

WHISPA: A Step Towards Proactive Collective Stress Management

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ABSTRACT

The influence of collective stress is frequently observed in participants engaged in group meetings. This can be beneficial, energizing group dynamics and fostering engagement. However, it can also hinder meeting efficiency. Beyond raising awareness of collective stress, there is a need for contextualized methods that guide participants towards meaningful change with a positive impact on the meeting process. The goal of the project is to subtly encourage participants to proactively respond to collective stress through behavioral change, making meetings more effective and comfortable for everyone involved.

The design features a soft silicone surface embedded with air channels, layered beneath a transparent acrylic tabletop. When collective stress rises, the silicone inflates, forming soothing patterns and gently lifting the tabletop. Users can press the table to release air, intuitively relieving stress through interaction. If no action is taken, the table gradually rises after ten minutes, prompting a shift to a stand-up meeting to refresh group dynamics. This intervention offers strategies for understanding and coping with collective stress, impacting participants psychologically, physically, and the group dynamic while meeting.

Keywords

Collective stress, meeting environments, shape-changing interfaces, group dynamics, workplace intervention

1. INTRODUCTION

Within the context of the workplace, people usually encounter different types of stressors and are aware of their individual stress responses, while they may be less aware of the collective stress experienced by their team, which refers to the stress experienced by a group or organization and the collective coping responses to stressors (Lansisalmi et al., 2000a) These collective stressors can emerge from external pressures such as environmental changes and organizational demands, as well as internal factors including undervaluation of employees and reputational issues within a group (Staff, 1966). Research has shown that collective stress can impact group dynamics and potentially lead to decreased productivity and overall well-being of the working group (Festinger, 1954).

Compared to individual stress, collective stress is more challenging to detect, and there are less widely utilized solutions in real-world applications. The individual stress state can often be identified through clear physiological indicators such as changes in heart rate variability (HRV), along with increases in heart rate and blood pressure. Well-known intervention methods for individual stress include practices such as meditation, yoga, and physical exercise. When it comes to collective stress examination, researchers employ two primary methodological approaches: the individual aggregation approach, which integrates and analyzes physiological data collected from multiple individuals, and the emergent collective approach, which examines group factors such

as group sound patterns. For instance, in the study by (Bao et al., 2023), HRV was used as one of the indicators for observing collective stress, combined with scales to assess changes in collective stress levels. When it comes to coping strategies for collective stress, positive interventions in real-world applications remain to be further explored. One psychology study discusses learned uniform responses to stressors as a form of collective coping mechanism (Lansisalmi et al., 2000b), while in HCI, researchers explore visual approaches to raise awareness and assist individuals or groups in managing collective stress.

Given the diversity of workplace contexts, interventions for collective stress can be tailored to specific scenarios to influence existing workflows seamlessly and positively. Research has shown that effective collective coping strategies can enhance group cohesion and facilitate social comparison (Morris et al., 1976). What is intriguing is that meeting scenarios demand close collaboration, focused attention, and active participation from all group members, making collective stress intervention especially challenging. Studies suggest that team building and individual communication skills should be prioritized over organizational-level variables when attempting to reduce work stress (Smeltzer, 1987). Also, when communication networks also in turn affect the stress levels of other participants (Kalish et al., 2015). These findings show the potential of research on group dynamics and collective stress in related areas.

This research explores how interactive interventions can be used to encourage proactive responses to collective stress in meeting contexts, to improve group engagement and meeting efficiency. Based on this, Whispa, an innovative meeting table design that introduces a new framework for interaction with a shape-changing table surface, is developed. The table incorporates an inflatable silicone layer, combined with a transparent acrylic top layer. When collective stress levels rise during meetings, the silicone layer inflates to create soothing patterns while gently elevating the tabletop. Users are encouraged to release tension by pressing on the surface and making it deflate. If collective stress continues to increase and users have not taken action, the table gradually rises, suggesting a transition to a standing meeting to refresh group dynamics. Initial feedback indicates that this design has the potential in positively influencing group dynamics during meetings, while offering more opportunities for further iteration and implementation.

2. RELATED WORK

2.1 Methods for Alleviating Stress

Prior research has explored various approaches to stress management in social and group settings, focusing on communication-based interventions and technological solutions to share or alleviate stress in society. Studies have investigated both direct conversational approaches and computer-mediated communication systems for addressing stress-related challenges.

For instance, the potential of socially assistive robots in alleviating stress and anxiety is demonstrated in (Abbas et al., 2020), and a useful safety mechanism that helps individuals allocate attention to process new information and challenge negative beliefs that sustain social anxiety is been explored (Markovitzky et al., 2012). In addressing collective stress specifically, examples include the BallBounce system, a workplace biofeedback tool (Nkem & Xue, 2023) and approaches that transform collective stress into entertaining social stress-relieving behaviors (Bao et al., 2023).

In meeting scenarios, there remains a gap in how to support groups experiencing collective stress through explicit or implicit communication while maintaining meeting productivity. Compared to natural language-based communication for influencing people, shape-changing interfaces offer unique potential for dynamic affordances that can naturally guide behavioral changes (Rasmussen et al., 2012).

Additionally, research by Rodríguez et al. (2019) suggests that collective problem-focused coping strategies may be more effective in reducing employees' stress appraisal and organizational stress climate than individual or co-active problem-focused coping. This indicates that group-level interventions may be particularly well-suited for meeting scenarios, though their effectiveness requires further investigation.

2.2 Research on Enhancing Meeting Efficiency

Research on meeting efficiency has also explored various design interventions. Bachour et al. (2010) developed a shared display embedded in an interactive table to indicate participants' levels of involvement. Body posture also plays a role in influencing individual and group dynamics during meetings. Research by Nair et al. (2015) found that participants who maintained an upright sitting posture experienced less anxiety and expressed fewer negative emotions compared to those with a slumped posture. An upright posture was associated with higher self-esteem, improved mood and reduced negative emotions, even during stressful tasks.

Research on meeting formats has shown that stand-up meetings can enhance information sharing and problem-solving, especially in agile projects (Stray et al., 2016). Another study shows that while sit-down meetings are 34% longer than stand-up meetings, they do not produce better decisions or higher satisfaction (Bluedorn et al., 1999).

These findings suggest opportunities for interventions that subtly guide postural changes during meetings when collective stress levels are elevated. Such interventions could help influence group dynamics or enhance the overall meeting atmosphere.

3. DESIGN PROCESS

The initial design concept involves an agent that can deliver supportive information to participants in the meeting when the collective stress level increases. It should positively affect the group dynamics of the meeting and encourage proactive action to collective stress after raising awareness. The challenges lie in figuring out the appropriate type of information to provide, the intervention mechanism, the form of delivery, and the interaction prototype, while ensuring alignment between user needs and design objectives in the specific meeting context.

Thus, a workshop was set up to explore the requirements for collective stress management and gather group perspectives on implementing such a system in meeting scenarios. The workshop

structure emphasized group collaboration and discussion to reach collective insights, ensuring the resulting design would address group-level needs rather than individual preferences.

3.1 Workshop Settings

The workshop was designed within the context of a creative collaboration session, framed around a concrete scenario as an educational group work setting. The subsequent design concept will be developed according to the requirements identified from this context, while also considering the potential for a broader application in various collaboration contexts that share similar collective stress conditions.

The expected outcomes include the user needs and requirements for stress management in group settings, preferred types and formats of supportive information, and design properties that facilitate effective interpretation of the information when encouraging proactive responses to collective stress, ensuring the information is easily understood and actionable in the context.

Participants

The session included three groups, each consisting of three participants who were familiar with each other. This group composition was chosen to ensure a natural interaction and group dynamic among the group in the workshop, which can positively influence how the requirements are perceived and the consensus is reached. The group size is kept small at three members to maintain the balance between ease of communication in the workshop and the ability to observe group dynamics and experiences, while also reflecting the typical group structure commonly seen in educational settings at the university. All participants in the workshop are students from Tu/e.

Materials provided

To guide participants discussing and reflecting on specific issues within a clear and feasible framework, there are three core materials provided in the workshop: the category cards of information, the design property cards, and three collaboration boards.



Figure 1 The category cards of information

Each participant is provided with a set of category cards (Figure 1) explaining three different types of information that the agent may

deliver. Each card explains the information in the meeting context, with examples on the card back, making the concepts easier to understand and envision. Participants can keep these cards throughout the workshop and refer to them as required during discussions and activities.

These three categories of information reflect the level of autonomy that participants expect the agent to have in addressing potential issues related to collective stress during the meeting. The classification is inspired by the Levels of Digital Twin Framework (Agrawal et al., 2023), which makes categorizations with digital twin agents, and has been adapted with slight adjustments in terminology and grouping to align with the context of the workshop. These cards are designed to explore how much influence users are willing to accept from information about collective stress during meetings and to stimulate participants' thinking during the semi-structured interviews.

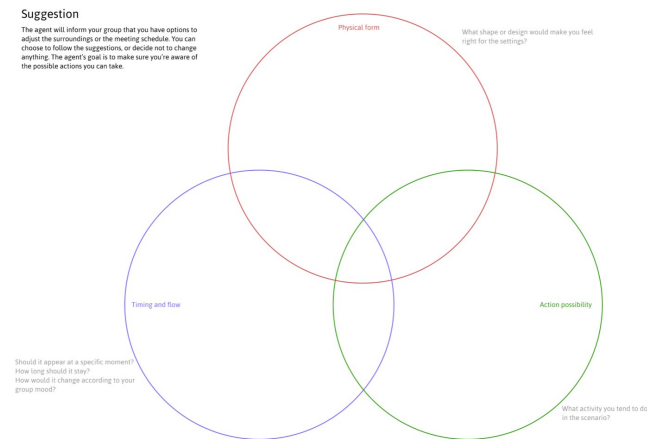


Figure 2 One of the three collaboration boards, suggestion edition

To provide a clearer and theoretically grounded approach for understanding the interactions users will consider appropriate in the meeting context, an interaction design framework (Figure 2) was introduced, in which terminology was slightly simplified to help the participants think within this existing framework. The framework originated from the illustration of the three form elements of interaction design (Vallgård, 2014). In the workshop, this allowed participants to focus on specific aspects, such as interaction form, material or shape characteristics, and dynamic changes, while considering both interaction and the conveyance of information.

Each group in the workshop had a set of three collaboration boards, which participants used to explore their perceptions of the three types of information.

Rigid It is stable and unband. 	Soft It has a fluid shape. 	Instant Quickly show up then disappear. The meeting The 'thing' 	Apparent-Covered Its appearance and disappearance both convey a message. 	Interaction capacity individual (s) group
Pure color It more suitable than the colorful one. 	Colorful It more suitable than the pure color one. 	Seamless flow All the things that happened previously can be seen. 	Real time response It reacts quickly response action 	Body movements change sitting position stand up for a while walk around
Attention-grabbing Everyone will notice. 	Not eye-catching It's subtle, easily overlooked. 	Gentle-Powerful The way it gives feelings to people is telling something. 	Long term be here, always. The meeting The 'thing' 	
Transparent-Solid Its changing optical properties reveal more, even in ordinary objects. 	Standalone items It could be ... table and chairs items in the room or something more	Immersive and Surrounding It could be part of... the wall the door the floor	Hand-based interaction subtle action such as moving fingers playing around with full hand gestures	

Figure 3 The design property cards

Building on previous research in interaction design and semantic categorization frameworks (Dassen & Bruns Alonso, 2017), terms relevant to the workshop context were selected, categorized, and interpreted to create prompt cards (Figure 3). These cards are not meant to constrain participants to the options presented, but instead serve as references and sources of inspiration, helping participants avoid confusion or uncertainty when engaging with the theoretical framework. Participants are free to either work within the content of the cards provided or to extend their thinking beyond it. In the workshop, ten copies of each card were placed at the center of the table, allowing participants to access and review them as needed.

Semi-structured interview

At the end of the workshop, a semi-structured interview is conducted to gain deeper insights into participants' choices and reflections. It also helps to gather further insight into the challenges and needs participants will have in similar situations in their daily lives. The questions are as follows:

1. What type of information do you prefer in the scenario?
2. Do you think the type of work, or the type of meeting will affect your choice?
3. How do you think this type of information helps you in this scenario?
4. Do you think that there will be differences when the information is delivered to the individuals or to the group? For example, you get a notification on your mobile phone or you have a shared screen and you all see the information on it?
5. Would you prefer to engage in the coping process together, through social activities, rather than through individual activities?
6. Would you like to use this type of technology/information to manage collective stress?

7. What do you usually do in your previous group work when you want to cope with the collective stress of the group?

Settings

In addition to the core materials mentioned above, a storyboard was provided to illustrate a scenario where collective stress was rising and affecting the efficiency of the group. Participants were also given sticky notes to write down reflections related to the card content or their own ideas, which they could then place on the appropriate areas of the collaboration boards (Figure 4).



Figure 4 Workshop settings

Procedure

The workshop took place in a meeting room with a round table setup. Each session lasted about one hour.

The session began with the organizer presenting the storyboards, explaining the meeting atmosphere depicted and the specific signs of collective stress experienced by the individuals in the storyboards. At the same time, the definition of the design was introduced, including an agent that would detect increasing collective stress in a group and provide information to raise the awareness of participants or change the situation. After the background information, participants were given five minutes to read the category cards in hand and ask questions.

In the collaboration phase, the three collaboration boards were displayed one by one in the order of presentation, suggestion, and intervention. Participants had ten to fifteen minutes to collaborate and discuss on each board, placing the design property cards they felt fit the vision on the boards and sharing their reasoning. Participants were encouraged to make notes or sketches on the cards and use sticky notes for additional ideas. After all three collaboration boards were completed, user interviews were conducted.

3.2 Analysis and Key Insights

The affinity mapping approach (Figure 5) was selected to analyze the large volume of qualitative data gathered during the workshop, including participants' selected cards, written ideas and reflections, and the interviews.

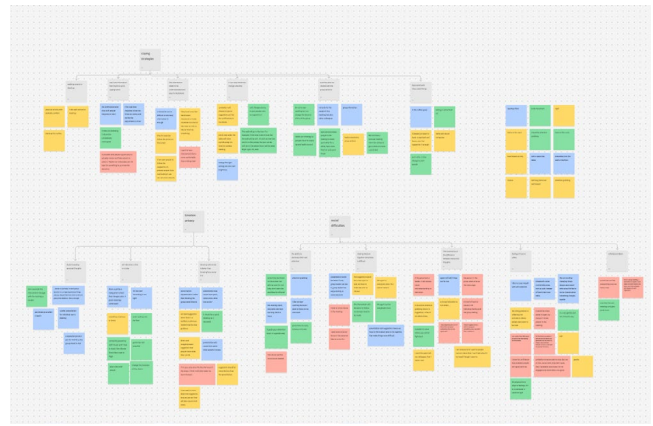


Figure 5 The affinity mapping process

By listing and categorizing a large amount of the data or ideas, finding patterns, themes, or relationships, and giving labels and reviews, the insights from the workshop were found as follows (Table 1).

Category	Details
Identification of Users' Preferred Information Types	Information should be clear and easy to implement.
	It should encourage behavior change naturally.
	Real-time information that prompts quick coping actions.
	Avoid disclosing personal thoughts.
	Providing indications, hints, or light jokes.
Coping Strategies	It's more helpful to know what to do rather than just how bad things are.
	Activities that promote positive group dynamics.
	Activities related to stress relief.
Pain Points & Requirements	Actions like walking or standing up.
	The ability to focus and control their attention.
	Collaborative decision-making can sometimes be challenging.
	Uncertainty about differences in people's thoughts.
	A need for trust and a sense of safety.
	Issues with scheduling and time management.

Table 1 Categorized insights list

The results of the study indicate that participants have a clear preference for interventions that are proactive and provide intuitive guidance. These interventions should be straightforward and closely linked to familiar stress-relief activities. It is suggested that these strategies will help guide users toward meaningful behavior changes that improve meeting dynamics. Participants also reach consensus on the need to reduce uncertainty about how to suggest a quick break or end the meeting, while maintaining focus and efficiency. These insights will inform the subsequent design.

4. IMPLEMENTATION

4.1 Design Concept

Whispa is an interactive tabletop design consisting of a silicone layer with air channels, covered by a transparent acrylic sheet. The design aims to raise awareness of collective stress at the early stages and improve group dynamics during meetings by encouraging collective and subconscious interactions.

When the silicone layer is inflated, it creates a soothing pattern on the tabletop and lifts the surface slightly. Users can engage by pressing on the tabletop, relieving stress through the tactile interaction and the sound of air being released. If collective stress continues to rise and there is no interaction between the users and Whispa, the silicone layer inflates again, and the tabletop's height increases to guide participants into a standing meeting. This offers participants an opportunity to move, change posture, or see it as a moment to propose new perspectives while refreshing the group dynamics.

To illustrate the interaction flow more clearly, the following storyboard is provided (Figure 6).



Figure 6 The storyboard

4.2 Prototype Implementation

The idea for the inflatable silicone layer was inspired by common stress-relief materials, such as slime, which provide tactile and interactive ways to alleviate stress. When implementing the design, silicone was chosen due to its widespread use, versatility, and properties similar to stress-relief materials.



Figure 7 Silicone layer fabrication process

Given the size constraints, cut acrylic sheets are glued together to form the mold (Figure 7). A one-centimeter-thick layer of silicone compound was poured into the mold. Once the first layer was partially cured, a thin plastic film was placed on top to form the air channels, ensuring the film was spread evenly to prevent potential air leakage. A second layer of silicone liquid was then poured over the plastic film to fully enclose it. After the silicone had solidified, the mold was removed.

During the prototyping process, alternative methods were also explored. For instance, air channels could be created using a mold release spray applied to the first layer. This approach required the first silicone layer to fully cure before application.

Each of the methods mentioned above presented its own challenges and none turned out to be an ideal solution. However, these attempts were important steps in the process of refining the prototype.

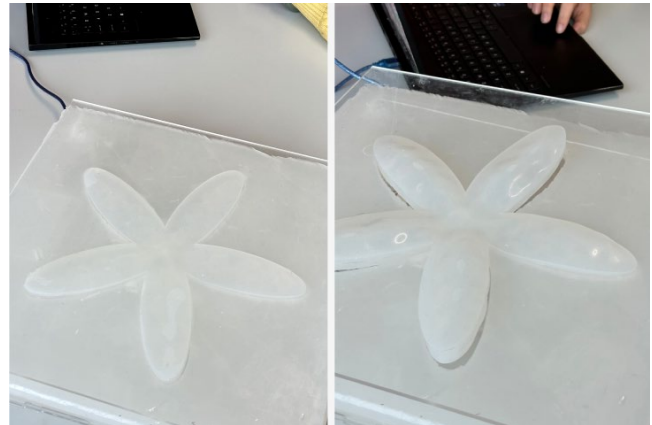


Figure 8 Comparison of the functional prototype. The left image shows the prototype in a deflated state, while the right image shows the prototype after inflation

The inflation and deflation of the silicone (Figure 8) are controlled by an Arduino air pump, with manual input signals from the serial monitor simulating detected collective stress.

5. FEEDBACK SESSION

5.1 Setup and Procedure

A feedback session was conducted to explore the impact of the current prototype on the group dynamic and awareness of the collective stress during the meeting, and to gather insights for further development.

During the session, the prototype was placed at the center of the tabletop, with participants seated around it. They were assigned specific arguments and asked to discuss a given topic within a set time frame. The stress stimuli are inspired by the TSST (Trier Social Stress Test)(von Dawans et al., 2011). This setup was designed to simulate the intended meeting scenario in the design concept.

Due to the prototype's current limitations, such as its size not covering the entire tabletop, participants were instructed to keep their hands in contact with its surface while meeting. This was intended to mimic the natural behavior of resting hands casually on the table.

During the session, the silicone layer of the prototype was inflated twice, corresponding to Stage B and Stage D. At Stage B, the silicone was inflated slightly, signaling the detection of a rise in collective stress levels. At Stage D, the silicone was inflated again

to the same level as in Stage B, and the entire tabletop was lifted using a manual adjustment of the height-adjustable table, representing a continued rise in collective stress. During this process, the group dynamics were observed. At the end of the session, participants completed a questionnaire and answered several interview questions. The questionnaire is designed based on State Tait Anxiety Inventory (Elwood et al., 2012). Irrelevant questions within these methods will be removed, and some questions will be adjusted based on the specific context.

5.2 Participant

The group setting was similar to the settings for the workshop. A total of three groups were tested, each consisting of three participants who were familiar with each other. Additionally, all participants in this feedback session had prior experience with group collaboration and were students from TU/e.

5.3 Questionnaire Findings

Based on the questionnaire results, participants reported a noticeable increase in their awareness of collective stress after using the prototype. They also felt that the meeting was somewhat more organized, and their confidence or willingness to propose new ideas improved slightly (Figure 9).

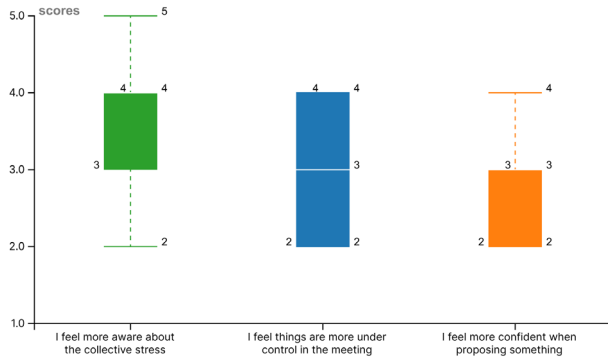


Figure 9 Questionnaire results on overall prototype interaction

In the first interaction phase, Stage B, 7 out of 9 participants chose to interact with the prototype. After the interaction, participants generally felt more pleasant and at ease. They also recognized a noticeable improvement in group dynamics, which became more active and positive. However, there was still some mild confusion and hesitation during the subsequent meeting discussions (Figure 10).

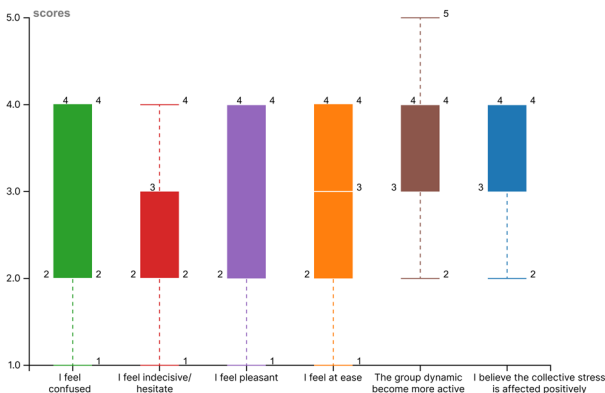


Figure 10 Questionnaire results for stage B experience

In the second interaction phase, Stage D, all 9 participants chose to interact with the prototype. Similarly, they experienced a positive emotion when interacting and recognized the positive impact on collective stress. At this stage, the levels of confusion and hesitation among participants were slightly lower compared to the first interaction phase (Figure 11).

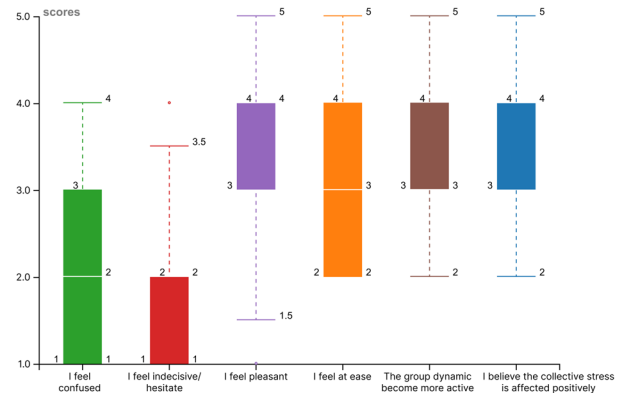


Figure 11 Questionnaire results for stage D experience

Finally, since this feedback session focused primarily on qualitative aspects and involved a limited number of participants, the quantitative results presented should be viewed as indicative rather than conclusive.

5.4 Combined feedback

Based on observations and feedback collected through interviews, the findings are summarized as follows:

Interpretation of the prototype's shape-changing information

Participants generally interpreted the prototype's shape changes as a positive signal. During less active moments in the meeting, the prototype encouraged participants to re-engage in the discussion by interacting. In more intense situations, it acted as a reminder for social manners. For example, P2 remarked, "It responded at the exact moment we all fell silent, so I felt it was reminding us to talk more." Another group agreed that the dynamic response of the prototype encouraged them to reflect on their communication strategies, particularly struggling to convince others. P9 suggested that the prototype could also convey positive messages, such as through warm light or regular movements, to alleviate collective stress and encourage a calmer atmosphere.

Impact on meeting workflow

Participants noted that the prototype promoted collaboration rather than disrupting or pausing the workflow. Although group members spent time interacting with the prototype, the overall meeting workflow appeared to become more positive. One group agreed that during prolonged meetings, participants often became distracted and silent, which increased hesitation and communication gaps. The interaction with the prototype helped them to concentrate. Some participants felt that the interaction did not interfere with the workflow since the prototype remained outside their central field of view and did not demand excessive attention. As P4 explained, "The feeling you get is quite long-lasting, but not too strong."

However, participants also pointed out challenges. The noise generated during inflation could be disturbing. Also, the time taken for the silicon to deflate after being pressed needed to align with user expectations. If it was too long, it caused slight

confusion, while if too short, it felt disappointing. As P7 noted, “I like to feel the elasticity when I press it, and this helps ease the stress better.”

Influence on group dynamics

During the meetings, the interaction with the prototype slightly shifted the direction of the discussion or brought participants back to the original topic, helping address potential collective stress. P5 noted that the prototype’s inflation increased awareness of others’ emotion state, encouraging them to listen more attentively and respond to others’ opinions. The design also created a sense of ritual, making participants more focused and engaged with the meeting content.

For stage D, some participants found the encouragement to stand up was clear and this made expressing ideas easier. P4 noted, “I just felt more confident standing up, it was like my mindset shifted automatically.” It was also mentioned that increasing the height of the table had a greater impact on group dynamics, as it required more physical movement. P3 noted feeling less pressure during this stage because the raised tabletop provided a sense of being shielded, enhancing feelings of safety. However, one group mentioned that the tabletop did not rise high enough to encourage standing, which limited its effectiveness in that phase.

Willingness to interact with the prototype

Most participants showed willingness to interact with the prototype and described it as subconscious and natural. Two participants mentioned that during regular meetings, they often leaned on the table or engaged in small tactile actions to relieve stress, making this type of interaction feel intuitive. P5 shared, “When I’m arguing with someone, I naturally press on the table to calm myself, and this prototype happens to be there.”

Participants also agreed that their willingness to interact with the prototype was influenced by others in the group. When others engaged with the prototype, they were more likely to follow, aiming to fit in with the group behavior.

Improvements to enhance the interaction experience were suggested. Four participants noted that the current prototype did not allow users to feel the tactile sensation of the silicone layer during interaction. P1 proposed adding soft lighting effects to make the prototype more attention-grabbing and to provide clearer feedback during interactions. Two participants recommended adding visible cues to guide users to press on the prototype, such as engraved hand shapes on the underside of the acrylic layer. Finally, two participants noted that during the later stage of interaction, the inflation effect of the prototype was less noticeable because the tabletop height adjustment drew more attention.

6. DISCUSSION AND LIMITATION

From the feedback, it is indicated that the current prototype and interaction flow have a positive impact on the group dynamics of teams experiencing collective stress. The design enhances user participation during meetings, raises awareness of collective stress, and encourages intuitive, proactive responses without disrupting the workflow. However, there are still aspects of the prototype and interaction framework that require refinement.

Prototype implementation

The prototype is still in its early phase, leaving room for improvement in both structural design and the technical components that support the interaction. Some user confusion was

linked to unresolved details, such as operational noise, varying tactile feedback caused by differences in silicone flexibility and inflation levels, and the coordination between the prototype and the adjustable desk. Addressing these challenges would improve the overall user experience and functionality.

Factors influencing the user experience and refining the interaction framework

Several factors were mentioned by users as potential influences on their experience when interacting with the prototype, including the timing of silicone inflation, the response latency, the prototype’s stability, and the tactile feedback it provides. The feedback has revealed the need for a more precise and well-defined interaction framework. For example, considerations should include how long the silicone layer should remain inflated after an initial interaction, the duration of user interaction with the desk to avoid interrupting the workflow, and how these variables affect user perception. This requires further research and close collaboration with users to build clear interaction guidelines.

The study also revealed the complex relationship between group dynamics and prototype interaction. While in the feedback sessions, it is primarily observed that individual interaction with the prototype encouraged collective participation, further research is needed to explore how interaction patterns and group dynamics mutually influence each other throughout the meeting process.

Expert feedback and real-life application

Apart from further user testing, obtaining feedback from relevant experts would help assess the feasibility and practicality of applying this design in a real-life setting. The current research and feedback sessions lack input from such stakeholders, which could be a valuable addition to future iterations of the project.

7. CONCLUSIONS

In this project, Whispa, which features a soft silicone surface embedded with air channels beneath a transparent acrylic tabletop, was designed to help participants in educational meetings aware of collective stress and take proactive actions to address it. Though the design shows potential value, further iterations and a more thorough evaluation are needed in the future.

The project included workshops to explore user needs and design insights. After the prototype was implemented, a feedback session was conducted to gather user feedback on the interaction flow. The potential directions for future development have been discussed.

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