Evaluating the Effectiveness of AromaHub in Reducing Collective Stress: A User Study

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***Abstract*—Excessive work stress has a negative impact on the health and productivity of office employees, making collective stress management crucial. This study proposes the AromaHub system, which combines artificial intelligence and multi-sensory intervention to enhance stress management. The AromaHub system detects stress levels through facial expression recognition and convolutional neural network algorithms, and automatically triggers aromatherapy. The system includes a fragrance diffuser and a hydrosol machine with jellyfish shaped spray design to provide a soothing visual effect. In the experiment, laptop cameras were used to detect collective stress during online meetings. 24 participants were randomly divided into six groups, with three groups using the AromaHub system and three groups serving as the control group. Mathematical tasks were used to trigger stress, and real-time facial expression analysis evaluated stress levels to activate interventions. The results showed that AromaHub reduced participants' stress levels. Future research will focus on privacy protection issues and explore the integration of wearable technology to enhance the practicality and effectiveness of the system.**

***Keywords*—Collective stress, multi-sensory, facial expression recognition**

I. INTRODUCTION

Excessive work stress seriously affects personal health and organizational productivity. Some perspectives in organizational psychology and sociology suggest that stress is also a collective phenomenon that is widely influenced by the work environment [1, 2]. This viewpoint emphasizes that stress experiences and coping mechanisms are shaped by collective factors in organizational culture[3]. Collective stress arises from shared stressors within an organization, such as interpersonal interactions, common deadlines, or organizational change[4, 5]. Unlike individual stress, collective stress involves the perception and response of the entire team to stressors[6]. Social psychology research shows that organizational stress climate reflects the overall level of stress within an organization and its impact on employees [2, 3]. Studies on emotional contagion have shown how stress spreads within teams and affects group dynamics[7, 8].

Effective strategies for coping with collective stress include problem-focused and emotion-focused approaches[9]. Research has shown that collective problem oriented coping (i.e., working together to address stressors) is particularly effective in reducing overall stress levels[9]. Collective stress affects individual health, but coping with it properly helps to enhance team cohesion, reduce productivity decline, and lower employee turnover rates[2]. By cultivating a supportive organizational culture and implementing team interventions, organizations can enhance overall vitality, alleviate stress, and promote a more efficient and positive work environment.

The current stress management methods mainly focus on individual level strategies, which often fail to address the complexity of collective stress in organizational environments. Traditional stress management techniques, such as cognitive-behavioral therapy (CBT)[10], mindfulness based stress reduction (MBSR)[11], and relaxation exercises, aim to help individuals cope with stress by altering cognitive processes, increasing self-awareness, and promoting relaxation[12]. Despite the increasing demand for collective stress management methods, many organizations still rely primarily on individual centered approaches[13]. This highlights the need for further research and development of strategies that combine individual and organizational interventions to more effectively manage workplace stress.

II. RELATED WORK

Effective stress management is crucial for personal health and organizational efficiency. Stress not only disrupts endocrine balance and damages the immune system, but may also lead to cardiovascular and chronic diseases[14]. In addition, stress can weaken teamwork, increase absenteeism and employee turnover[15]. Collective coping strategies can effectively reduce overall stress within the organization through team sharing of coping strategies and organizational level interventions[16]. Technological innovation, such as wearable devices, stress monitoring applications, and virtual reality (VR) technology, provides new stress management methods to help monitor and intervene in stress in real-time[17, 18, 19].

Technological innovation in the field of human-computer interaction (HCI) has played an important role in stress management. Personal informatics (PI) systems and biofeedback systems help users better manage stress by providing data-driven self insights and physiological signal feedback[20, 21]. Visual feedback methods, such as the Breakaway project[22] and MoveLamp[23], enhance users' stress awareness and behavior change by visualizing body posture and activities. Auditory feedback also plays an important role, as Sonic Cradle[24] and BreathTray[25] improve stress states through music and sound feedback.

Olfactory feedback regulates psychological and physiological responses through odor stimulation. Studies have shown that scents such as lavender and orange can effectively reduce stress and improve emotions[26, 27]. In addition, multi sensory technologies[28] such as virtual reality (VR) and the Internet of Things (IoT) intelligent environment promote relaxation through immersive experiences and environmental adjustments, support cognitive-behavioral therapy and mindfulness practices, and further improve stress management and emotional health [29, 30, 31].

Stress detection involves identifying and understanding stress responses through various measures, which can be broadly categorized into physiological, psychological, and physical methods. Psychological stress is often assessed using self-report questionnaires, such as the State-Trait Anxiety Inventory (STAI)[32] and the Relaxation Rating Scale (RRS)[33], which measure perceived stress and relaxation levels. Physiological methods include the use of sensors and devices to measure stress-related biological indicators. For instance, Photoplethysmography (PPG) is used to monitor changes in blood volume and heart rate, while Heart Rate Variability (HRV) assesses the variation in time intervals between heartbeats, both of which can provide insights into stress levels and autonomic nervous system activity[34].

Facial expression recognition(FER) is an important way of detecting emotions and can instantly reflect an individual's stress state. The facial expressions of basic emotions such as anger, disgust, fear, happiness, and sadness are widely present in different cultures, providing the foundation for emotional computation[35]. Traditional facial expression recognition methods include Local Binary Patterns (LBP) and Directional Gradient Histograms (HOG), while Convolutional Neural Networks (CNNs) and Recurrent Neural Networks (RNNs) in deep learning significantly improve recognition accuracy[36, 37]. Various standardized databases, such as CK+[38]and FER2013[39], provide abundant data resources to support technical development. Gao et al. developed a real-time system that detects driver stress from facial expressions of anger and disgust, using pose normalization to enhance accuracy[40]. Giannakakis et al. analyzed stress and anxiety through facial cues like eye and mouth activity, head movements, and camera-based heart rate, achieving stress detection[41].

III. Concept Design

A. Concept Design

AromaHub is an innovative system that aims to improve the overall atmosphere of the office environment, relieve collective stress, and promote the physical and mental health of employees through the combination of advanced technology and natural aromatherapy. The system combines modern technology with traditional aromatherapy to provide customized stress management solutions for office spaces through real-time data monitoring and interactive feedback.

Design Considerations

1) Application of Calm Technology

Low-disruptive: The system is designed such that interventions do not disrupt the user's work. To keep the work environment tranquil, we reduce reliance on sound and strong visual stimulation by using natural visual and olfactory feedback.

Automation and Adaptability: The system should automatically identify and respond to stress conditions, reducing the user's operational burden. This automated feature ensures real-time and effective stress intervention.

2) Non-intrusive design

Natural integration into the work environment: Hardware devices and interventions are designed to integrate seamlessly with the work environment to avoid additional psychological burden or physical interference.

User Privacy Protection: The system is designed to strictly protect user privacy and only process and store necessary data.

3) Multisensory Experience

The system integrates visual and olfactory stimuli to provide a multisensory stress relief experience.

AromaHub Design

The name “AromaHub” combines the concepts of “Aroma” and “Hub.” “Aroma” reflects the system’s core idea of using fragrances to provide comfort and relaxation, while “Hub” signifies the system as the central point for multi-sensory experiences. AromaHub aims to effectively manage collective stress in office environments, improving the overall well-being and work efficiency of employees. Its core functions include real-time stress monitoring and automated intervention. The system (see Fig. 1) uses convolutional neural network (CNN) algorithms to capture and analyze employees' facial expressions through cameras, determine emotional states and convert them into collective stress levels. Based on this data, the system automatically triggers diffusers to help employees relieve stress. The diffuser is designed as a jellyfish-shaped spray, which not only provides a visual calming effect, but also combines with a hydrosol function to customize the release of a more natural aroma. AromaHub ensures that all data is encrypted to protect user privacy and uses advanced security protocols to prevent data leakage and unauthorized access.

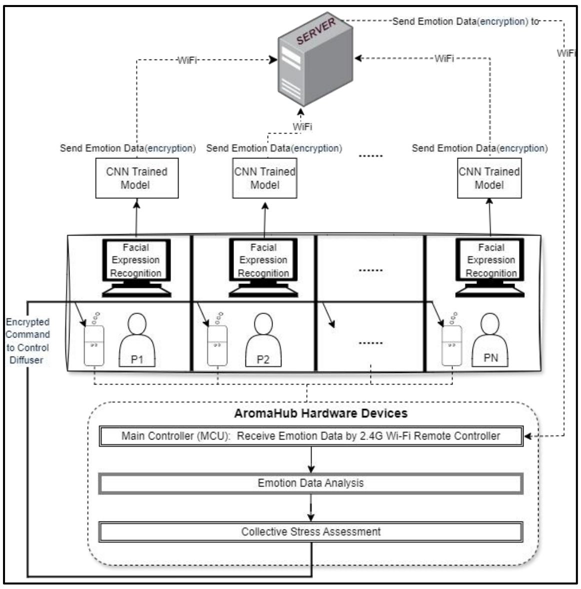

Fig. 1. The System Architecture.

B. *Experimental Design*

Participants

A total of 24 participants were recruited for this study, including 10 females and 14 males. All participants were college students in China, including both undergraduates and graduate students, aged between 21 to 35 years old (mean=26, SD= 4.03). All participants had no heart disease, normal visual and olfactory functions, and no history of lavender allergy. The participants were divided into six groups of four each, and further divided into two subgroups to promote cooperation and competition. Three groups were intervened using AromaHub, while the other three groups did not receive intervention as the control group. All participants voluntarily participated and signed an informed consent form. The research plan and data collection procedure have been approved by the local ethics review committee.

Set up

The experiment used individual laptop cameras to detect collective stress in online meetings. The experiment was conducted in four rooms with the same configuration (see Fig. 2). Each room was equipped with the following devices: a laptop with a camera and mouse, a diffuser, and a photoplethysmography (PPG) device. The room environment had been carefully adjusted to maintain quietness, with temperature and humidity controlled within comfortable ranges to ensure the reliability of the experiment and the comfort of the participants.

Each participant had a PPG device securely fixed on their left index finger to record pulse wave data. The participants were instructed to maintain hand stability and adopt a comfortable posture. For left-handed participants, the PPG device was fixed on the index finger of the right hand. The data collected by PPG equipment served as the ground truth for the experiment, which was used for comparative analysis with the stress levels recorded by the emotion recognition system after the experiment was completed.

The emotion recognition software was launched at the beginning of the experiment, and the participants logged in to the pre-set online meeting to complete the mental arithmetic tasks[42]. A timer in each computer would be set at five minutes for each round of math task. The diffuser was kept powered on for the experiment groups, so that it could start based on the real-time collected collective stress values and took corresponding intervention measures, while the diffuser kept off for the control groups.

Tasks

In order to simulate the stressful situation at work, we selected different levels of mental arithmetic tasks as stressors to control the stress levels. This study designed two tasks to stimulate the different stress levels of the participants, each task was limited to five minutes to complete 30 questions. Task 1 involved two-digit addition and subtraction, designed to induce low stress levels; Task 2 included three-digit addition and subtraction, designed to induce higher stress levels.
During the test, the participants were not allowed to use computing devices or paper and pen, and could only rely on mental arithmetic to complete the questions. The participants performed tasks through an online collaborative office platform-WPS, and the progress of the two groups of subgroup members was displayed in real time on the platform. The system provided instant prompts when errors occurred, requiring the participants to correct them. Although team members could collaborate with each other to complete the task, conversation was prohibited throughout the test to ensure the independence of the task and the authenticity of the sense of stress.

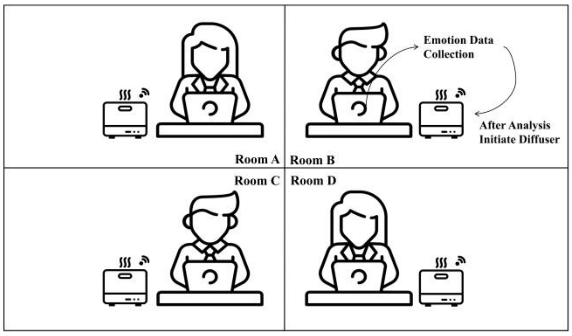

Fig. 2. Set up of the Experiment.

Experimental Procedure

This experiment lasted 40 minutes and was designed to simulate the participants' reactions to different stressful situations. The entire experiment procedure included baseline measurements, two rounds of stress tasks, the use of AromaHub, and final data collection.

Step 1: Baseline Measurement
- At the beginning of the experiment, the participants were introduced to the experimental process and watched a peaceful video to help them relax. During this period, the participants' baseline stress level was measured. Afterwards, the participants filled out the RRS and STAI questionnaires to assess their self-reported initial stress level.

Step 2: Initial Stress Task
Two participants were randomly assigned Task 1(low stress stimulus), while the other two were assigned Task 2(high stress stimulus) to simulate different stress levels in a group, reflecting various common office scenarios, such as situations where some individuals were under tight deadlines while others were not. Each task must be completed within five minutes, during which the participant's stress level was monitored. If the collective stress threshold was reached, the four AromaHubs would start the aroma intervention together. After the task, participants filled out the RRS and STAI questionnaires to assess changes in stress levels.

Step 3: First AromaHub Intervention
After completing the initial stress task, participants of experiment group used the AromaHub for five minutes. During this process, stress levels were continuously monitored. Participants filled out the RRS and STAI questionnaires again to assess the impact of AromaHub on stress levels. While Participants of Control Group were asked to rest quietly for 5 minutes, without any intervention or social interaction.

Step 4: Second Round of Stress Tasks
All participants performed a second round of tasks, which were all high-stress tasks, solving 30 three-digit addition and subtraction problems. If the collective stress threshold was reached, the four AromaHubs started the

aroma intervention again for the experiment group. After the task, participants filled out the RRS and STAI questionnaires to assess changes in stress levels.

Step 5: Second AromaHub Intervention

In the final phase of the experiment, participants of experiment group used AromaHub again for five minutes while their stress levels were monitored. Upon completion, participants filled out RRS and STAI questionnaires to assess final stress levels and their changes. While Participants of Control Group were asked to rest quietly for 5 minutes, without any intervention or social interaction.

Step 6: Interview

We collected qualitative data through questionnaires to analyze experiences and feedback of participants from experiment groups on the experiment. While the participants of control group enjoyed ten minutes rest. This data was used to evaluate the overall effectiveness of the stress task and the impact of AromaHub on stress levels.

Measurement and Data Analysis

1) Emotion Recognition

We used facial expression recognition (FER) technology to analyze participants' emotion. We estimated the participants' stress levels by calculating the proportion of these negative emotions(anger, sadness, sadness, and disgust)[43]. In this system, we calculate the proportion of negative emotions for each participant in each 30-second window, which is the ratio of negative emotions to total emotions detected. We then determine if the proportion exceeds 50% for each of the four participants. If fewer than 2 participants have a negative emotion proportion above 50%, we do not proceed with further analysis. If two or more participants exceed this threshold, we recognize collective stress and standardize the data, normalizing it to a 0-100 scale. The ratio of negative emotion(NER) is categorized into three levels: mild stress for 0-33%, moderate stress for 34-66%, and high stress for 67-100%.

2) Physiological Data

In the collection and analysis of physiological data, we mainly used photoplethysmography (PPG) to measure stress levels. Through PPG technology, we can obtain heart rate variability (HRV) data, which reflects stress levels by analyzing the variability of heart rate. Specifically, we used the standard deviation of heart rate intervals (SDNN) to quantify stress, and lower SDNN values indicated higher stress levels. To assess individual stress levels, we referred to existing research[44], with specific criteria being: SDNN below 50 indicates high stress, between 50 and 100 indicates low stress, and above 100 indicates no stress.

3) Self-report: Subjective assessment of anxiety and relaxation

To obtain participants' subjective feelings about their own stress, we used a self-report method. Participants filled out the State-Trait Anxiety Inventory (STAI) to measure their anxiety levels, with scores ranging from 20 to 60, where higher scores indicate greater levels of anxiety[32]. In addition, we used the Relaxation Rate Scale (RRS) to assess participants' relaxation levels, with scores ranging from 1 to 9, where 9 indicates extreme relaxation[33]. The data from the STAI and the RRS helped us understand the participants' subjective relaxation and anxiety states.

4) Interview Analysis: collective stress awareness and intervention effect

We collected qualitative feedback from participants of experiment groups on their understanding of collective stress and the intervention effect of the AromaHub through interviews.

C. *Results*

Quantitative Results

For the data we collected, we first conducted a Shapiro-Wilk test to determine if the data follows a normal distribution due to the small sample size. We needed to use non-parametric test for the data did not follow the normal distribution. We used Mann-Whitney U test to compare the mean difference in stress levels between the experimental group and the control group. For the measurement data of the same group of participants under different conditions, we used the Friedman test to evaluate the changes in stress levels at different stages.

1) Physical data

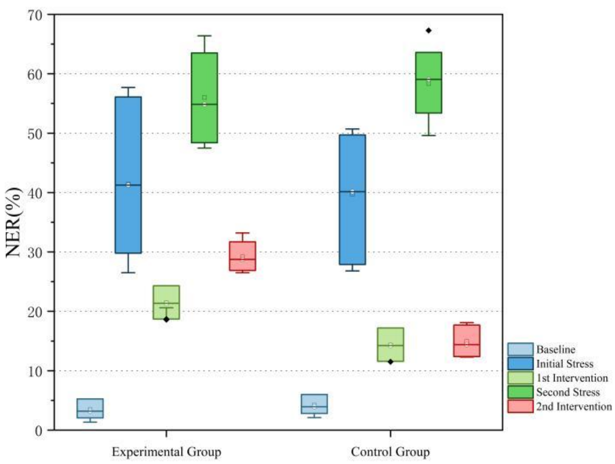

Fig. 3. Result of NER.

As shown in Figure 3, compared with the baseline stage (Mdn=3.83, SD=1.30), the NER scores significantly increased in the initial stress stage (Mdn=40.15, SD=10.50, $p<0.001$) and the second stress stage (Mdn=56.70, SD=5.28, $p<0.001$), indicating that stress stimulation led to a significant increase in participants' perception of stress.

In the intervention results of the NER scale, the experimental group scored significantly lower in the first intervention stage (Mdn=14.25, SD=1.85, $p<0.001$) and the second intervention stage (Mdn=14.40, SD=1.97, $p<0.001$) than in the initial and second stress stages, indicating that the intervention effectively reduced stress perception. The score of the control group in the first intervention stage (Mdn=21.35, SD=1.85, $p<0.001$) was also higher than that in the initial and second stress stages, but the score significantly decreased in the second intervention stage (Mdn=8.00, SD=0.49, $p<0.001$). Further comparative analysis showed a significant difference in scores between the experimental group and the control group during the first intervention phase ($p<0.001$) and the second intervention phase ($p<0.001$). This indicates that the experimental group had significantly better effects than the control group in the intervention, and the different intervention measures led to significant differences in effectiveness.

2)Self-report data

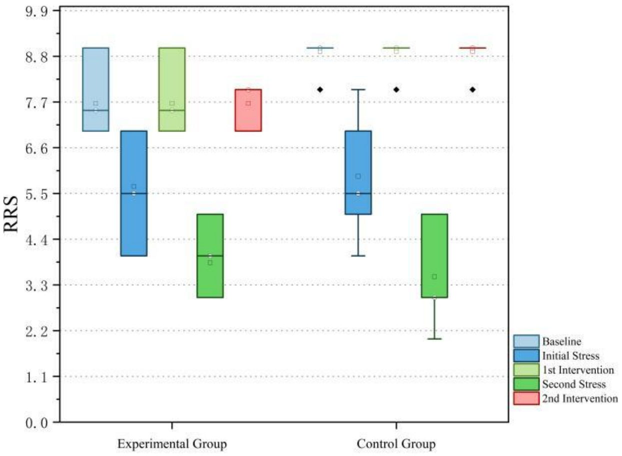

Fig. 4. Result of RRS.

As shown in Fig. 4, compared to the baseline stage (Mdn=9.00, SD=0.20), the RRS scores in the initial stress stage (Mdn=5.50, SD=1.17, p<0.001) and the second stress stage (Mdn=4.00, SD=0.82, p<0.001) significantly decreased. This indicates that stress stimulation led to an increase in participants' perception of stress. For the STAI scale(Fig. 5), compared to the baseline stage (Mdn=21.50, SD=1.18), there was a significant increase in scores for the initial stress stage(Mdn=36.00, SD=4.62, p<0.001) and the second stress stage(Mdn=42.00, SD=1.32, p<0.001), indicating that stress stimuli induced an increase in subjective stress.

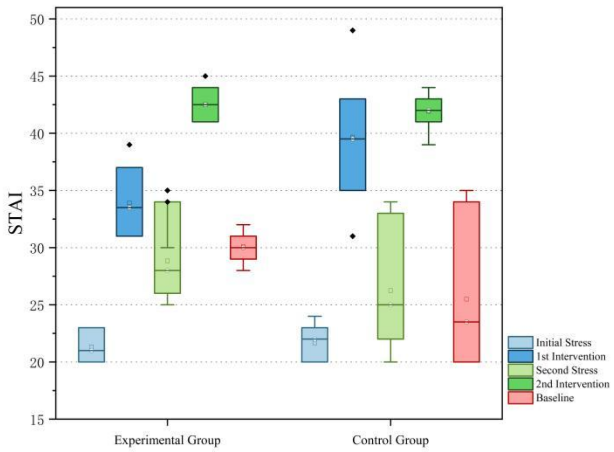

Fig. 5. Result of STAI.

For the intervention results of the RRS scale, the experimental group had significantly higher scores in the first intervention stage (Mdn=9.00, SD=0.29, p<0.001) and the second intervention stage (Mdn=9.00, SD=0.29, p<0.001) compared to the initial stress stage and the second stress stage. The control group also had significantly higher scores in the first intervention stage (Mdn=7.50, SD=0.78, p<0.001) and the second intervention stage (Mdn=8.00, SD=0.49, p<0.001) compared to the initial stress stage and the second stress stage. Further comparative analysis showed that there was a significant difference in scores between the experimental group and the control group during the first intervention stage (p=0.03), and a significant difference in scores during the second intervention stage (p=0.03). This indicates a significant difference in the effectiveness between the experimental group and the control group.

Regarding the intervention results of the STAI scale, the experimental group showed a significant decrease in scores during the first intervention stage (Mdn=25.00, SD=4.64, p<0.001) compared to the initial stress stage, while the second intervention stage (Mdn=23.50, SD=5.50, p<0.001) showed a significant decrease in scores compared to the second stress stage. The first intervention stage (Mdn=28.00, SD=2.79, p<0.001) of the control group showed a significant decrease in scores compared to the initial stress stage, while the second intervention stage (Mdn=30.00, SD=1.08, p<0.001) showed a significant decrease in scores compared to the second stress stage. The comparison of intervention effects between the experimental group and the control group revealed a significant difference in the first intervention stage (p=0.03) and the second intervention stage (p=0.04). These findings suggest that the interventions, which included the use of AromaHub and engaging in leisure conversations, subjectively helped participants feel more relaxed and reduced their perceived stress levels.

3)Physiological data

As shown in Fig. 6, compared to the baseline stage (Mdn=96.75, SD=1.64), the SDNN in the initial stress stage (Mdn=73.20, SD=6.01, p<0.001) and the second stress stage (Mdn=67.70, SD=5.66, p<0.001) significantly decreased. This indicates that stress stimulation led to an increase in participants' perception of stress.

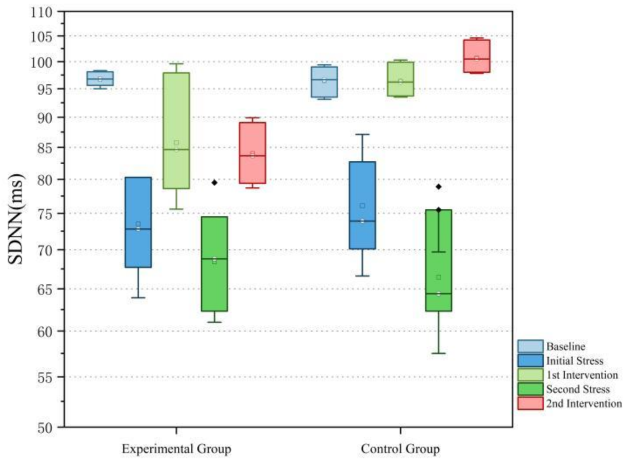

Fig. 6. Result of SDNN.

For the intervention results of the SDNN, the experimental group had significantly higher scores in the first intervention stage (Mdn=96.20, SD=2.45, p<0.001) and the second intervention stage (Mdn=100.05, SD=2.49, p<0.001) compared to the initial stress stage and the second stress stage. The control group had slightly higher scores in the first intervention stage (Mdn=84.65, SD=7.66, p=0.08)compare to the initial stress stage, and had a significantly higher score in the second intervention stage (Mdn=83.65, SD=4.24, p<0.001) compared to the second stress stage. Further comparative analysis showed that there was a significant difference in scores between the experimental group and the control group during the first intervention stage ($p=0.02$), and a significant difference in scores during the second intervention stage ($p<0.01$). This indicates a significant difference in the effectiveness between the experimental group and the control group.

Qualitative Results

1)Enhancing awareness of collective stress

Most participants generally reported that the system helped them identify changes in collective stress through changes in jelly-fished spray, thereby better understanding the dynamics of collective stress. For example, P8 mentioned: “The smoke ring changes in the system allowed me to intuitively understood the team's stress situation, and this visual feedback made me feel the collective stress of the team more clearly.” However, there is still room for improvement in accuracy and real-time performance to better reflect actual stress levels.

2)Aromatherapy intervention effect

The aromatherapy intervention of the AromaHub system had shown some effectiveness in relieving stress, but the effect varied depending on individual differences. Most participants gave positive feedback on the effectiveness of aromatherapy. P5 mentioned, “The scent of lavender was helpful for my stress.” In addition, the hydrosol the AromaHub produced as an aromatherapy additive to make the scent more natural and fresh, which was more popular than traditional essential oils. P18 said, “The fragrance was very natural and felt more soothing.” However, there were also some feedback pointing out inconsistencies in the effectiveness of aromatherapy. P7 added, “Some people may not like aromatherapy, and such interventions may not be suitable for everyone.” This suggests that in the future, more options may need to be provided to meet the needs of different users.

3)Importance of timely intervention

The AromaHub system had shown significant advantages in providing timely intervention, as it can help manage stress by identifying collective stress in real-time and taking prompt measures. Participants generally believed that this feature was a significant advantage of the system. P11 mentioned, “AromaHub's timely intervention helped us take action before stress problems worsened.” P19 also stated, “The system's rapid feedback ensured that we could adjust quickly and prevent stress accumulation.” However, some participants pointed out that the accuracy of stress detection in the system needs to be improved.

4)Selection of stress detection methods

The AromaHub system used facial recognition technology as a stress detection method, which had been recognized by participants as a non-invasive approach. Especially in the experimental environment of online conferences, this design helped alleviate users' concerns about camera privacy. P1 commented, “The non-invasive nature of facial recognition technology was very good. We didn't need to wear additional equipment, making the experience more natural.” However, although online meetings in experimental environments may alleviate concerns about camera privacy, in practical applications, users may still have concerns about camera privacy issues.

5)The impact of collective stress on individuals

AromaHub prompts the team's stress level by releasing jelly-fished spray with a lavender scent, which has different effects on different participants. For example, P16 stated: “When I saw the lavender scented spray release, I felt that participant in my group was under stress, which made me feel a little relaxed.” This indicated that the system used scent cues to indicate collective stress, which can help some users feel a relative relief when they realized that others were also experiencing stress, thereby easing their personal stress. P2's feedback is different: “Actually, I was very focused when doing mental arithmetic math problems, so I didn't pay much attention to the stress state of others.”

Comparison of Four Stress Defection Methods

All four methods for stress detection revealed that stress indicators significantly increased compared to baseline levels, indicating that stress stimulation effectively heightened participants' stress perception. The intervention measures demonstrated a notable effect in reducing stress perception, with the experimental group showing superior outcomes compared to the control group, especially in the negative emotion scores (NER), Relaxation Rate Scale (RRS), and State-Trait Anxiety Inventory (STAI) assessments. Additionally, heart rate variability (SDNN) showed significant improvement with interventions, suggesting that the interventions positively impacted physiological stress levels. These patterns indicate that, while the methods differ in specifics, they all effectively capture stress changes and that the interventions substantially improve both perceived and physiological stress.

IV. Discussion and Future Work

A. Key Findings

Increase Awareness of Collective Stress

The AromaHub system has demonstrated significant effectiveness in enhancing collective stress awareness. Through its visualization and olfactory cues, the system can effectively help participants identify and understand the collective stress level of the group. The lavender scent and jelly-fished spray pattern released by the system provide participants with intuitive stress information, enabling them to perceive stress fluctuations in the team in a timely manner. The application of these functions enables participants to better grasp changes in team emotions and take appropriate adjustment measures in their work.

Non-intrusive of the Intervention

The AromaHub system emphasizes non-intrusiveness in the design of intervention methods, which has been widely recognized by most participants. The system avoids direct contact and device wearing in traditional intervention methods, thereby reducing interference with users' daily work. Participants generally believed that this methods help them maintain focus at work without the need for additional operations or intervention equipment.

Improved Communication Among Workers

The AromaHub system has shown significant effectiveness in improving communication among participants. By providing real-time feedback on collective stress, the system promotes interaction and dialogue among team members, allowing them to have a deeper understanding of collective stress levels. This transparent information helps them pay more attention to the work status of colleagues. Participants can perceive the current level of collective stress, which enables them to support and cooperate with each other when facing stress.

Need for Non-Intrusive Method of Data Collection

The AromaHub system uses facial recognition technology for stress detection, which avoids the need for additional devices and enhances the user experience. Although the experiment alleviated concerns about camera privacy through online meetings, in practical applications, users still have concerns about privacy. To further enhance the effectiveness of the system and protect user privacy, it is recommended to explore other non-invasive technologies.

Effectiveness of Multi-Sensory Experience

The AromaHub system effectively enhances the stress management experience through multi-sensory interventions of visual and olfactory senses. The smoke ring emitted by the system is shaped like a jellyfish, providing a soothing visual effect and helping users relax. At the same time, the system uses a homemade hydrosol fragrance, which is fresher than traditional essential oils and has received high praise from users.

B. Factors Influencing Effectiveness

The influencing factors of system effectiveness mainly include individual differences, office environment, and data privacy. Individual differences have a significant impact on system effectiveness, and users' responses to visual and olfactory interventions vary from person to person. For example, some users are very sensitive to fragrance, while others may be more sensitive to visual effects. The system needs to provide sufficient customization options to meet the needs of different users. The diversity of office environments can also affect the performance of systems. Open and closed offices have different requirements for stress intervention, and system design should be flexible to adapt to various office environments, ensuring effectiveness in different environments. In addition, data privacy issues are also an important factor affecting the effectiveness of the system. Although the system uses non-invasive methods for stress detection, users' concerns about data privacy still exist. Ensuring the security and privacy of data is key to improving user trust and system effectiveness.

C. Future Research and Practical Applications

Future research should focus on more diverse stress detection methods and more personalized intervention strategies to meet the needs of different users. Research should focus on how to optimize system performance in various office environments, ensuring its applicability and effectiveness. In terms of practical application, it is recommended that fully considering the individual differences of employees and data privacy issues when introducing similar systems. At the same time, the system design should have flexibility to adapt to different office environments and provide more customization options to enhance employee acceptance and the actual utility of the system.

V. CONCLUSION

The AromaHub system has shown potential in enhancing collective stress awareness and promoting communication among team members. The system effectively helps employees identify and cope with stress levels through real-time feedback through visual and olfactory interventions. However, there is still room for improvement in the stress detection and individual preference for odor in the system. Future research should focus on optimizing these aspects, exploring more non-invasive methods, and providing personalized interventions for different office environments. In practical applications, priority should be given to user privacy and system customization to ensure the acceptance and effectiveness of the system in managing workplace stress.

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