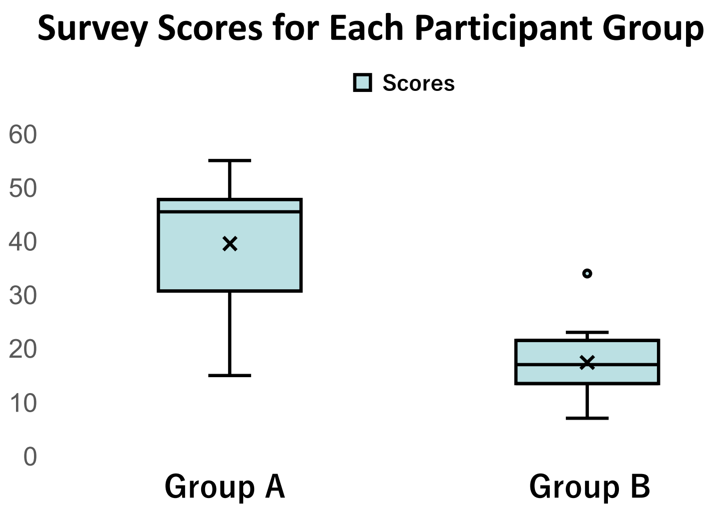



**Figure 1:** Score differences between Groups A and B based on the questionnaire results.

#### 3.4.1. Is there a significant difference in the accuracy rates of health information interpretation between participants who know the interpretation rules and those who do not?

The questionnaire results regarding the designs for participant Group A, who knew the interpretation rules, and Group B, who did not, are shown in Figure 1. A Mann-Whitney U test, suitable for non-normally distributed data with paired samples, was used to quantitatively compare the score differences based on the presence or absence of prior knowledge about the health information represented by the designs. The p-value was approximately $5.50 \times 10^{-5}$, which is extremely small, confirming a statistically significant difference in scores between Group A and Group B.

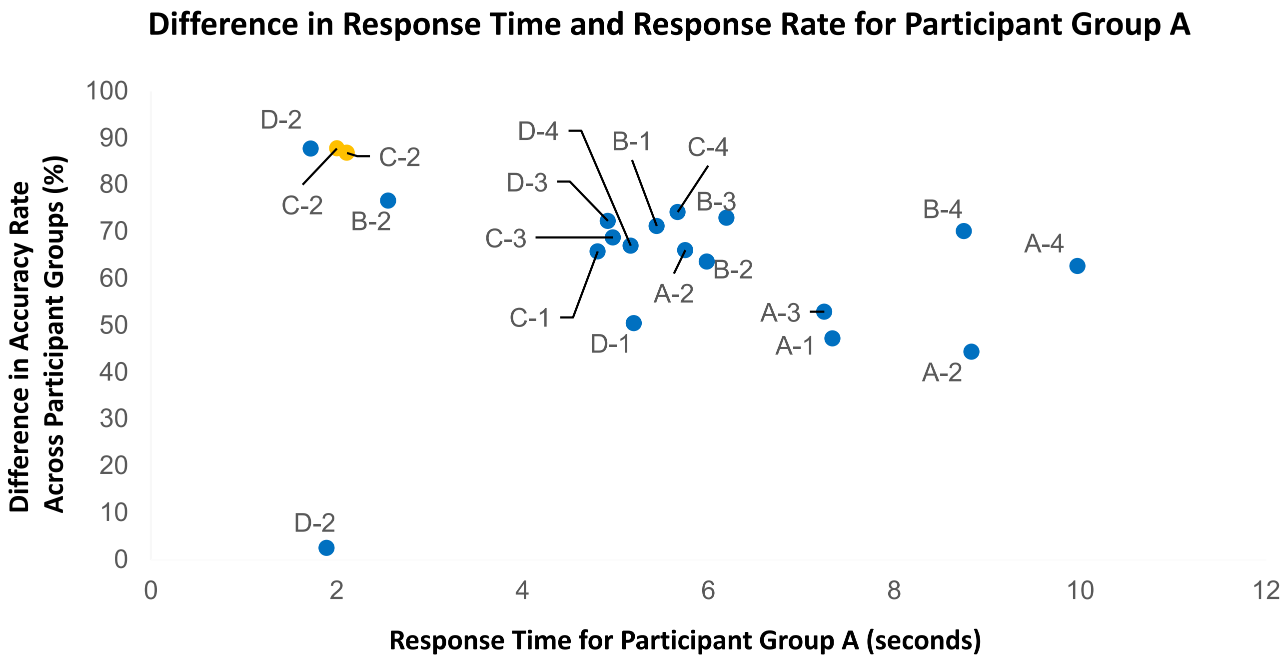



**Figure 2:** Response times for Group A and the accuracy differences between the two groups based on questionnaire results.

### 3.4.2. Which Designs Achieved Short Response Times and Significant Accuracy Differences Between Groups?

The response time per question was longer for Group A compared to Group B. This can be attributed to Group A participants needing to consider the interpretation rules to determine what health condition each design represented. To evaluate designs that achieved short response times for both groups and significant accuracy differences between them, Figure 2 shows the response times for Group A and the accuracy differences between the two groups. For the visualization rule that arranges four designs horizontally (A-2, B-2, C-2, D-2), variability in accuracy was observed depending on the health condition being represented. To address this, evaluations were conducted using two different questions under the same rule. This variability can be explained by the ease of identifying "good health" or "poor health" at the far-right position of the four designs, whereas middle conditions like "moderately good health" or "moderately poor health" required relative judgments. For example, in the weather motif, it is immediately clear that a sunny image represents "good health," but distinguishing between "cloudy" and "partly cloudy" for intermediate conditions can be challenging. Participants also noted that the four-panel visualization method was less intuitive for intermediate conditions in motifs other than avatars. This feedback aligns with the accuracy results. Additional comments included: "Avatars are easy to interpret at a glance due to their expressions," and "Flower and weather designs are harder to interpret because they require relative comparisons with other health-related designs." From Figure 2, it is evident that the avatar-based visualization method (C-2), marked by orange dots, achieved the shortest response times and the largest accuracy differences between groups.

The horizontal axis represents the response times for Group A, while the vertical axis represents the accuracy differences between the two groups.

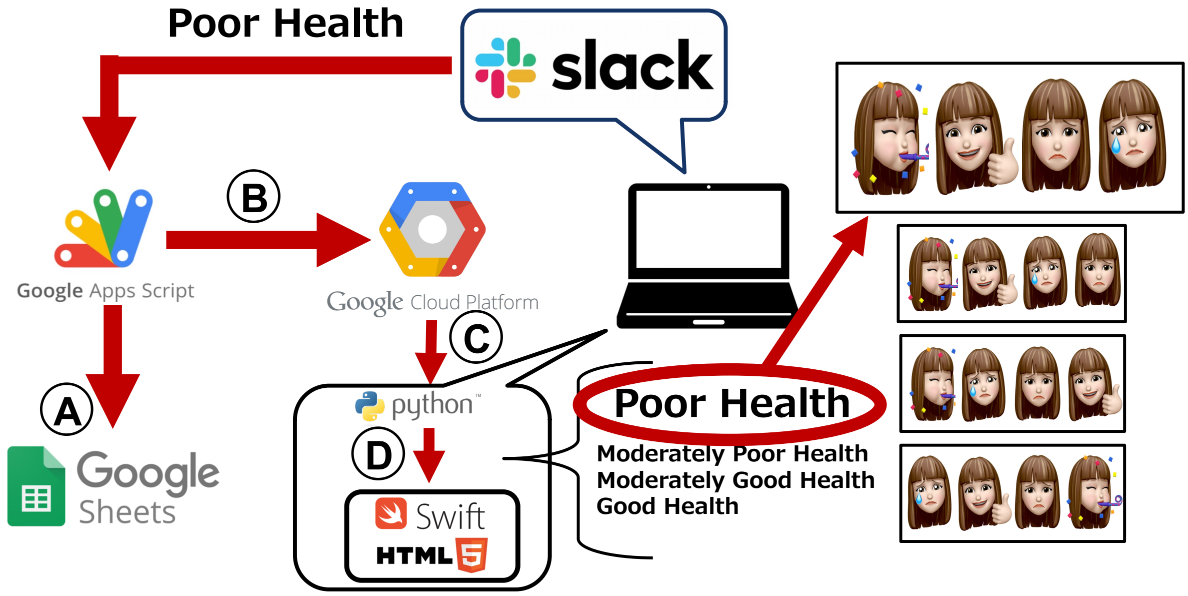



**Figure 3:** System architecture of the health visualization system using screensavers.

## 4. Design and Implementation of the Health Visualization System Using Screensavers

### 4.1. Approach

To improve presenteeism, it is essential for individuals to be aware of their own health conditions and for others in the community to recognize when someone is unwell. However, visualizing sensitive information such as personal health conditions requires a system that considers privacy protection. To address this, we propose a system that utilizes screensavers to visualize health conditions in a way that is easily noticeable to others but only accessible to individuals within the same community.

### 4.2. System Design

The system architecture of the proposed system is illustrated in Figure 3. A Slack bot, used as a messaging tool within the community, prompts users at specified times to provide their health condition by selecting one of four options: "Poor health," "Moderately poor health," "Moderately good health," or "Good health." As shown in Section A of the figure, the collected health information is stored and managed using Google Sheets via Google Apps Script[2], an application development platform provided by Google. In Section C, Google Cloud Platform, a suite of cloud computing services provided by Google, receives HTTP requests from Google Apps Script. Then, in Section D, a program on the visualization user's computer updates the screensaver based on the obtained health information. The screensaver on the user's computer displays an image corresponding to their health condition using one of four avatar designs. To track the number of participants present in the laboratory at specific times, participants carried a Hibeacon[3] device measuring $3.7cm \times 3.7cm$, which was attached to their bags or keys. A Hibeacon is a device that periodically transmits unique ID information, allowing a receiver to detect when the user enters the range of the beacon signal. In this experiment, the receiving system used was Obniz[4].

[2]https://www.google.com/script/start/
[3]https://www.hibeacon.jp/#link01
[4]https://obniz.com/ja/jobs

# 5. Investigation Using the Health Visualization System with Screensavers

In this experiment, a health visualization system using a screensaver was developed with four designs that had been highly evaluated for their privacy protection features. The author themselves participated as the sole visualization user, utilizing the system for one week in a laboratory shared with 35 other participants. This study investigated the usability of the screensaver system, the recognition rate of health information, and the relationship between recognition rate and personality traits. However, it should be noted that the visualization user was the author, which may introduce bias into the results.

## 5.1. Research Questions

To evaluate the effectiveness of the proposed system, this study addressed the following three research questions:

- Evaluate the usability of the proposed system based on the recognition rate of the visualization design.
- Evaluate the usability of the proposed system based on the recognition rate of health condition information.
- Investigate whether there is a correlation between the recognition rate of health conditions and users' personality traits.
- Evaluate the usability of the proposed system based on user acceptance of the system.

## 5.2. Experiment Overview

The experimental setup is shown in Figure 4. Prior to the experiment, a preliminary questionnaire was conducted to measure personality traits using the Big Five scale developed by Namikawa (2012) [15]. The experiment was carried out over the period from November 13 to November 17, 2023. The experimental period was set to less than one week to evaluate the initial effectiveness of the proposed system within a short timeframe. This experiment focused on understanding the recognition tendencies of the screensaver content within the laboratory and the comprehension of health information. However, investigating the long-term effects of the system and its influence on user behavior change remains a future challenge. Thirty-five participants, excluding the visualization user, took part in the experiment. The participants comprised 32 males and 3 females, aged between 21 and 55 years, with an average age of 25.5 years (SD = 7.93). Before the experiment, participants were briefed on the experiment's details and provided with an explanation of the interpretation rules for the four-panel avatar design displayed on the screensaver. During the experiment, participants were asked to complete a daily questionnaire upon returning home. The questionnaire included whether they had seen the visualization user's screensaver that day, what health condition was displayed, and their impressions.

The visualization user, who provided health information, was prompted daily at 10:00 AM by a Slack Bot to answer a health-related question by selecting one of the four health conditions. The proposed system then displayed a design corresponding to the reported health condition on the screensaver. The screensaver was placed in a central area of the laboratory where it was easily visible, even to participants seated far away, as they would frequently use the central trash bin or kitchen. The system was configured so that the screensaver activated after 5 minutes of inactivity and remained active without transitioning to sleep mode. The visualization user maintained their usual routine, including time spent in the lab, taking the computer out of the lab, or leaving it unattended. The health conditions visualized from November 13 to November 17 were "Poor health," "Poor health," "Moderately poor health," "Moderately good health," and "Good health," respectively.

**Figure 4:** The display of the health visualization design on the screensaver

**Table 2**
Visualization User's Lab Presence and Screensaver Active Time

| Date | a)[1] | b)[2] |
|---|---|---|
| 2023/11/13 | 13.2 h | 4.6 h |
| 2023/11/14 | 13.6 h | 4.8 h |
| 2023/11/15 | 9.2 h | 2.8 h |
| 2023/11/16 | 10.1 h | 3.4 h |
| 2023/11/17 | 10.7 h | 3.7 h |

[1] The time spent in the laboratory by the user displaying the health visualization design on the screensaver
[2] The total time the health visualization design was displayed on the screensaver

# 6. Results and Discussion

All 35 responses were deemed valid. The evaluation and discussion were conducted based on quantitative data derived from the recognition rates of the screensaver and qualitative data obtained from participants' comments at the end of the questionnaire.

The total time the visualization user spent in the laboratory and the total duration for which the screensaver was active are shown in Table 2.

**Table 3**
Participant Counts and Ratios During the Health Visualization Experiment Using Screensavers

| a) Date | b)[1] | c)[2] | d)[3] | e)[4] | f)[5] (%) | g)[6] (%) |
|---|---|---|---|---|---|---|
| 11/13 | Poor Health | 19 | 6 | 5 | 31.6 | 83.3 |
| 11/14 | Poor Health | 24 | 8 | 4 | 33.3 | 50.0 |
| 11/15 | Moderately Poor Health | 27 | 7 | 5 | 25.9 | 71.4 |
| 11/16 | Moderately Good Health | 31 | 15 | 11 | 48.4 | 73.3 |
| 11/17 | Good Health | 20 | 14 | 10 | 70.0 | 71.4 |

[1] Visualized Health Condition
[2] Number of participants present in the laboratory
[3] Number of participants who recognized the screensaver
[4] Number of participants who correctly recognized the health condition from the screensaver
[5] Percentage of participants who recognized the screensaver out of all participants present (%)
[6] Percentage of participants who correctly recognized the health condition out of those who recognized the screensaver (%)

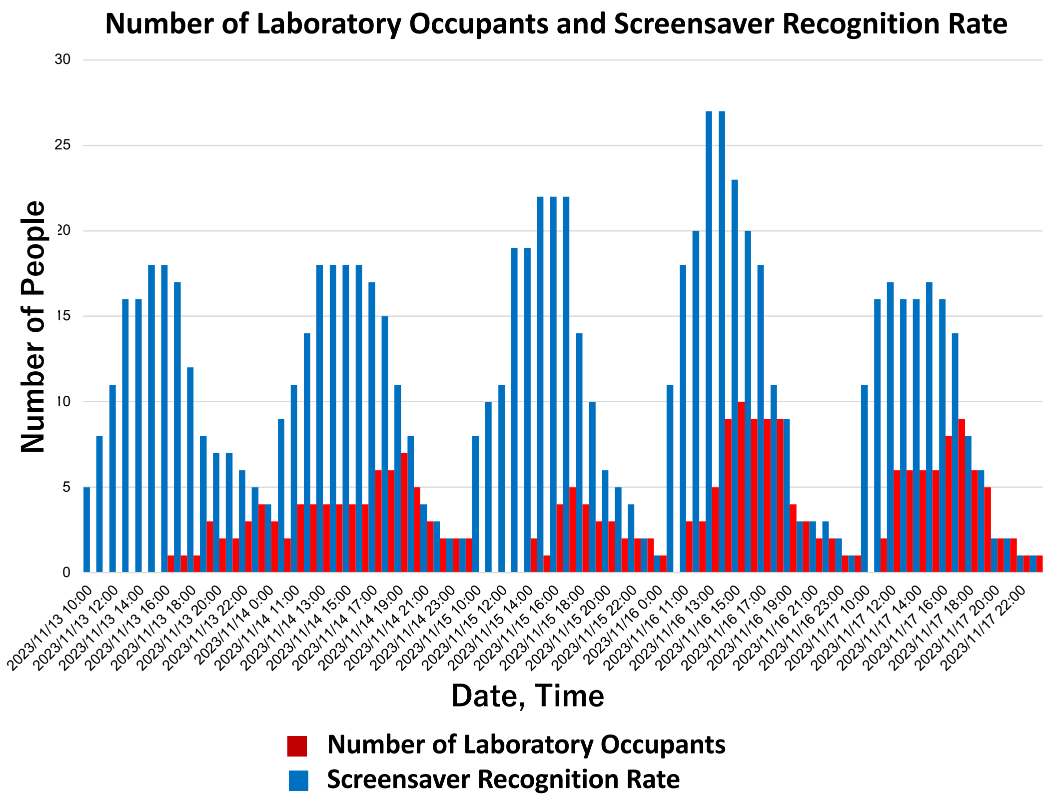



**Figure 5:** Number of participants present in the laboratory and those recognizing the screensaver

**Table 4**
Correlation Between Health Information Recognition Rates and Personality Traits Among Participants Who Saw the Screensaver

| Big Five Traits | Correlation Coefficient [1] | p | Presence of Correlation |
|---|---|---|---|
| Extraversion | 0.121011199 | >0.5 | N/A |
| Conscientiousness | -0.065547886 | >0.5 | N/A |
| Neuroticism | -0.152129035 | >0.5 | N/A |
| Openness | -0.206616447 | >0.5 | Weak Negative Correlation |
| Agreeableness | 0.057455967 | >0.5 | N/A |

[1] Correlation Coefficient with Correct Recognition Rate

## 6.1. Evaluating the Effectiveness of the Proposed System Based on Recognition Rates of Visualization Designs

The number of participants present in the laboratory and the number of participants who recognized the screensaver's visualization designs are shown in the bar graph in Figure 5. The number of participants who noticed the screensaver is presented in column d) of Table 3, while the percentage of participants who noticed the screensaver out of all participants present is shown in column f). It was observed that the number of participants noticing the screensaver increased towards the end of the experiment compared to the beginning. This trend is likely due to participants developing a habit of checking the screensaver as part of their environment and becoming more curious about its content. Indeed, the questionnaire responses during the experiment indicated that participants were more likely to check the screensaver later in the experiment, and some participants specifically mentioned the visualization user's screensaver.

On the other hand, despite the screensaver being placed in a visible location in the laboratory, some participants noted that they did not have many opportunities to see it because they did not frequently go near the visualization user's location. Additionally, seating location had a significant impact on visibility. Another issue was that the content displayed on the screensaver was static images, which made it less noticeable as a screensaver, as some participants mentioned. In future iterations, incorporating animations into the visualization designs and introducing multiple visualization users could enhance recognition rates.

### 6.2. Evaluating the Effectiveness of the Proposed System Based on Health Information Recognition Rates

The number of participants who correctly recognized health information among those who noticed the screensaver is shown in column e) of Table 3, and the corresponding recognition rate is shown in column g). On the first day of the experiment, participants who noticed the screensaver were those who were particularly attentive to the experiment. Their high level of understanding of the visualization rules likely contributed to the high recognition rates of health information.

On the second day, while more participants paid attention to the screensaver, some feedback from the questionnaire suggested that their understanding of the visualization rules was insufficient, resulting in difficulty recognizing health information quickly. On the third day, when "Moderately Poor Health" was visualized, and the fourth day, when "Moderately Good Health" was visualized, many participants confused these intermediate categories, often mistaking one for the other. This suggests that the single visualization user made it challenging for other participants to deeply understand or engage with the interpretation rules.In this experiment, only one participant was targeted for visualization. Due to this limitation, the results obtained hold significance as an initial validation under specific conditions, but discussions regarding its applicability to group usage and different environments remain future challenges. Further experiments involving multiple participants are necessary. In the future, introducing multiple visualization users could encourage participants to both visualize and recognize health information, potentially increasing interest in the visualization designs of other users.

### 6.3. Correlation Between Health Information Recognition Rates and User Personality Traits in the Proposed System

During the experimental period, we investigated the correlation between the accuracy of participants' recognition of health information displayed on the screensaver and the elements of the Big Five personality traits. The results are summarized in Table 4. Since the data did not follow a normal distribution, we used Spearman's rank correlation coefficient for analysis. The analysis revealed a very weak negative correlation ($r=-0.2066$) between the accuracy of recognizing the visualization design and the "Openness" trait of the Big Five; however, this correlation was not statistically significant ($p>0.05$). The small sample size of 35 participants may have limited the power to detect significant correlations, warranting cautious interpretation of the results. Nonetheless, the weak negative correlation based on Spearman's rank correlation coefficient is noteworthy. A possible explanation for this finding is that individuals with lower openness are known to pay closer attention to details and exhibit careful observation [16], which may have enhanced their understanding of the experimental design. Additionally, individuals with lower openness often show resistance to change, which might have led them to focus more on the experiments involving the newly introduced system in the laboratory. While the observed trend suggests a potential relationship, no statistically significant differences were identified. The small sample size likely contributed to insufficient power for detecting significant correlations. Future studies should address this limitation by increasing the number of participants and conducting evaluations with a larger sample size to more rigorously assess the relationship between personality traits and the accuracy of recognizing health information. This will enable a deeper understanding of the interaction between participants' personality characteristics and the effectiveness of visualization designs.

## 6.4. Evaluate the Usability of the Proposed System Based on User Acceptance of the System

Feedback on the system's acceptance was collected from participants who interacted with the visualization system (including both the health information visualizer and the observers). This section discusses how factors such as privacy protection and the promotion of communication influenced system acceptance, based on qualitative evaluation.

### 6.4.1. System Acceptance by the Visualizer

**Sense of Security Provided by Privacy Protection** Regarding system acceptance, the visualizer stated that they "did not feel much discomfort or resistance" toward visualizing their health information through the proposed system. They attributed this to the sense of security provided by privacy protection. Specifically, the visualizer mentioned that, when they were unwell and unable to focus on their work due to a cold, there was a psychological barrier to voluntarily reporting their poor health condition. However, the proposed system abstracted the health information into "feeling unwell" and limited its interpretation to specific individuals. This design reportedly provided the visualizer with a sense of security. This privacy-conscious feature is suggested to have contributed to reducing the psychological burden of taking rest when needed. Additionally, the visualizer positively evaluated the characteristic of the screensaver, which limited the recognition of health information mainly to nearby colleagues. They noted that nearby colleagues are often those with whom they have established trust, making it easier to receive support or expressions of concern. Particularly during poor health, receiving care from trusted individuals increased their sense of security and potentially improved the overall workplace environment.

**Promotion of Communication** During the experimental period, the visualizer received two comments from other participants, such as "Are you feeling unwell? Are you okay?" This type of communication reduced the need for the visualizer to directly convey their condition and provided opportunities to receive words of care and support from colleagues. Furthermore, the visualizer indicated that the disclosure of health information could ease the psychological burden of requesting early leave when necessary. These results suggest that the system can contribute to improving workplace comfort and usability.

**Bias Resulting from the Visualizer Being the Author** In this study, the visualizer was the author, which introduces the potential for bias in their subjective feedback. To address this limitation, future research should involve multiple visualizers and evaluate the system under various environments and conditions. Additionally, collecting feedback from a more diverse range of participants is essential to enhance the reliability of findings regarding the system's acceptance and effectiveness.

### 6.4.2. System Acceptance by Observers

**Psychological Impact of Displaying Health Information** One participant expressed that they "found it harder to initiate conversations when the visualizer was unwell," suggesting that health visualization does not always promote communication in all situations. This indicates that while increased consideration for others' health can be positive, it may also lead to increased psychological barriers when initiating interactions.

**Visibility and Usage Limitations** One participant suggested that "it would be helpful if health information were displayed even when the visualizer was seated and the screensaver was inactive." This highlights the need to optimize the system's operation and display timing. Additionally, comments such as "I was able to check the information during restroom or break periods" suggest that the screensaver serves as a useful tool for sharing information during periods of absence. Another participant mentioned, "The information was displayed on the computer screen, allowing me to check it not only in the laboratory but also during classes." This implies that the system has the potential to share information beyond specific physical spaces.

#### 6.4.3. Summary

Feedback from both the visualizer and the observers suggests that the proposed system has a certain level of effectiveness in reducing psychological burdens, promoting communication, and facilitating information sharing. However, challenges such as display timing, visibility, and distance limitations have also been identified. These findings provide significant insights into improving the proposed system and considering its broader implementation in workplace environments.

## 7. Future Directions

The experimental period of this study was limited to one week, which was appropriate for evaluating the initial effectiveness of the system. However, longer-term evaluations are necessary to examine the system's sustained effects and its influence on user behavior change. Future studies will aim to enhance the screensaver's design by incorporating animation features, thereby creating a more screensaver-like appearance and potentially improving recognition rates. Additionally, implementing the health visualization system with multiple participants in a group setting will allow for the investigation of how such a system can collectively influence user behavior. Furthermore, future research will explore the relationship between susceptibility to the system's effects and personality traits, aiming to identify personality characteristics that are more receptive to the system's influence.

## 8. Conclusion

This experiment confirmed the recognition rate of health information when the proposed system was implemented by a single visualization user. Additionally, a negative correlation was observed between the Big Five trait of openness and the recognition rate of health information. Understanding how individuals with different personality traits interpret and process information is crucial for designing effective communication strategies. In future studies, experiments involving multiple visualization users will be conducted to evaluate the effectiveness of the proposed system, including its potential for inducing behavioral changes. Furthermore, as the visualization user in this experiment was the author, there is a possibility of bias in the findings. Expanding the scope to include a more diverse group of visualization users will enhance the reliability and generalizability of the results. Another limitation of this study was the short duration of the experiment, which lasted only one week. While this was sufficient for initial evaluations, longer-term studies are necessary to assess the sustained effects of the system and its influence on user behavior over time. Additionally, the use of static images in the visualization design may have contributed to the lack of attention paid by some users to the content displayed by the screensaver. Future research should explore methods to improve the recognition rate of the visualization content by incorporating innovative animations into the design. Such improvements may increase user engagement and the overall effectiveness of the system.

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