

Master Thesis

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AmbientTeams

Staying socially connected in remote knowledge
working teams

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Abstract

With the shift towards remote work, casual, informal conversations are no longer guaranteed to happen because of the lacking serendipity. Such informal discussions are further challenged because of missing cues from co-workers about their availability or social states. In addition, despite increased challenges with mental health, tools focusing on the social challenges of remote work are still lacking. For this reason, we developed AmbientTeams, a casual and informal tool that attempts to reduce the perceived distance in remote work by creating opportunities for more informal interactions. AmbientTeams attempts to achieve this by sharing moods and status messages with the team, or more generally, fostering informal communication among team members. We evaluated our research prototype on a group of 6 knowledge workers who agreed on using AmbientTeams for one workweek.

Zusammenfassung

Mit der Verschiebung in Richtung Fernarbeit sind zwanglose, informelle Gespräche aufgrund der fehlenden zufälligen Zusammentreffen nicht mehr garantiert. Solche informellen Gespräche werden außerdem durch fehlende Hinweise von Kollegen über ihre Verfügbarkeit oder ihren sozialen Status erschwert. Darüber hinaus gibt es trotz der zunehmenden Herausforderungen im Bereich der psychischen Gesundheit immer noch keine Tools, die sich auf die sozialen Herausforderungen der Fernarbeit konzentrieren. Aus diesem Grund haben wir AmbientTeams entwickelt, ein zwangloses und informelles Tool, das versucht, die wahrgenommene Distanz bei der Fernarbeit zu verringern, indem es Möglichkeiten für informellere Interaktionen schafft. AmbientTeams versuchte dies zu erreichen, indem es die Möglichkeit schafft, Stimmungen und Statusmeldungen mit dem Team zu teilen, oder allgemeiner gesagt, die informelle Kommunikation zwischen den Teammitgliedern fördert. Wir evaluierten unseren Forschungsprototyp an einer Gruppe von 6 Wissensarbeitern, die sich bereit erklärten, AmbientTeams eine Arbeitswoche lang zu nutzen.

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Introduction

Software development has become increasingly distributed in recent years [HM01]. This development is caused by globalization trends [Her07] and the increasing popularity of working from home [Eco21]. Reasons for increasing work from home include a more flexible schedule, increased work productivity, and spending less time and money on commuting [Flo19; Mul+09]. Additionally, the increased flexibility and autonomy allows employees to more easily manage their family responsibilities and leads to higher job satisfaction and employee retention [Mul+09; GH07; Mad11].

However, global software development brings challenges; namely, coordination and collaboration in a remote setting become significantly more difficult [Her07]. This is because communication, especially informal communication, is hampered [SCS06; Her07; HM05], and the group awareness required for successful coordination and collaboration is lacking [Her07; GPS04].

Through these difficulties, spontaneous, more informal communication is more difficult in remote work, resulting in reduced spontaneous communication [KEG88; SCS06; Her07; HM05]. This is not desirable because such spontaneous communication, such as “corridor talk” or “watercooler talk” can help news spread more quickly among teams [Her+00], or reduce coordination problems [HG99] by gathering important background information that enables more effective teamwork [Lan07; HM01]. Common problems related to communication are that remote team productivity is further reduced by technical problems encountered in computer-mediated communication [SCS06]. Furthermore, the richness of communication is drastically reduced because written text is the most common communication medium used by remote software developers [GPS04]. Text-based communication, however, does not have equal ability to convey rich information, resulting in, among other things, limited ability to convey emotional information [Hö08].

The lack of social interactions can lead to other interpersonal problems. Examples include difficulties in building trust, maintaining working relationships, or leading to not feeling connected to the team [Com+20; OO06]. Furthermore, a lack of social and emotional interactions can lead to workplace isolation [MMM07; Gor20; Mul+09].

There is a large body of existing research focused on improving these coordination and communication challenges. This is usually done with task/coding-related awareness tools ([Bie+07; Jak+09]) or tools that primarily promote spontaneous communication through virtual offices ([Sas99; Lou+12]). Another concept aimed at promoting informal communication is microblogging in the workplace (e.g. [ES08; ES10; Zha+10; Dul+13]). Since there seems to be evidence that software developers can find all the information they need to do their jobs even without task- or work-object-oriented approaches [GPS04], our approach builds primarily on existing microblogging approaches. Specifically, our approach builds upon the core idea of WeHomer [Dul+13], which was the first to extend a micro-blogging approach with sentiment sharing. The motivation

for sharing moods comes from García, Favela, and Machorro [GFM99], who argued that when you are aware of the emotional state of your employees and act accordingly, you get better results from collaborative work. We argue that such solutions focusing on Emotional Awareness are underrepresented by recent research. To make this point stronger, worrying figures relating to workers' well-being and mental health, stating that the pandemic has led to an increase in stress in 65.9% of people 44.4% report a decrease in mental health. As a result, AmbientTeams is a "people first" approach to sharing mood and status to provide important informal and social awareness information with the goal of reduced feelings of isolation when working remotely by encouraging more informal exchanges with team members. By reducing feelings of isolation in the workplace, we could improve individual well-being and the entire team's performance. This is because strong team cohesion has been shown to positively impact team effectiveness and productivity [Car+17], and feeling disconnected from colleagues has been shown to decrease engagement in productive tasks [Eco20].

AmbientTeams differs from existing micro-blogging solutions in that it is more mood-oriented and minimalist in its functionality and design than WeHomer. This is due to the person-centered approach that AmbientTeams takes: The content of the textual information is not put in the foreground but is meant to complement the shared moods, visualized in avatars that are at the center of AmbientTeams. In terms of its appearance, AmbientTeams takes an unobtrusive and minimal approach, unlike existing virtual office approaches - hence the "ambient" in its name. Despite the goal of unobtrusiveness, AmbientTeams offers video conferencing built into the application. Our research aims to discover how AmbientTeams is being used, what knowledge workers are sharing, and the broader implications of such an approach. Thus, the research questions we sought to answer are:

Information Sharing

RQ1: Is there a need for sharing moods/states with team members, and what are the reasons?

RQ2: What are knowledge workers willing to share with their team?

Impacts

RQ3: What are the effects of Ambient Teams?

RQ3.1: Do mood and state sharing increase the awareness between team members, and how? What do they learn from each other?

RQ3.2: Does it make users feel better to share information with their team?

RQ3.3: Does it stress/relax users to see more about their team?

RQ3.4: Does AmbientTeams reduce the feeling of isolation in remote knowledge work teams?

Tool usage and workflows

RQ4: How do knowledge workers use and interact with AmbientTeams? How do they integrate it into existing workflows?

To answer those questions, a small preliminary evaluation with five knowledge workers was conducted, who used AmbientTeams over a period of one week. Our participants confirmed the importance of being aware of their co-workers' moods, something that was also found by García, Favela, and Machorro [GFM99] and Dullemond et al. [Dul+13] and which fundamentally motivated our approach. As a consequence, the mood-sharing functionality was the most popular feature among participants. Regarding the broader effects of AmbientTeams, we found that it 1) helped knowledge workers be aware of each other's moods and availability status, 2) got to know each other better, 3) enabled (non-work-related) communication outside of AmbientTeams, and 4) spurred self-reflection on one's moods. To summarize, the main contributions of this work include

1. Development of a mood-sharing approach that allows moods to be shared with the team with minimal effort
2. Insights into the mood and status sharing behaviors within knowledge work teams and the impact such sharing can have on personal relationships, workplace isolation, or collaboration
3. Provision and initial testing of a study design that can be used for a more comprehensive study, along with suggestions for future features that resulted

Related Work

Remote work offers numerous benefits for both the employee and employer compared to traditional co-located work. Benefits on the employee side include a more flexible schedule, higher job productivity, and less time and money spent commuting [Flo19; Mul+09]. The increased flexibility and autonomy allows employees to more easily deal with their family responsibility and leads to higher levels of job satisfaction and higher employee retention [Mul+09; GH07; Mad11], both highly beneficial for the employer. The employer can further profit from savings in real estate costs and increased productivity [Mul+09]. In addition to those general benefits, there is another popular reason for building distributed teams: the possibility to build teams with talents from all over the world [Car99].

However, remote work creates new challenges for the company and its employees. Therefore, it is not surprising that much research has been done in this area, most of which coming from Computer-Supported Collaborative Work (CSCW). The general goal of existing solutions is to support distributed teams in accomplishing work as effectively and efficiently as possible. While a lot of research goes into collaboration and coordination challenges in remote work, the goal of AmbientTeams is fostering social, informal interactions. As a result of our research effort, we identified four main social challenges that result from working, namely the feeling of workplace isolation, reduced informal communication, missing awareness, and reduced well-being. Together with existing solutions aiming at solving those problems, those four challenges are discussed in the subsequent sections.

2.1 Workplace Isolation

Marshall, Michaels, and Mulki define workplace isolation as the “psychological construct that describes employees’ perceptions of isolation from the organization and from co-workers. Isolation perceptions are formed by the absence of support from co-workers and supervisors and the lack of opportunities for social and emotional interactions with the team” [MMM07, p. 198]. They further suggest a categorization into social isolation and organizational isolation. Organizational isolation stems from the perception that remote workers might feel “out of sight, out of mind” [BK99], which is related to a lack of awareness, which is discussed in ???. Social isolation relates to the fact that remote workers miss informal chats, spontaneous discussions, and meetings around the water cooler [CK02]. For those reasons, a closer look at communication and, more specifically, informal communication will be given in the following section.

2.2 Communication

Research in the field of software development states that co-workers are the most used source of information used by developers [KDV07], emphasizing the importance of team communication inside software development teams. When shifting from traditional, co-located work to remote work, studies find different results regarding the communication frequency. While Kraut, Egidio, and Galegher [KEG88] and Allen et al. [All+84] find a decrease in communication, Mulki et al. [Mul+09] find increased communication in a remote setting. A possible reason for more communication includes the need for remote workers to over-communicate their availability status to their co-workers [KSO12]. Reasons for communication reduction could be the active effort required to bring back ad-hoc meetings [Mil+21], or the lack of the required awareness to initiate a conversation. Regardless of communication frequency, working remotely and thus using software to communicate leads to having more misunderstandings due to missing cues, leading to more misunderstanding and thus reducing communication effectiveness [Mul+09]. This is because text-based communication (which is often used in software development) has very limited capacity, and thus a lot of socio-emotional information is lost [Has+17]. This likely is a reason why face-to-face communication is still very important for many developers [Sto+16] and a lack thereof, which is caused by working remotely, can lead to workplace isolation, making it harder to develop personal relationships and build trust [Mul+09]. Gajendran and Harrison [GH07] state that working from home with high-intensity (more than 2.5 days a week) harmed relationships between co-workers, something that is enforced because of the Covid-19 pandemic. Since informal communication helps developing work relationships [Com+20; OO06], it is of special importance in distributed teams.

2.2.1 Informal Communication

Kraut et al. define informal communication as “communication that is spontaneous, interactive and rich” [Kra+, p. 5]. Differences to formal communication include lack of planning and the fact that the content of the communication is unknown in advance. Kraut et al. [Kra+] further state that over 85% of all conversations are informal, and that informal communication happens more often if there is a short physical distance between parties. Similarly, Hinds and Mortensen [HM05] find that members of distributed teams engage less in informal conversations. This reduction of informal communication is unfortunate since informal communication is crucial for achieving high productivity and social goals [Kra+] such as developing work relationships [Com+20; OO06]. More concretely, in the field of software development, informal communication plays a critical role due to the fast speed at which informal communication distributes knowledge across a team or company [FL98; MH01]. Also, informal communication can increase awareness, enabling developers to work efficiently [HM01]. In the ever-changing field of agile software development, this is particularly useful because requirements can change, and formal communication channels cannot spread the news as fast. Besides, informal communication is essential for conflict identification and handling [HM05]. The fact that teams with a high degree of social interactions often have better team cohesion [SCS14], and informal communication is normally much more frequent than formal forms of communication [Kra+], further pronounces the importance of informal communication.

Because of those benefits, it is no surprise that numerous approaches are fostering informal communication inside distributed teams. One of the earliest proposed solutions for promoting informal communication in distributed teams was VideoWindow [FKC90]. Despite being an early solution, the authors already identified two essential requirements such a system must offer: low personal cost and the need for a visual channel. If the cost for initiating conversations are too high, the system will not be helpful because the tool will not be used. The visual channel also

plays a vital role by recognizing the presence of other people, indicating whether a conversation can be initiated. Sasaki [Sas99] developed a hallway system that was able to raise awareness and helped to indicate that one might have a question but failed to promote casual interactions. In comparison, Lou et al. [Lou+12] manages to provide awareness information that is relevant to engage in everyday conversations and a low-effort mechanism to initiate such informal discussions. It does so by providing social cues which help understand the availability of others and thus creating a context for subsequent communication.

As a consequence of the global pandemic, many commercial tools have been published recently. Branch¹, Reslash², Wonder³, or Gather⁴ also follow the goal of increasing spontaneous, informal communication by creating virtual offices where users can move around with avatars and interact with others. Tandem⁵ is another tool with a focus on collaboration and takes a less playful approach by being more similar to traditional communication apps user interfaces.

Another form of communication that has been studied extensively is the concept of microblogging. Studies have shown that microblogging is a form of informal communication [ES10] that is “like a virtual coffee machine as a meeting place” [ES08, p. 158]. Further, many existing microblogging approaches have found that microblogging results in people feeling more connected [ES10; Zha+10]. Likewise, their study participants found microblogging very helpful because it allowed them to stay aware of what their team members are doing [Zha+10]. In addition to purely sharing text-based content, which is the standard in microblogging, Dullemond et al. [Dul+13] developed a microblogging system that allows the users to attach a mood to each message which helped the teams feel more connected. What they did not measure, however, is the isolated effect of mood sharing.

Due to the value of providing additional awareness and sharing moods in the workplace, the following two sections focus on those two concepts.

2.3 Awareness

A reason for coordination and communication challenges in a remote work environment is the lack of awareness, so it is of great interest to increase awareness in distributed teams. Literature provides various definitions of awareness [CE07; Gro13; GST05]. Due to the popularity and granularity of the model proposed by Gutwin, Greenberg, and Roseman [GGR96], we decided to use their definition of awareness for this work. Gutwin, Greenberg, and Roseman [GGR96] define group awareness as a combination of:

- **Informal Awareness**

Informal awareness is the general sense of the presence, availability, and activities of others. It is the “glue that facilitates casual interactions” [GGR96, p. 6].

- **Group-Structural Awareness**

“Group-structural awareness involves the knowledge about people’s roles and responsibilities, their positions on an issue, their status, and group processes” [GGR96, p. 6].

- **Social Awareness**

“Social awareness is the information that a person maintains about others in a social or conversational context” [GGR96]. It includes, for example, the attention state of the other person, their emotions, or the level of interest [GGR96, p. 6], or whether a person can be disturbed [GG95].

¹<https://branch.gg>

²<https://reslash.co>

³<https://wonder.me>

⁴<https://gather.town>

⁵<https://tandem.chat/>

- **Workplace Awareness**

Workplace Awareness defines the awareness that results from the real-time combination of elements workers keep track of when working together. Such elements could be people, actions, objects, and many more [GG95].

It is important to note that those four awareness types are not excluding but rather overlapping with each other. Put differently, informal, social, and group-structural awareness are all part of workplace awareness. In the case of software developers, for instance, a study shows that developers checked the availability status of their co-workers almost as many times as their compiler output [KDV07]. This indicates the importance of informal awareness. Providing group-structural awareness is essential because of difficulties when trying to find experts in a distributed team [HM03]. Social awareness is a necessity to initiate and carry on a conversation, and thus very relevant due to the high communication needs of software developers [PSV94]. Additionally, with less face-to-face communication and more computer-mediated communication, it is consequently more difficult to transfer emotional information [RCB96].

To address the problem of missing awareness when working remotely, a wealth of research developed approaches to increase awareness in distributed teams. Popular tools made explicitly for software development teams focus on providing awareness by on work items, developers' activities (e.g., which files they have opened or recently changed) and thus put the code base and tasks in the foreground of coordination [Bie+07; Jak+09; ESS+92; DCR05]. Cheng et al. [Che+03] introduces JazzBand, an IDE plugin visualizing the team members to increase peripheral awareness enhanced with status messages and chat functionality facilitating coordination.

While the majority of the above-mentioned awareness tools require user interactions to be helpful, there have also been attempts for creating ambient approaches to raise awareness in the work environment [MCR20; OMF06; DPH12; AD12; R  c+04]. Downs, Plimmer, and Hosking define ambient devices as devices that "present dynamic information in an at-a-glance manner and have low attentional requirements" [DPH12, p. 508].

2.4 Well-being: Emotions, Moods, and Sentiments

A common finding in research regarding remote work is that employees work longer hours, experience more stress, and have difficulties with mental health [Spa20; Mul+09; Qua20]. A recent study in the context of the global Covid-19 pandemic lists the negative impacts from working from home, such as increased burnout, lack of separation between work and life, and feeling disconnected from co-workers [Spa20]. A Psychological study highlights that the mental health of remote workers should be considered and is very important to be communicated and talked about [GWS13]. Yet, emotions can get lost or misunderstood inside text messages due to the lack of cues in text-based communication [H   +08]. For this reason, Kuwabara et al. [Kuw+02] highlights the need for connectedness-oriented communication, because it is critical for developing social relationships, and harder to do over distance. McDuff et al. [McD+12] further state the usefulness of being able to assess one's emotional state (e.g., when considering mental health issues). Their approach, AffectAura, is developed using different kinds of sensors to predict emotions and provide an overview of them in a diary-like fashion with the purpose of self-reflection [Dul+13]. Guzman and Bruegge [GB13] emphasize the importance of emotion in software development, however focusing on the emotional state towards a project, not of individuals. MobiMood is a mobile application focusing on individuals by letting them share their moods, but not targeting a work environment [CHO10]. Saari et al. [Saa+08] developed another mobile application with mood sharing features aimed at knowledge workers. However, while the researchers developed the prototype, their approach's usability and use cases were not studied.

Different affective responses exist that can be useful for sharing with the team, namely emotions, moods, and sentiments. Emotions are typical reactions to events and therefore have a definite cause and are typically short-lived. Emotions differ from moods in that moods are longer in duration, have no clear target, and are less intense [Fri+94; BN07]. Sentiments can be described as states associated with objects rather than individuals and therefore are relatively permanent [BN07].

When it comes to measuring emotional experiences, the literature does not reach a consensus on the best measurement method. However, the valence-arousal dimensional model is most commonly referred to as the better model [Rus80; MR09]. It is a two-dimensional model where the valence dimension contrasts states of pleasure with states of displeasure (positive vs. negative), and the arousal dimension contrasts states of low arousal with states of high arousal (high vs. low) [MR09]. More concretely, the arousal dimension “describes the degree to which an emotion is associated with high or low energy” [Tse+14, p. 1334]. High arousal thus represents emotions such as surprise or excitement, while low arousal represents states of low activation such as sleepiness. Results of this model can then be used to map onto a discrete set of basic emotions such as surprise, fear, disgust, anger, happiness, or sadness [BN07].

2.5 Ambient, Glanceable Displays

Makes sense?

Approach

While the team awareness gained by existing tools allows knowledge workers to understand who they are working with and what they are working on, and what the impact of a change can have on others, which is essential for successful collaboration [DB92], they only cover a very limited view of awareness by providing very limited social or emotional information. Because of that, we put more emphasis on social, casual information exchanges to help remote teams facing challenges with workplace isolation, team awareness, informal communication within their team, and well-being. We aim to tackle these issues by allowing knowledge workers to quickly learn about the availability, moods, and other states of their core team members in a lightweight, informal manner. The critical underlying concepts of our approach are elaborated in the following.

3.1 Unobtrusive Design and Glanceable Window

By mimicking real offices, virtual office approaches, which have been coming out a lot due to the COVID-19 pandemic, all have a significant downside: requiring a fair bit of user interaction due to the visually complex interface. We argue that this adds a lot of unnecessary overhead and reduces long-term usability. In contrast, there are exceptions, such as Tandem¹, which takes a slightly different approach in that it is less playful and visually demanding than the other commercial tools. However, our approach goes a step further by introducing a glanceable, ambient view, which does not require significant, additional effort to be helpful. Having a limited amount of information on an ambient display is critical for both not being interruptive and costly to use [DK04]. Thus, we want to keep interactions lightweight and casual, so the functionality is kept simple, maybe even limited, by design. The information shared and displayed will be transient, meaning that there will be no chat history available, making the tool essentially unuseful for formal communication and keeping the user interface as clean and straightforward as possible. In addition, our approach visually emphasizes the topicality of information displayed to avoid outdated data that clutters the user interface. Further, to minimize interruptions and distractions, targeted use of notifications and the ability not to be contacted and to hide potential distractions is required. What's more, many existing ambient solutions include physical devices (e.g., [DPH12; AD12; R c+04]), which might not be suitable for a remote team setting due to the size of the device or the device with the awareness information not being visible to off-site team members.

TODO: Talk about glanceable window (first find RW and stuff and write that section)

¹<https://tandem.chat/>

3.2 Focus on People

Remote workers fear being “out of sight and out of mind” [BK99] and potentially suffer from the perception of workplace isolation [Mul+09; MMM07]. Additionally, virtual workers might fear that their efforts are not recognized or valued as much as their co-located colleagues [CK02]. Despite those facts, existing ambient approaches developed for use at the workplace don’t seem to focus on social awareness, an essential type of awareness at the workplace [GGC96]. Some, such as JazzBand and ContactMap [Che+03; Whi+04] follow similar principles by visualizing individual team members. However, by being an Integrated Development Environment (IDE) plugin, we argue that JazzBand’s resulting communication likely is work-related and only used when coding and limited to software developers. Similarly, ContactMap facilitates email communication, a formal type of communication and thus being unlikely to include any form of social awareness. For those reasons, our approach does not focus on work artifact-based awareness and its implications for more effective and efficient collaboration, but rather the people behind those artifacts by representing different team members’ social states to raise social awareness. One essential part of our people-centered approach is purely visual; avatars of the team members are prominently placed in an ambient manner, which visually focuses on the people rather than work artifacts. Other social awareness information displayed by our approach is elaborated in the following section.

3.3 Mood and Context Sharing

To leverage the positive impact of microblogging on the feeling of connectedness among colleagues [Dul+13], the users can share their feelings with their colleagues through microblogging with optional mood sharing. Because of the fact that topics that are blogged about are usually informal [ES10], and mood sharing seems to act as a springboard for conversations according to Church, Hoggan, and Oliver [CHO10], microblogging is one way to foster informal and spontaneous chats in our approach. Existing microblogging tools designed specifically for use at work lay the foundation of our approach and the information we want to visualize in our glanceable, always-on-top view. However, microblogging is a purely text-based form of communication. As García, Favela, and Machorro [GFM99] already mentioned in 1999, there is a need for emotional awareness inside groupware. Therefore, and similar to [MRM11], we argue the awareness of moods in a work environment is underrepresented in research, especially in a society where many are facing mental challenges caused by the global COVID-19 pandemic. Extending the purely text-based microblogging systems, Dullemond et al. [Dul+13] developed a microblogging system that shares selected moods in addition. We use their idea as a foundation for our work, to study the behavior of mood sharing when making it optional, something not done by Dullemond et al. [Dul+13]. Last but not least, combining an ambient approach introduced above with such micro-blogging functionality is a combination that has not yet, to our knowledge, been proposed in existing research. In contrast to Saari et al. [Saa+08], who developed another mobile application with mood-sharing features aimed at knowledge workers, we will study both of our approach’s usability and use cases in a preliminary evaluation.

3.4 Spontaneous Interactions

Remote workers miss the social interaction of informal chats and spontaneous discussions [CK02], which makes the fostering of those types of communication a goal of our approach. While the microblogging concept employed by our approach has the potential to increase spontaneous interactions, our approach also offers additional functionality, namely an ever-running break room

and quick one-on-one interactions, to further foster and allow such conversations to occur.

Ever-Running Break Room and Random Video Calls

Allowing to see the team, and not just relying on text-based information, is possible by joining an ever-running break room. The goal is to mimic the water-cooler in the office. Thus, visiting a breakroom as simple as possible, similar to just walking to the coffee machine in an office and signaling to the other team members that you are now on a break, is required. This effortless joining of a breakroom is motivated by Chang and Ehrlich [CE07], who emphasize that initiating a conversation must be as simple as possible. This approach also applies to the possibility of speak to another random team member through a video or audio call. Should a user feel the need to talk to another team member, they can indicate that now would be an appropriate time for a short informal conversation. If other team members feel the same, two team members can randomly be paired up for a virtual video call.

Directed Interactions

For scenarios where you want to react to a mood or status message shared by another team member, or you want to get another team member's attention, there's a way to send direct messages that are meant to be short-lived and informal. In cases where a direct message is not required, and the goal of a user is to get attention from another team member, the user can make use of the concept of "nudging". This concept aims to help in cases of help-seeking, a known problem when working remotely [HM03]. Recalling the transient nature of our approach, this communication mechanism is best suited for making a non-interruptive request that is not urgent.

Research Prototype

The above outlined key concepts were then developed into the key features of our research prototype, *AmbientTeams*. Before stepping into the core features employed in *AmbientTeams* and aligning them to the above-mentioned key concepts (see chapter 3), a brief introduction into the more technical aspects and a general overview of the application are given.

4.1 Architecture

AmbientTeams is a cross-platform desktop application based on Electron¹. To facilitate the implementation of the interactive user interface in *AmbientTeams*, VueJS² is used as the JavaScript framework for the front-end. To maintain JavaScript as a common language for the front-end and back-end, NodeJS³ is used on the server-side. The server provides both a REST API for basic CRUD functionality for users and teams and a WebSocket endpoint since much of the data required for *AmbientTeams* comes from the server in real-time.

4.2 Teams and “Favorites”

There are two types of teams in *AmbientTeams*; regular teams are stored on the server and require a unique identifier to join, similar to a straightforward invite-based approach often seen in practice. For scenarios where a user is part of multiple such teams, team members from different teams can be linked to a “favorites” team. These favorite teams only exist on the local machines of the users. In general, there is no visual difference between the two types within *AmbientTeams*, except that 1) there is no always-on break room for Favorite Teams, and 2) team members of a Favorite Team combine all status and direct messages when a Favorite Team member is part of multiple regular teams. This is different from regular teams, where status messages and direct messages are limited to that one team.

¹<https://www.electronjs.org/>

²<https://vuejs.org/>

³<https://nodejs.org/>

4.3 Avatars

At the core of our approach are the avatar representations of the users. While we could have opted for traditional profile pictures that allow users to upload an actual photograph, we decided to use the abstract form due to privacy reasons, allowing relatively simple mood manipulation on such avatars. Also, using an avatar library gives the user interface a more clean, uniform look, which is why we make use of `getavataaars`⁴ to create and manipulate avatars. Users are asked to create their own avatar during the sign-up process and have the possibility to change the appearance later on. To represent the currently selected mood of each user, AmbientTeams automatically adjusts the eyes, eyebrows, and mouth types supported by the `getavataaars`' Application Programming Interface (API) to best possibly represent the selected emoticon.

4.4 Windows

AmbientTeams consists of two main windows; the team overview and the ambient window.

4.4.1 Team Overview Window

The team overview window is responsible for maintaining a connection to the server, authenticating, login functionality, settings. Additionally, once users have authenticated inside the team overview window, they are redirected to the team overview view where all teams and team members are visible (see Figure 4.1). By clicking on the edit icon next to the team name, the user can select team members from each team that will then be displayed on the other main window, the ambient window. This is demonstrated in Figure 4.1, where the user is selecting the team members to be displayed on the ambient window. In summary, apart from authentication purposes and initial application setup, the team overview window is primarily intended for people who are part of multiple teams and want to get a quick overview of all the different teams they belong to.

4.4.2 Ambient, Glanceable Window

The Ambient window is always on top of other windows (see Figure 4.2), which on the one hand, makes it easy to stay informed about moods and other statuses of your team members, but on the other hand, can also cause interruptions and distractions. We used a transparent borderless window to keep the ambient overlay as ambient and unobtrusive as possible. However, if the window is still distracting, it can be easily minimized or closed altogether using the menu that can be accessed by clicking the minimize icon (see Figure 4.3b). Opening the team overview window can be achieved by clicking on the three dots in the menu, which will display a small drop-down menu with the option to open the team overview window. Also, in this menu, the ambient window can be enlarged or reduced to fit different screen resolutions and personal preferences.

Further, certain functionality is only visible when the user is hovering over this window. When hovering over the ambient window, the user can select the team they want to show and sees the names of the individual team members, as shown in Figure 4.3b.

⁴<https://getavataaars.com>

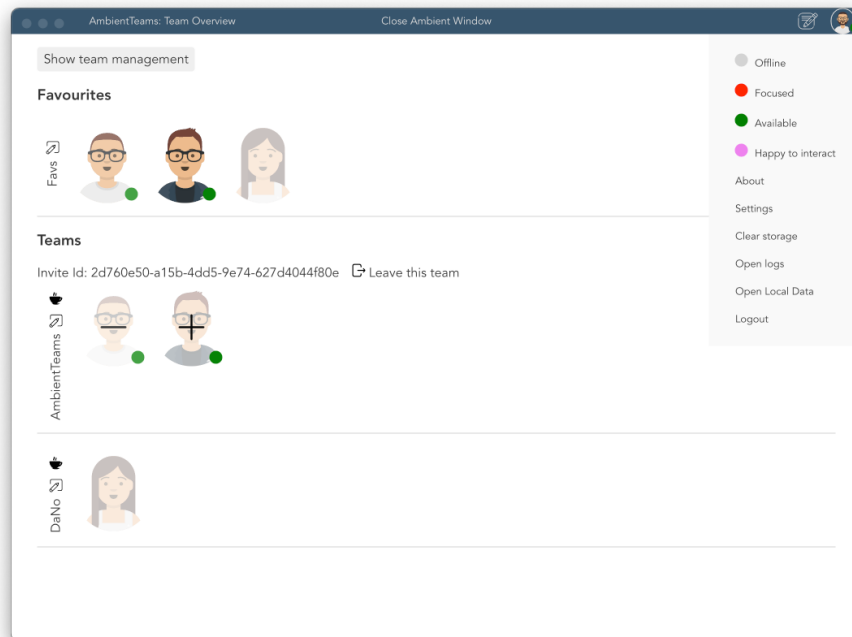


Figure 4.1: Team overview window

4.5 Availability Status

AmbientTeams wants to keep the number of interruptions to a minimum, which is why there is the “Focused” availability state (see Figure 4.9c) that exists in addition to the three others (“Available”, “Offline”, and “Happy to Interact”). Users in this focused state cannot be called. Further, they don’t see any direct messages or incoming nudges until they leave the focused state. In addition, focused users cannot directly interact with other team members, avoiding potential self-distraction. The availability state “Happy to Interact” was included to address the lack of serendipity in remote work. When selected by at least two team members, an automatic match-maker runs every minute and randomly pairs two people, who are then routed to a video call.

4.6 Sharing Moods and Status Messages

The user can open the sharing window from both the team overview and the ambient window, and the system tray menu. All of those actions will open the sharing window as shown in Figure 4.4a, where on the left, a preview of the current avatar and the selection of available moods are listed. There are nine available moods, visualized using popular emoticons available through OpenMoji⁵, an open-source emoji project. The first four of the available emoticons are more optimistic, the fifth is a neutral face, and the last four are emoticons representing rather negative emotional states. The selection of the emoticons started with six basic emotions: surprise, fear, disgust, anger, happiness, and sadness [An+17]. This list was expanded over time to better suit the work environment (TODO: Find references to support some of the moods/emotions that we

⁵<https://openmoji.org>

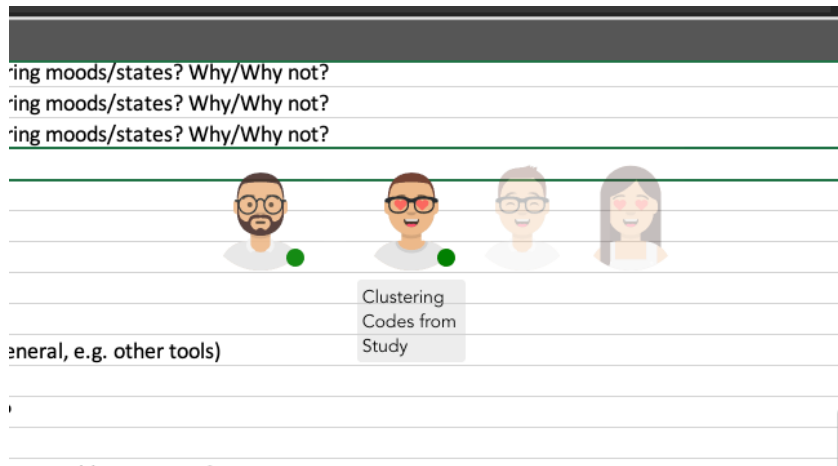


Figure 4.2: Always-on-top ambient window while working on another task

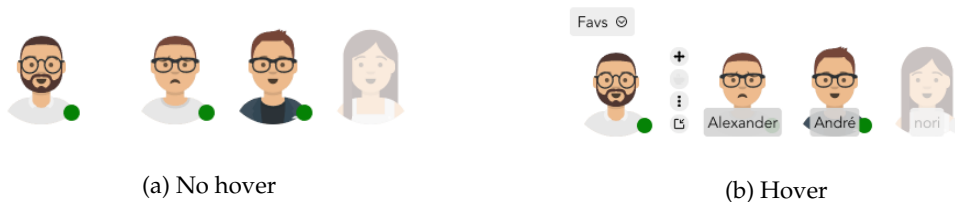


Figure 4.3: Ambient window

added) by adding a neutral and tired emoticon and two more positive emotions (loving hearts and grinning) to make the selection more balanced. Due to limitations with the avatar API, we could not render “fear” well enough, which led us to remove it. On the right, the user can enter additional context in a simple, standard textbox. The contents of this textbox are, if available, pre-populated with the current status message for the currently selected team. Additionally, the text is highlighted when the window is created, facilitating overwriting the current status without using the mouse to select the text manually. Status messages’ length is limited to 140 characters, motivated by the initial limit of Twitter [Dul+13]. Below the textbox, the user can find a button to share the status message with either all teams or a single team.

As a reminder for the user to share their moods and potential additional context with team members, the sharing window also appears automatically at pre-defined times. The location we chose for this pop-up is the lower right corner of the user’s primary monitor to minimize the potential for distraction. Overall, the window has the same functionality but includes two additional buttons to defer the prompt for either 5 minutes or 1 hour (see Figure 4.4b). The scheduled sharing window is displayed at three pre-defined times throughout the day, namely at 9:00, 13:00, and 16:00 local time.

To ensure that the information shared within AmbientTeams is up-to-date, a few measures have been taken. The first is purely visual: avatars are increasingly hidden the longer there has been no current activity. Such activities include status and mood sharing, direct messaging, and nudging. This automatic hiding should motivate users to interact with such hidden team members and easily spot updates from colleagues. Another measure we have taken to avoid showing users outdated content is automatically resetting status updates and moods at midnight.

Since the goal of AmbientTeams is to encourage informal communication, there is no chat

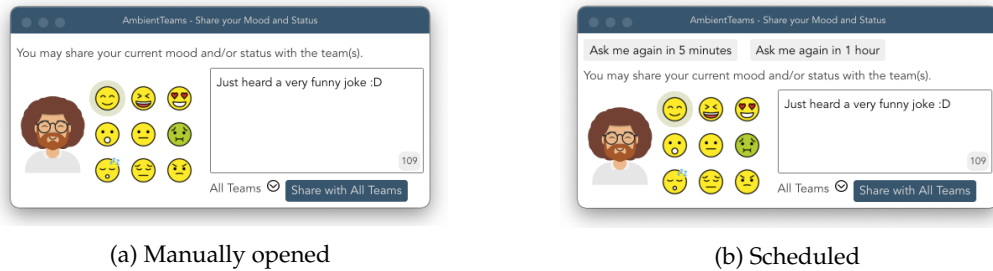


Figure 4.4: Sharing window

history or other history built into the application. With this impermanence, we want to promote more casual and less formal communication and hope to avoid AmbientTeams becoming just another tool to keep track of work.

4.7 Ever-Running Breakroom

As mentioned before, our goal was to create ever-running breakrooms as effortlessly as possible. Figure 4.5a shows the state of the ambient window when the user has clicked on the coffee icon. After the user clicks on this coffee icon, the other team members will see an indication that there is a breakroom in progress (see Figure 4.5b). However, to avoid unnecessarily creating a break room and potentially interrupting the initiating user, the break room is not created until another user clicks on the coffee icon.

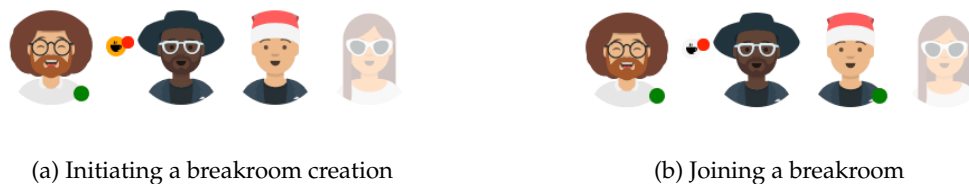


Figure 4.5: Breakroom creation

Once at least two team members have clicked the breakroom icon, a breakroom is created in the back-end with twilio⁶, and they are redirected to the breakroom view (see Figure 4.6). At any point, other team members can join and leave the breakroom, and it will remain active as long as at least one team member is present. We want to avoid users forgetting the time and staying too long in the breakroom. For this purpose, a 15-minute timer is started as soon as one enters the break room. When this timer reaches its end, the user automatically leaves the break room.

⁶<https://www.twilio.com>

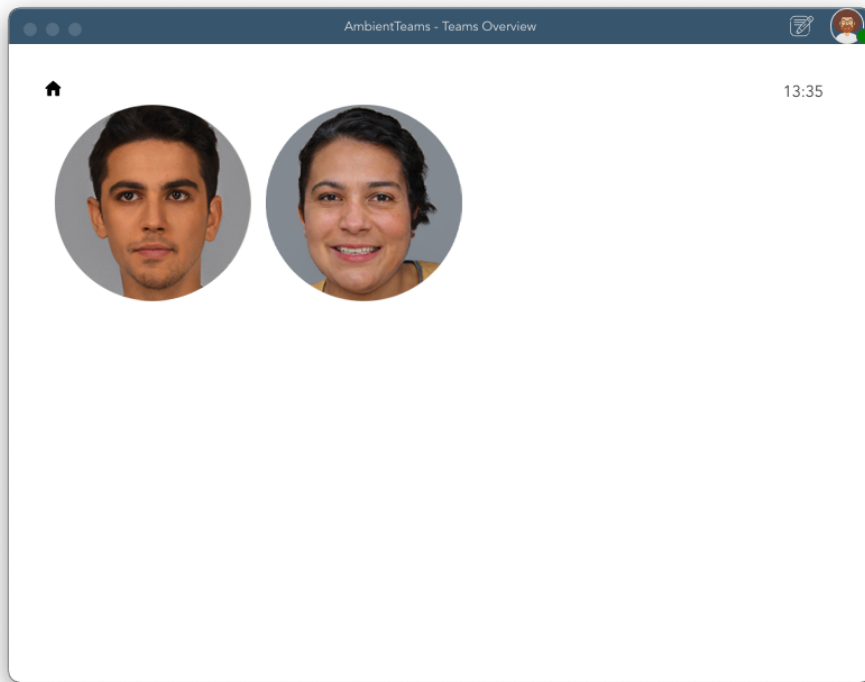


Figure 4.6: Breakroom, pictures are artificially created with <https://generated.photos/>

4.8 Direct Interactions

In addition to broadcasting sentiments and status messages, there is also the ability to interact directly with an individual team member. Hovering over individual team members brings up an overlay that offers three different interaction options, namely 1) direct messaging, 2) nudging, and 3) direct calling (see Figure 4.7).

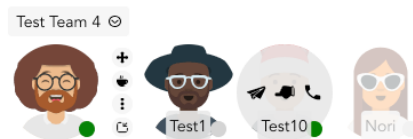


Figure 4.7: 1:1 interaction overlay

Direct messaging is very similar to status message sharing but without mood sharing and team selection options. After clicking the message icon, the message window (Figure 4.8) is displayed at the user's current mouse position to minimize the distance needed to interact with the window's contents. As in the status sharing window, there is a character limit of 140 characters.

In Figure 4.9 all three interaction options are visualized. Direct messages are distinguished from status messages by the message icon located to the left of the actual message. Nudging uses a hand icon pointing to the team member in question. For a video call, the video stream overlays

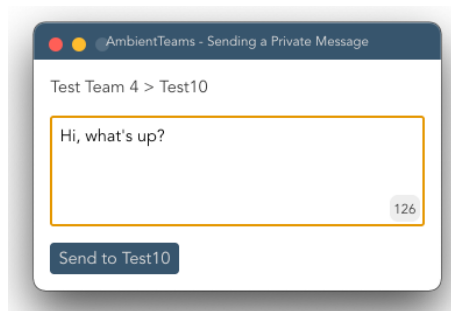


Figure 4.8: Messaging window

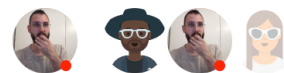
the team member's avatar, and the availability status of both participants is automatically set to "Focused". Users can hover over their avatar if they want to mute or pause the video stream. To end a call, you need to hover over the corresponding team member and click the hang-up icon.



(a) Direct message



(b) Nudging



(c) Ongoing video call

Figure 4.9: 1:1 interactions

Preliminary Evaluation

To evaluate the above-mentioned research questions, a preliminary evaluation was conducted. Optimizing and improving our approach with the help of feedback from the participants is the primary goal of this master thesis. Further, we want to learn which status and moods knowledge workers share with their closest team members, what they learn from their team-mates' sharing, and the overall impact on their perception of workplace isolation, which can help us develop both the study and the tool further.

The timeline of the preliminary evaluation is shown in Figure 5.1. Before the study was officially started with the kick-off meeting with the whole team, each participant was asked to sign and return the consent form (see Appendix A). Additionally, each participant was kindly asked to fill out a questionnaire containing some demographic questions, as well as a 10-item questionnaire about their perception of workplace isolation. During the kick-off meeting, the possibility to ask any questions the participants may have regarding the consent form will be given. The goal of the kick-off meeting was to install AmbientTeams and to show the individual features to the team. Following the kick-off meeting, AmbientTeams is used during at least three workdays. After that, but before the final interview, another questionnaire is sent to the participants.

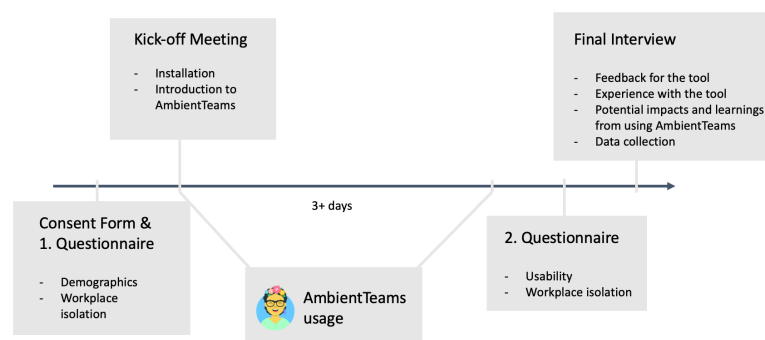


Figure 5.1: Study timeline

In the following sections, we present more details about the study procedure.

5.1 Participants Recruitment

As a first step, an interested team had to be recruited. To that end, the researchers' personal network was used. To that purpose, the study description is forwarded to the contacts, and once an interested team has been identified, it is checked whether it fulfills the participation criteria and if the prospective participants are (technically) allowed to install AmbientTeams on their computer. If this is not the case, the company's consent and approval to install AmbientTeams is first obtained. To provide the company with as much information as possible about the study and the confidentiality of the data collected, the consent form and a study description will be given to the company for review. After gaining the company's approval, the individual interested team members are approached by presenting the study, discussing the steps and goals of the study, and emphasizing that participation is entirely voluntary. For the participants to stay anonymous, each participant is assigned a random pseudonym, e.g., P392, which they were asked to provide as answers to the first question in both questionnaires. The requirements for teams participating were:

1. At least three team members
2. Three or more common working days a week
3. Spending the majority of their workday on the computer
4. Working remotely as much as possible (ideally completely remote)
5. Having all the required rights to install AmbientTeams on their work computer
6. Willingness to use AmbientTeams during at least three full days of work
7. Using macOS or Microsoft Windows
8. An active internet connection

5.2 Pre-Study Questionnaire

The pre-study questionnaire contains some basic demographic questions, as well as an established workplace isolation questionnaire developed by Marshall, Michaels, and Mulki [MMM07]. The demographic questions ask about age, gender, work industry, work experience, and job title. Further, a sense of the team's current communication culture is obtained, whether they are aware of their co-workers' feelings and progress, and the preferred working style (remote vs. on-site) is gathered for each participant. The workplace isolation questionnaire is used as a baseline measurement, and the same questionnaire is also asked at the end of the study, before the final interview, to gain potential first insights into whether our approach can decrease the perception of workplace isolation amongst knowledge workers. The workplace isolation questionnaire contains ten questions and employs a 7-point Likert-Scale, where 1 stands for "strongly disagree", and 7 stands for "strongly agree". Finally, the participants could optionally write down their expectations for the study. The complete pre-study questionnaire can be found in Appendix C.

5.3 Initial Meeting

Due to the relatively small number of team members and their flexibility, it was possible to have one kick-off meeting with the entire team. During this meeting, the consent form (see Appendix A) and study instructions (see Appendix B) were discussed briefly, and opportunities for asking questions were given. Then, we guided the participants through the installation process and explained and demonstrated the functionality of AmbientTeams. Finally, each participant joined the team that we had created before the meeting. Following the kick-off meeting, the study period officially began.

5.4 Evaluation Phase

The team voluntarily offered to use AmbientTeams for one workweek as opposed to the three days that were planned initially. During this period, the participants were instructed to continue working as usual. The participants were instructed to contact us should there be an issue or have any other feedback. For very short feedback, AmbientTeams also has a simple feedback-sending feature. During this evaluation phase, application usage data is collected. To that end, Table 5.1 shows an overview of all data collected and what research question they are relevant for, together with the location of storage (local vs. server). Local refers to the participants' computers, whereas server refers to the server hosted at the Department of Informatics at the University of Zurich. In other words, the data stored on the server is automatically shared with the researchers. At the same time, only the participants can access the locally stored data unless explicitly shared at the end of the study.

5.5 Post-Study Questionnaire

After the evaluation phase, the participants were asked to fill out another questionnaire, which, similarly to the pre-study questionnaire, takes about 5 minutes to complete. In addition to some control questions about the extent to which the participants worked remotely during the study and how long AmbientTeams was approximately running in the foreground, a usability questionnaire is presented. Usability is measured using the System Usability Score (SUS) introduced by Brooke et al. [Bro+96]. As mentioned before, the last block of the post-study questionnaire is the same workplace isolation questionnaire that was answered in the pre-study questionnaire. The complete post-study questionnaire can be found in Appendix D.

Together with the pre-study questionnaire, the goal of the post-study questionnaire is to find insights into a potential impact of AmbientTeams on the perceived workplace isolation, and thus. Also, the SUS will help us better understand and quantify the usability of our approach.

5.6 Semi-Structured Final Interview

Complementing the quantitative data collected during the study, semi-structured final interviews are conducted with each participant individually. The goal of those interviews is to find valuable insights into the usage of AmbientTeams, its strengths, weaknesses and impacts, their sharing behavior. All the interview questions and their relevance for the research questions can be found in Appendix E. The interviews are designed to take approximately 45 minutes per participant, including the time required to export the local data at the start of the final interview. Because of the potentially confidential information contained in the collected data, participants are free to

Data collected	Storage	Relevance
User: email, display name, hashed password, the teams the user belongs to, avatar created on signup	Server	-
Teams: name of the team and belonging team members	Server	-
Status/direct messages: timestamp, content, team, and user(s) the message belongs to	Server	RQ2, RQ4
Availability status: timestamp, selected availability status, user	Server	RQ4
1:1 calls: start/end timestamp, call participants	Server	RQ4
Breakroom	Server	RQ4
Nudging	Server	RQ4
Random calls	Server	RQ4
Moods: timestamp, selected mood, user	Server	RQ4
Feedback: content, user	Server	-
Window actions: timestamps of opening, minimizing, closing, or restoring windows that belong to AmbientTeams	Local	RQ4
App running time: timestamps of manually starting or quitting AmbientTeams	Local	RQ4
Team changes: timestamps and destination team when switching teams inside AmbientTeams (ambient window)	Local	-
Active windows: information about the active windows while ambient teams is running (see https://github.com/sindresorhus/active-win for more information)	Local	-

Table 5.1: Data collected during the preliminary evaluation and its relevance for the RQs

obfuscate the contents of the active windows file before uploading it to UZH dropfiles¹. The interviews are recorded, if the participant allows, and then transcribed. Two researchers (one being the author of this thesis) independently open-coded the transcripts to analyze the interviews.

5.7 Participants

Using our private network of contacts, we were able to find an interested team for the preliminary evaluation. The group initially consisted of six knowledge workers working at a Swiss company operating in the FinTech sector. Unfortunately, one person was eliminated from the study because this person was inactive when using AmbientTeams and could not be reached even after several attempts. The remaining five people consisted of three employees who had been part of the company for about two years, and two had joined their team about three months ago when the study started. While all participants were between 25 and 34 years old, their work experience ranged from 3 (working student) to 13 years (senior accountant). Out of the five participants, three were female, and two male.

¹<https://dropfiles.uzh.ch/>

Results and Discussion

This chapter presents and discusses the results that we found through analyzing the collected data (see Table 5.1), results from the semi-structured interviews, and findings from the two questionnaires.

6.1 Usability

The results from the usability questionnaire which the participants answered at the end of the study are shown in Figure 6.1. For the questions with even numbers, e.g., Q2, Q4, etc., negative answers are desirable, whereas, in questions with uneven numbers, e.g., Q1, Q3, etc., positive, blue responses are ideal. Generally, the result looks very promising. There are, however, some answers worth discussing. The “disagree” answer from Q1 came from P586. P586 also disagreed that the various functions of the application were well-integrated (Q5). The reasons for these answers could be found in the interview, where the following statement was made.

Uhm, as a separate tool, I would not use it. Integrated into another communication tool, I might use it, yes. -P586

The “agree” response in questions Q4 and Q10 came from P163, indicating that the number of featured in AmbientTeams is quite demanding to understand simply during the initial meeting. Nevertheless, this participant did not mention any usability issues in the interview nor through direct feedback, leading us to believe that it was straightforward to use after the initial challenge of understanding the application.

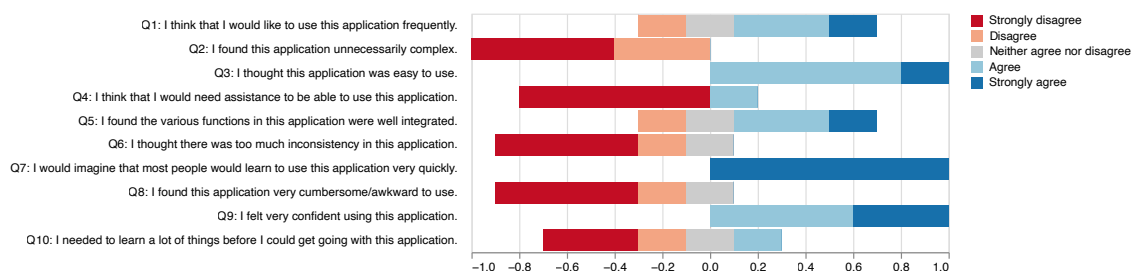


Figure 6.1: Usability questionnaire results

The individual participants' answers were then converted into the SUS score for each question according to Sauro [Sau11] to get a comparable score. The resulting average SUS score was 81.1 across all five participants (see Table 6.1). According to Sauro [Sau11], one would need to score above 80.3 to be in the top 10% of the 500 studies using the SUS. 80.3 is also the point where users are more likely to be recommending the product to a friend [Sau11], making us believe that AmbientTeams was easy and intuitive to use.

Participant	SUS score
P038	82.5
P163	80.0
P586	70.0
P751	82.5
P904	90.5
Average	81.1

Table 6.1: Usability questionnaire results and resulting SUS score

6.2 Tool Usage and Workflows (RQ4)

A detailed timeline view of the participants and their selected availability state ("Available", "Focused", or "Happy to interact") throughout the study is visualized in Figure 6.2. Those three states combined are looked at as the time when the application was running (potentially in the background). This is because the user is automatically set to an offline state if the connection to the server is lost. Upon successful connection to the server, the user's availability state is also automatically set to "Available". It is worth mentioning that this metric could be slightly erroneous if participants manually set their availability status to "Offline". This would, however, only underestimate the time spent online in Figure 6.2, making our results as conservative as possible. All in all, the average time spent in a non-offline state, and thus AmbientTeams was running (potentially only in the background), was 7.13 hours per day (std. 3.57), with a minimum of 0 and a maximum of 12.7 hours. Except for the inactivity on the weekend, only some participants did not use AmbientTeams some days. To be precise, only 5 out of a total of 30 workdays showed no or very short running time. The fact that P038 could not participate in the initial meeting with the rest of the group explains the lack of usage on the first day of the study. In general, because the kick-off meeting took place in the early afternoon, the relatively short running time on the first day was to be expected. The remaining days with very little only time most likely indicate non-working days for those participants because had they worked on those days, AmbientTeams would have automatically started as soon as they had started up their computer.

The results show that the participants did not often change their availability states and thus mainly relied on the automatic availability status setting of AmbientTeams. The "Focused" state was selected a couple of times in the first two days of the study, yet this behavior did not continue throughout the study.

6.2.1 Challenges and Novelty of the Ambient Window

Figure 6.3 illustrates that both the ambient window and the team overview window were almost exclusively opened when those windows were in focus. In other words, both of those windows were opened, interaction took place, and then they were closed or minimized again, making them

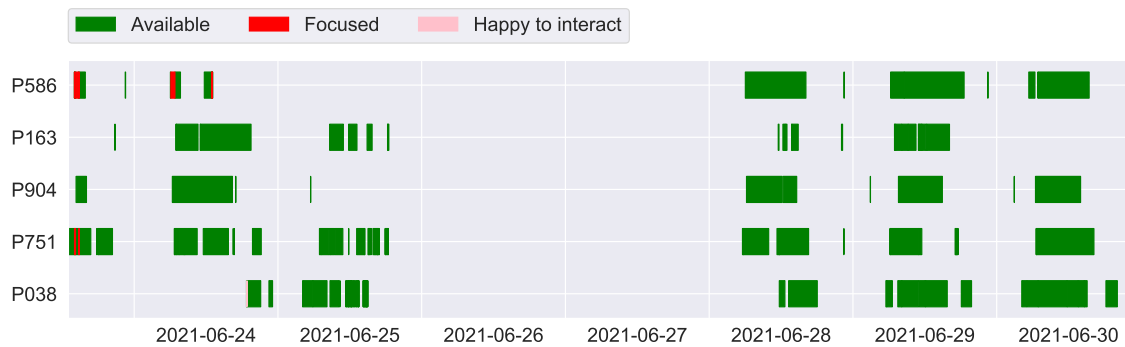


Figure 6.2: Time spent in the different availability states

disappear from the user's monitor. This is the result we expected to happen in the case of the team overview. In contrast to our beliefs, however, the ambient window was used very similarly. As a result, the ambient window only very rarely was kept open as a glanceable, always-on-top team view when working on other tasks.

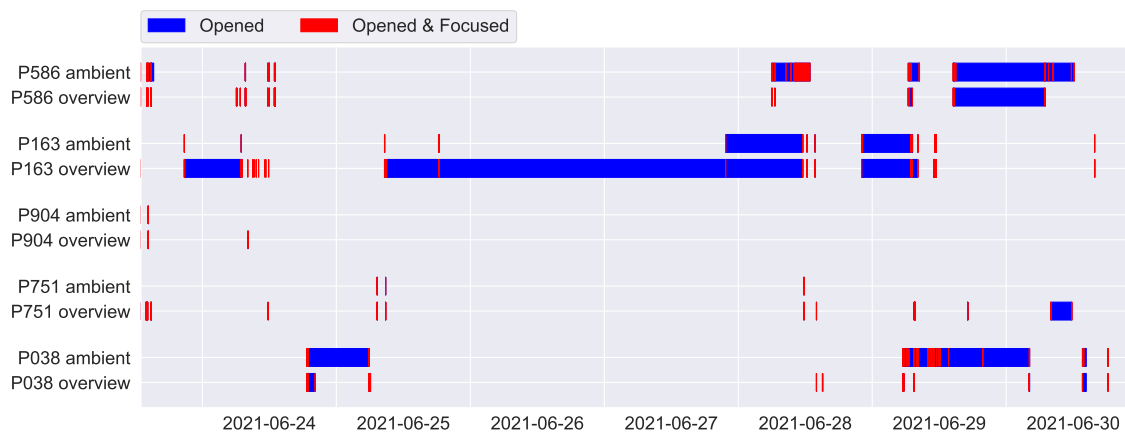


Figure 6.3: Time AmbientTeams was opened vs. opened and focused

The interviews gave us some more insights into possible answers for why the ambient window was not kept open while working on other tasks.

I tried it in the corner of the monitor, then it did not work, but in the corner of the window did not really work because there you have to click to close other windows. Then I put it somewhere in the middle, but then I needed to put some buttons there, so sometimes I got annoyed and then closed it. -P038

We hypothesize that this particular user most likely was using a single monitor setup and had a hard time finding a suitable position for the ambient window. P586 mentioned that the ambient window was too small and thus too difficult to properly move around, indicating that this participant might have missed this part of the demonstration during the kick-off meeting. In addition to the annoyance of the ambient window experienced by P038 and P586, P163 mentioned that

manually closing an application that automatically starts up is something that happens almost automatically to them because of established habits. The hassle and difficulties of positioning the ambient window are a rather crucial issue that potentially requires further development; the case described by P163 could be solved by not allowing to close the ambient window during a future study.

To make the ambient window fit better into their workflow, P038 suggested that it should ideally not stay on top of other windows and instead just come to the foreground again once a team member has shared something new. P586 similarly suggested that the ambient window ideally should fade out when not being used.

Despite the criticism around the ambient window, it was still used by all the participants except for P904 and seen as one of the best aspects of AmbientTeams by P751:

I liked that the ambient window feels very dynamic and refreshing compared to other tools.
-P751

Despite this positive statement, this participant used the team overview window more, which is surprising because all the participants were only part of one team during the study, eliminating the potential advantage of the team overview window, in our opinion.

6.3 A Need for Status and Mood Sharing (RQ1)

From the interviews, we could identify two reasons why there is a need for mood sharing at the workplace: the lack of 1) awareness and 2) social interactions in remote work environments. This finding further confirms our motivation to create AmbientTeams in the first place.

Lack of Awareness

P163 explained that there is a lack of awareness of the *real* mood when working remotely. Even though you might see them during video conferences, it makes the impression that feelings expressed through such calls might not be real.

I think it's a good idea, especially now if you work either hybrid or completely remote, I think then it is quite difficult to see the mood of your team colleagues, because now in most video conferences you make a happy face into the camera, so it is also difficult to see your mood how your mood really is right now. -P163

To highlight this point more, four out of five participants mentioned in the pre-study questionnaire that they are not or only partially aware of their co-workers' moods. This is because of missing cues resulting from working from home, according to P586.

I like to ask people how they feel but being in a room with your colleagues gives you more information about how someone is actually feeling. -P586

Those two statements both talk about the concept of honesty in regards to expressing feelings, a topic that was, unexpectedly, talked a lot about during the interviews and will therefore be covered in more detail in section 6.5.

But why is mood awareness important? Being aware of your co-worker's feelings is essential for personal relationships, something important, says P751.

Yes, it [feeling of co-workers] is important to me because if you think about how much time you spend with your co-workers, it is very important that you have good personal relationships with those people. Even when it's not clear how much longer you will be working together with those people. -P751

In addition, certain conclusions about the current workload of employees can also be drawn through the exchange of moods and states, facilitating task assignment.

Sometimes I then [at a previous company] got the feedback that they already finished with work or that they have no more tasks left. With something like AmbientTeams they could set like a bored state, and I would have been able to give them a new task. -P163

Lack of social contact / task-focus

One participant (P032) talked about how working remotely often is very task-centric, which leads to forgetting about the “social aspects of an enterprise”. P586 mentioned that when working remotely, communication often is limited to be very business-focused, and conversations are therefore usually only started for business reasons.

I think during corona, you don't really have that breakroom time, so if you call somebody, it's mostly about business and not about private stuff. So, I think it's very difficult to get into a deeper connection with people you don't see that often. -P586

To conclude, there appears to be a need for some mood and status awareness-providing approach. The following sections look into how our approach, AmbientTeams, performed at tackling the challenges mentioned above.

6.4 Moods Were Shared the Most (RQ2)

Moods were the most actively shared states, with a total of 31 moods being shared. In contrast, only eight status messages were shared, three of which were in reaction to Switzerland's soccer game during that time. Generally speaking, none of the status messages contained any work-related information.

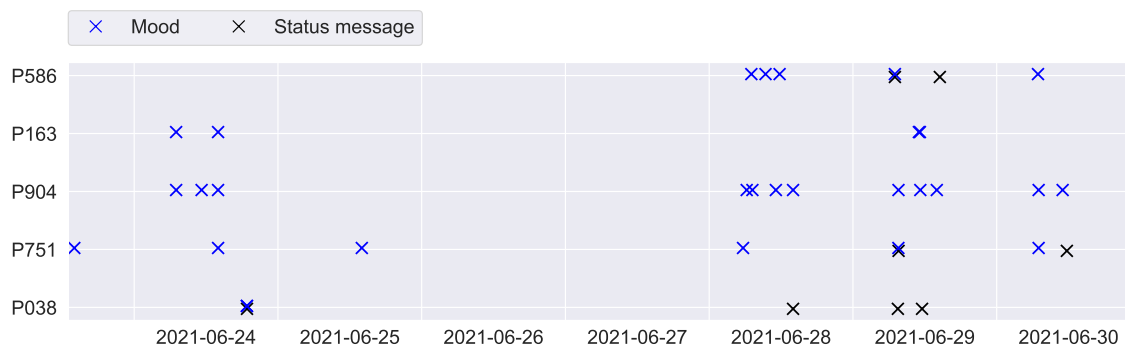


Figure 6.4: Moods and status messages shared

Looking at Figure 6.4 shows that in only three cases, moods and status messages were shared simultaneously. According to the interviews, a primary reason for sharing moods was the automatically scheduled popup, which helped to remind the participants to share something. The data confirm this finding; 25 of the 32 shared moods were shared through the scheduled popup window. However, the participants usually just shared the mood through an emoticon and did

not attach a text message. From P163, we learned that a potential reason could be that it was simply a lot quicker only to share the mood via emoticon, requiring only one click. P904 also mentioned that he/she did not see a reason to provide any more information to their mood (which was “tired” ten out of 12 times). TODO: Check if all three were negative.

While the scheduled popup helped remind the participants about sharing something, the motivation to share moods seemed to be that they knew the importance of communicating moods or interacting with co-workers (Pxxx). P586 also described how knowing that co-workers share the same feeling increases the likelihood of sharing this feeling yourself.

And just this thing that I said before, if you have something that you are very happy about, you think that other people also share, then you are more motivated to share it as well. -P586

Considering the relatively short time AmbientTeams was actively used, it is not surprising that many of its features were not used. More concretely, the features aimed at spontaneous interactions such as the breakroom and the random pairing for a video call were not used at all. While there have been two attempts of creating a breakroom, one on the second day of the study and one on the second to last day, none of them were successfully created because no other team member joined. P586 gave a possible explanation for why the spontaneous video chat features were not used during the interview.

But also maybe I have to mention that two or three weeks ago we started with virtual break rooms on Friday afternoons to try to keep up with people from work, especially for new people, because we don't really get the chance to get to know each other in home office. -P586

Consequently, it is possible that it is sufficient for the participating teams to meet once a week in their own virtual break room. Regardless of the use of the break room integrated into AmbientTeams, this indicates that the concept of such a break room is generally perceived as important. Similar to the breakroom, the directed video calls and the nudging functionality were only used during the initial kick-off meeting for testing purposes. While this shows that it was clear to the team how to use those features, they don't seem to have felt the need for those.

Things look a bit different when analyzing the direct messages that were sent through AmbientTeams. In total, there were six direct messages sent through AmbientTeams, coming from three different participants. One of those direct messages was a response to a missed call, and the other five were of either of type greeting or along the lines of “what are you doing?”. P032 gives an indication to why the team did not use the above-described functionalities:

Because now it's a bit, you know I can write to somebody in Microsoft Teams or AmbientTeams, and I would normally pick MS Teams because we use it, and you also have a message history which you don't have in AmbientTeams. -P032

Essentially, P032 explains that AmbientTeams has to differentiate itself from MS Teams, and it is doing so with the *Twitter approach* of broadcasting moods and messages, but not so much with other communication functionalities.

6.5 Negative Moods and Honesty (RQ2)

When looking at Figure 6.5, it becomes apparent that, except for P904, who pretty much constantly was “Tired”, the most frequently shared moods were positive (especially “Happy”).

Therefore, this finding raised the question, whether this was the real distribution of moods during the study or whether there could be a positive bias in moods when sharing. While P038 does not see a problem with sharing negative moods, because it's “normal, we are not in a happy

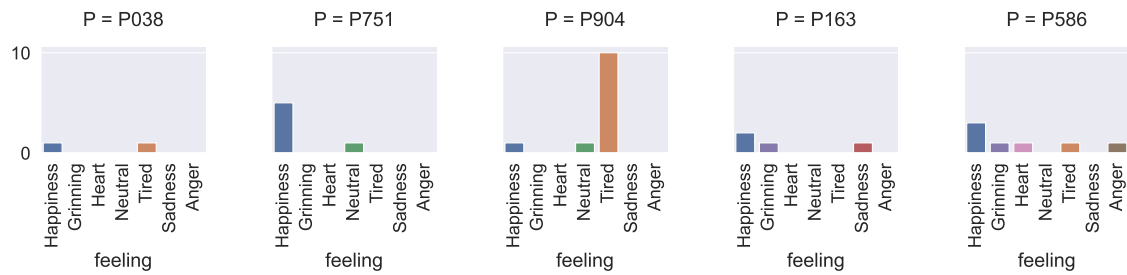


Figure 6.5: Distribution of shared moods

boat where everyone is happy all the time”, others (P163, P586, P163) would be more hesitant to share such moods. Reasons for not sharing negative moods include 1) *not wanting to give further explanations*, either for private reasons or not wanting to be distracted (P163), 2) *being fairly new to the company* (P751), 3) *not wanting to share them with the entire team* (P586), or 4) *because nobody wants to talk about negative feelings at work* (P586).

P751 further differentiates between the severeness of the experienced moods:

I don't think I would share regular negative moods when having a bad day, for instance, being this new to a company. If something really severe were to happen, however, let's say something personal or family-related, I would share such moods to inform other people. -P751

6.6 Increased Awareness of Who Is Around and How They Feel (RQ3.1)

The first effect of AmbientTeams was that participants learned who is around (P032, P586) and how they were feeling (P032, P751). P904 further noticed a key difference compared to their previous way of exchanging moods and feelings, which was usually done over text in the morning:

[...] I wouldn't have known how you were doing during the day without AmbientTeams. [...] And, I think that's when you get additional information about how you're doing during the day. -P904

This increased awareness had more implications, namely the possibility of getting to know each other better and bringing back a more natural way of communicating when working remotely. We will elaborate on both in the next sections.

6.7 Getting to Know Each Other Better (RQ3)

AmbientTeams led to one person (P751) in particular finding out that a colleague was very funny, which was unknown before the study.

Yes, actually about one particular person in the team. I did not know that this person was so funny before using AmbientTeams. The fact that I got to know one person a lot better during this one week and also having non-work-related talks now already exceeds my expectations for the study, to be honest. -P751

It is no surprise that P751 was pretty new to the company and thus did not have the chance to get to know all the team members too well. Due to this, this participant liked the fact that “this feature [mood sharing] allows to discover more about your colleagues, and it sheds light into a part that we tend to keep only for ourselves”, in particular seeing “moods and states of team members with whom I might not be currently working together too closely”. While the other participants did not learn something new about other people, P586 mentioned that using AmbientTeams confirmed the previous assumption “one team member is really just always very positive and too nice”, showing that there were in total two team members who took away a promising finding from the one week study.

We thus conclude that AmbientTeams has the potential to get to know individual team members better, especially for new team members, and learn more about team members with who you might not be in constant exchange.

6.8 Bringing Back “Natural” Communication

This section demonstrates the capabilities of AmbientTeams to bring back the more “natural” communication known from traditional office work to a remote environment. Such communication is enabled by providing “a lot more opportunities to approach another” (P904). P038 explains that by sharing moods and status with the entire team, everyone can see it, similar to when the entire team is in the office, and as a consequence, can react to what’s been shared:

[...], but I actually found it if you share it with the whole team. Because sometimes people then come back to you that you don’t expect. So I mean, sometimes you don’t have a good mood and people see it and want to cheer you up. So this substitutes a bit that part of the office life. -P038

Another reason for how AmbientTeams can trigger communication includes *seeing when someone comes online* (P032), which resulted in contacting this person. We see this as the equivalent of going into the office and being reminded of something that needs to be done simply by seeing your co-workers. Also, the fact that the majority of the participants would not necessarily share negative moods, P163 mentioned that he/she would still offer help in cases of an angry or stressed mood, another possible communication trigger.

Despite P163 pointing out that AmbientTeams itself makes it easy to start a conversation by “only having to click on the avatar of [...] to start a conversation”, this was not observable in the collected data. However, what we could observe, and this was also brought up during the interviews by P751 and P032, was that AmbientTeams acted as a trigger for external communication (e.g., Microsoft Teams, Zoom.us, etc.). To that end, we analyzed the active window titles of the participants during the study to see whether there is a higher chance of visiting external communication apps after leaving AmbientTeams.

TODO: Charts/Numbers about external triggers.

6.9 Mood Awareness via Self-Reflection (RQ3.2)

But I think it impacted myself because you’re always prompted to think about your own mood. -P751

In the previous sections, we presented results depicting the effect of AmbientTeams on other team members. However, we also found impacts on the person sharing moods themselves. More concretely, the self-reflection side of AmbientTeams was talked about by three people (P751, P904, and P586). P904 realized how their moods changed: “then maybe a few hours later you realized,

I'm actually not tired or not so neutral, but rather happy". We argue that mood awareness via self-reflection is something that could have many more applications and benefits. During the interview, one participant even gave a concrete example of how reflecting on moods could help find potentially hidden areas of interest.

If I had something that could then show me afterward that for example, every time I do something for IT I am very happy, then I can maybe try to seek more tasks in IT and find my potential in IT and my life itself to make any further education for instance. -P586

6.10 Workplace Isolation (RQ3.4)

The sections above can already hint at the capability of AmbientTeams to reduce the feeling of workplace isolation within knowledge work teams. This highly qualitative data was complemented with our approach to measure workplace isolation quantitatively; a questionnaire was asked before and after the study period. Before looking into the results of the questionnaire in Figure 6.6, a mistake from our side made us adjust the scale. The original workplace isolation questionnaire provides for a 7-point Likert-Scale. Unfortunately, our post-study questionnaire included a flaw where its answer range only was a 5-point Likert-Scale. To make the two somewhat comparable, the answers from the pre-study questionnaire for "somewhat disagree" and "disagree" were combined into "disagree", and similarly the answers for "somewhat agree" and "agree" were combined into "agree".

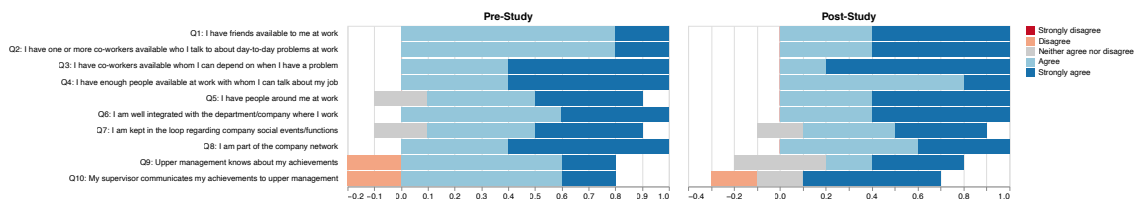


Figure 6.6: Results from the workplace isolation questionnaire, pre-study vs. post-study

In Figure 6.6, we see a slight trend toward more "strongly agree" for questions 1-3, 5, 6, 9, and 10, indicating a decrease in feelings of isolation at work. However, some responses also slightly worsened, namely Q4 and Q8. Despite the results indicating improvement in Q9 and Q10, we cannot assume that these results are effects attributable to the use of AmbientTeams for two reasons. First, the content discussed within and triggered by AmbientTeams was not work-related. Second, due to the study's small size, there was no control group, so a comparison between the two questionnaire results is highly speculative. Nonetheless, as in this study, the questionnaire could be an excellent supplement for a more extensive study in the future to provide a more accurate statement of perceptions of isolation in the workplace. We see it as a valuable complement to the semi-structured interview and are optimistic about the potential of AmbientTeams to reduce feelings of workplace isolation in knowledge work teams.

Future Directions

Having analyzed the interviews, collected data, and the questionnaires, the following sections elaborate on possible future directions that our approach, AmbientTeams, could take.

7.1 More Extensive Study

The first possible continuation of this work and the AmbientTeams approach is a more extensive study. Such a study would involve more teams, ideally teams that differ in various aspects such as industry, age of participants, and corporate culture. Based on the interviews, we have reason to believe that age (P904) and company culture (P163) may be predictors of willingness to share moods in the workplace. Also, the study design worked well in the small setting of this paper. No significant problems were reported concerning the tool. For those reasons, we see no problem with conducting the same study (except for some minor adjustments to the interview questions and questionnaires) in a larger setting without changing or adjusting the functionality of AmbientTeams. However, inputs gathered from the small study also outline some potential future directions and further developments of the tool, AmbientTeams, which could be realized before continuing with a more extensive examination. We discuss those possible updates in the following sections.

7.2 Focus on Asynchronous Communication

The lack of used synchronous communication features (video/audio calls) leads us to believe that the more realistic and promising approach would be to focus exclusively on the parts of asynchronous communication that are not yet integrated into existing communication tools (e.g., Slack, Microsoft Teams, Zoom.us). This change would mean that the main functionality of AmbientTeams would be limited to sharing moods and status messages. The functionality to nudge or directly notify other team members could also be retained as a potential communication trigger. Given our findings and the fact that most companies have established a communication culture using a software solution with advanced collaboration features, we believe that AmbientTeams should not compete with such tools but rather focus on what is different from them: mood sharing and informal status sharing. Simplifying AmbientTeams would also have the advantage of making it easier for study participants to learn, as there are fewer features to learn and discover.

7.3 Better Integration With Established Tools

Participants P163, P586, and P904 indicated that they would prefer to have only one application for their team communications. P163 argued that a single tool would increase the likelihood and time they would use AmbientTeams. We see two ways we could improve the use and user experience of AmbientTeams in the long term: 1) two-way synchronization of data between existing tools and AmbientTeams, or 2) complete relocation of AmbientTeams functionality to existing tools. The former means that AmbientTeams would remain a standalone desktop application and continue to benefit from the freedom it provides. It would use application programming interfaces (APIs) to push and pull updates to and from existing communication tools. Potential information that could be shared includes availability status and status messages. To maintain “one click on the avatar to start a call”, it could also leverage the more mature video conferencing capabilities of the existing solution for more seamless interaction between AmbientTeams, making it less like “just another tool” and more of a potential facilitator for using existing tools. The second measure would go in a completely different direction, essentially moving all of AmbientTeams’ existing functionality into existing ecosystems like Microsoft Teams or Slack. While this would satisfy our participants’ desire for a universal communication tool, we would also lose a lot of flexibility. The Ambient window would have to go, and it’s not yet clear how much of the functionality we could adopt. More research would need to be done on the capabilities of these established communication platforms before ultimately deciding on the better approach.

7.4 Self-Reflection

Feedback from P586, P904, and P751 told us that there is a genuine interest and potential benefit in reflecting on one’s mood. Therefore, a future direction of AmbientTeams could be toward a greater emphasis on self-reflection. This could be achieved through various new or slightly modified existing features. For example, when selecting a mood, the user could be asked via emoticons if they would like to share the selected mood or update the local mood. A dashboard could then provide the user with various visualizations to reflect on moods, similar to AffectAura [McD+12]. Similar to AffectAura’s functionality to link emotions to artifacts such as open web pages, documents, or calendar events, P586 mentioned that linking tasks to moods would be of high interest. In that case, the critical difference to AffectAura would be this two-sided view and the possibility to share moods should one wish, or instead keep private for more self-reflection purposes. In addition, such an approach would allow for new research ideas such as comparing shared moods and not shared moods, which could be interesting for following up the negative moods and honesty results from this thesis.

7.5 Task Awareness

As mentioned in the previous section, P586 liked the idea of linking moods to tasks for self-reflection. Similarly, P904 liked the idea of sharing a task list to get a sense of team members’ current workload in addition to the shared moods. Following the idea of integration with existing tools (see section 7.3), success and adoption would likely be highest if this feature worked seamlessly with existing task management software. At the same time, the core idea behind the AmbientTeams approach is that our focus is not on tasks, which raises the question of whether such a feature fits into our more social approach. We would argue that providing a simple, more well-being-focused measurement such as workload (e.g., the number of tasks currently assigned)

could be a people-focused measurement that could nicely complement the moods already shared in AmbientTeams, and could potentially further raise awareness.

Conclusion

After identifying the social challenges posed by remote work, AmbientTeams was developed to help knowledge workers address these issues, focusing on three main concepts: minimal design, focus on people and their well-being (via mood-based micro-blogging), and spontaneous interactions.

Complementing our initial research efforts, the interviews confirmed that there seems to be a need for an informal way of sharing information within knowledge work teams. Our approach aimed to help alleviate feelings of isolation in the workplace and communicate current social states with the team. The resulting research prototype, AmbientTeams, was used by a team consisting of five knowledge workers for five days. The usability questionnaire and interviews indicated that AmbientTeams was easy and intuitive to use, with the mood-sharing functionality being the most popular among participants. We then discussed the broader effects of AmbientTeams. We found that it 1) helped knowledge workers be aware of each other's moods and availability status, 2) got to know each other better, 3) enabled communication outside of AmbientTeams, and 4) spurred self-reflection on one's moods.

Further, we found that participants would reject automatic mood detection requiring constant camera access due to confidential data and privacy concerns. Nonetheless, other interesting directions for AmbientTeams were found and discussed. Possibilities to pursue in the future include focusing exclusively on the asynchronous exchange aspect and better integration with existing communication platforms.

Appendices

Appendix A

Consent Form



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Consent Form "Emotion and Status Sharing in Remote Knowledge Work Teams"

Principal Investigator

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Purpose

Working remotely has become very popular over the past years. Due to the Covid-19 pandemic this trend has grown even stronger, forcing many companies and their employees to work from home. Further, the majority of managers expect to have more flexible work from home policies post-pandemic, and employees would like to continue working from home (at least part-time), making the topic relevant also after the pandemic. However, working remotely also comes with various challenges for knowledge workers, such as feeling lonely and not belonging to a team, not knowing who to turn to in case of a problem, or not knowing what others are working on. While the latter has received a lot of attention in previous research, the existence of tools focusing on the social challenges of remote work is still lacking. By sharing moods and status messages, or more generally, fostering informal communication, team members can develop more personal relationships and teams feel more connected despite the distance. For this reason, we developed AmbientTeams, a casual and informal tool that attempts to reduce the perceived distance in remote work by creating opportunities for more informal interactions.

In this study we want to explore the usability and usefulness AmbientTeams. Further, our goal is to learn which statuses and moods knowledge workers are sharing with their closest team members, what they learn from their team-mates' sharing, and what the overall impact is on their perception of workplace isolation.

Study Procedure

Overall, the study spans across three or more workdays and consists of the following three steps:

1. A kick-off meeting where the study is explained and the opportunity for questions is given. Before attending the kick-off meeting you are kindly asked to fill out a short questionnaire on demographics and your work (taking about 5 minutes to complete). To submit this questionnaire, you will be given a pseudonym with which you will be identified with during the study. After the study is explained and there are no more questions regarding the consent form or other topics, you will be asked to install the application on your work computer. Upon successful installation, you will join the team and the main functionality of the application is explained by one of the researchers running the study.
2. During at least three workdays, we will ask you to continue to work as usual with AmbientTeams running on your computer. While running AmbientTeams, you are completely free in how and how often you use of the application.
3. At the end of the study we will ask you for feedback about how using AT impacted your work and productivity. Similar to the kick-off, we will kindly ask you to fill out another questionnaire prior to



that meeting. In the interview, you will be asked to export the locally stored data and explanations will be given on how the data can be obfuscated before uploading it to a secure drop-folder. All in all, the final interview will not take longer than 30-45 minutes.

Benefits and Risks

By participating in this study, you will have the chance to learn about your own and your co-workers' moods at work. You will use a casual and informal tool that attempts to reduce the perceived distance in remote work by creating opportunities for more informal interactions.

The main known risk of participating in the study is the loss of time required to participate in the study. We estimate the total amount of time required to participate in the study to be approximately 60 - 90 minutes during three workdays. You may use AmbientTeams for more than three days if you want to. We are aiming to make the most efficient use of your time by streamlining the setup and onboarding of the study and providing constant and timely support in case of difficulty with application usage, as well as allowing you to determine a suitable time for the study and interviews. Furthermore, you are free to withdraw from participation at any point during the study, without the need to provide a reason.

Personal Information

For this study, we will collect personal information about you such as your name, email, gender, age, and job role. Your name as well as other identifying information will strictly be kept separate at all times and will be stored in a subjects table at a different location from any other information you give. For AmbientTeams to function properly, it needs to upload to the server and persist some personal data, including status messages' and direct messages' content, shared moods, and active window titles.

To answer our research questions, we will only use your anonymized data (i.e. with the pseudonyms as explained in study procedure) and no identifying information will ever be shared outside of the research group and the confines of this study without your explicit permission. All data collected will be saved in password-protected storages. Your anonymized data will be stored no longer than 5 years. Any identifiable data (subject table) will be deleted after the project is published (if it is) and at the latest after 2 years.

Data, Storage & Confidentiality

AmbientTeams stores data **both locally on your computer and on a server hosted at the Department of Informatics at the University of Zurich.**

Data collected by AmbientTeams

At the end of the study, you will be asked to export your local data and share it with the researchers. Before uploading your exported data to a secure storage hosted by the University of Zurich, you have the opportunity to review and obfuscate the data. The local data contains only a pseudonym (e.g. P0123), provided to the participant at the beginning of the study, no information that would allow the data to be associated with personal data of a participant. Local data include window actions (opening, closing, minimizing, and restoring of AmbientTeams), general usage (starting and quitting of AmbientTeams), timestamps when the team was changed in the dropdown, and active windows (the active window is the window currently in focus and contains the name of the application and, in cases of web browsers, the current URL). In case you are working on something sensitive, we recommend to temporarily quit the AmbientTeams application.



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Data stored on the server

Since AmbientTeams allows to exchange your status and moods with co-workers and (optionally) allows to communicate via personal message or audio/video-chat, data has to be persisted on a central server. The server is hosted by the university of Zurich. All requests to and from the server are SSL encrypted by using the HTTPS (wss respectively) protocol. Since the data on server includes identifiable information about the participants, all the data stored on the server will be deleted after the completion of the project, at the latest 2 years after participation in the study. Further, the data that will be downloaded and stored on the password protected machines of the researchers to run the analysis will only contain random IDs and not the actual personal information of the participants. The following is stored on the server:

- User data: email, display name, hashed password, the teams the user belongs to, and the parameters of the avatar that was created by that user during signup
- Teams: name of the team and its members
- Status/direct messages: timestamp, content, team and user(s) the message belongs to
- Availability status: timestamp, selected availability status, user
- 1:1 Calls: start and end timestamps, call participants
- Moods: timestamp, selected mood, user

All audio/video calls are end-to-end encrypted using the WebRTC protocol and thus cannot be eavesdropped. In addition, the calls are also not recorded. It should be noted that messages (both status messages and private messages) are not encrypted, and **we strongly advise against sharing confidential data within AmbientTeams**. Also note that by sharing a status message with your team, all users who belong to that team will be able to see that message. That said, users not belonging to that team will never have access to your posted status messages.

Interview Data

If approved by you, the final interview will be audio recorded. The audio files will be deleted as soon as the interviews have been transcribed (automatically if interviews were taken in English and you give consent to use a transcription service below, manually otherwise).

Uses of the Study Data

The results of this study will potentially appear in both internal and external academic research presentations and publications, such as academic journals and conference proceedings. No findings gathered from the participation in this study will ever reveal the identity of the participants. Reference to specific participants will always be made under their pseudonym.

Contact for Information about the Study

If you have any questions or desire further information with respect to the study, you may contact Dario Bugmann (dario.bugmann@uzh.ch) or Dr. André Meyer (ameyer@ifi.uzh.ch).



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Consent for extended Data Uses

With your explicit consent, you can allow the researchers to transcribe the audio recording of the interview using a transcription service:

☐ I allow the use of a transcription service to transcribe my interview

With your explicit consent, you can allow the researchers to share the results or ask you to participate in future studies.

☐ The researchers might contact me in the future to share the results and/or ask me to participate in future studies.

Consent for Study Participation

Your participation in this study is entirely voluntary. You are free to withdraw your participation at any point during the study, without needing to provide any reason. Any information you contribute up to your withdrawal will be retained and used in this study, unless you request otherwise.

With your signature on this form, you confirm the following statements:

- An investigator explained the study and the listed conditions to me. I had the opportunity to ask questions. I understand the answers and accept them.
- I am at least 18 years old.
- I had enough time to make the decision to participate and I agree to the participation.

In no way does this waive your legal rights or release the investigators or involved institutions from their legal or professional responsibilities.

Participant's name

Location, Date

Participant's signature

Study Instructions

A study to understand Emotion and Status Sharing in Remote Knowledge Work Teams

Principal Investigator

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Supervision

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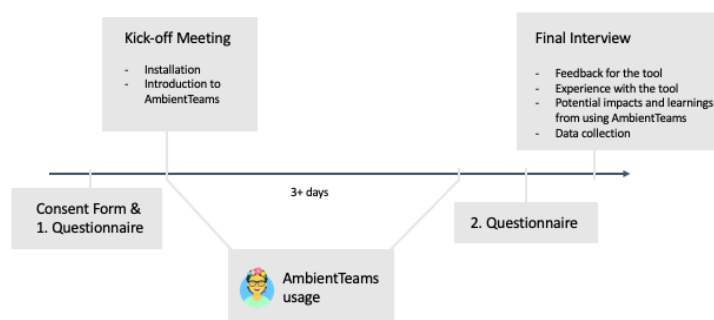
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Introduction

Common challenges of remote work include the feeling of not belonging to a team and feeling lonely, not knowing who to turn to in case of a problem, or not knowing what others are working on. While the latter has received a lot of attention in previous research, the existence of tools focusing on the social challenges of remote work is still lacking. By sharing moods and status messages, or more generally, fostering informal communication, team members can develop more personal relationships and teams feel more connected despite the distance. For this reason, we developed AmbientTeams, a research prototype which with we want to better understand social interactions within teams working remotely.

Study Overview



Study Procedure

Overall, the study spans across at least 3 workdays and consists of the following three steps:

1. A **kick-off meeting** where the study is explained and the opportunity for questions is given. **Before attending the kick-off meeting you are kindly asked to fill out a short questionnaire** on demographics and your work (taking about 5 minutes to complete). To submit this questionnaire, you will be given a pseudonym with which you will be identified with during the study. After the study is explained and there are no more questions regarding the consent form or other topics, you will be asked to install the application on your work computer. Upon successful installation, you will join the team and the main functionality of the application is explained by one of the researchers running the study.
2. During at least three workdays, we will ask you to **continue to work as usual with AmbientTeams running on your computer**. While running AmbientTeams, you are completely free in how and how often you use of the application.
3. At the end of the study we will ask you for feedback about how using **AT impacted your work** and productivity. Similar to the kick-off, we will kindly ask you to fill out another questionnaire prior to that meeting. In the **interview**, you will be asked to export the locally stored data and explanations will be given on how the data can be obfuscated before uploading it to a secure drop-folder. All in all, the final interview will not take longer than 30-45 minutes.

Installation (optional before the kick-off meeting)

TL;DR

Installation MacOS: <https://vimeo.com/563689368>

Installation Microsoft Windows: <https://vimeo.com/563689849>

MacOS

1. Download from <https://ambientteams.ifi.uzh.ch/releases/AmbientTeams-0.9.1.dmg>
 2. Drag icon into applications folder
 3. Open AmbientTeams
 4. You will be asked to give AmbientTeams permissions for
 - Microphone: Required for making voice calls
 - Camera: Required for making video calls
 - Accessibility: Required for retrieving information about the currently active window
 - Screen Recording: Required for retrieving information about the currently active window
 5. Grant the permissions and restart AmbientTeams
 6. Please check the following file: /Users/{your user name}/Library/Application Support/ambientteams/localDb/activeWindows
- If the file is not empty, everything worked! All the remaining steps will be done together with us in the kick-off meeting.**

Microsoft

1. Download from <https://ambientteams.ifi.uzh.ch/releases/AmbientTeams-Setup-0.9.1.exe>
2. Please select "keep" on the downloaded file

3. On the following popup, please select "show more" and "keep anyways" (this is because the application is not signed on windows due to very expensive code signing certificates)
4. Chose "more info" and then "run anyways"

5. Plase navigate to the following file:

%USERPROFILE%\AppData\Roaming\ambientteams\localDb\activeWindows

If the file is not empty, everything worked! All the remaining steps will be done together with us in the kick-off meeting.

Note: To quit AmbientTeams completely on Microsoft Windows, you have to click "exit" in the system tray

Additional Information

What if someone wants to join after the study has started?

Should anyone be interested in also participating in the study (and has not been in the kick-off) during the first day of the study, he/she is welcome to join. However, I kindly ask you to inform me beforehand.

Troubleshooting

In case you face an issue with AmbientTeams, either reach out directly to us (dario.bugmann@uzh.ch), or first try the following steps:

1. Refresh the window (either via keyboard shortcuts: macOS: cmd + R, windows: CTRL + R, or via right-click inside the team overview window)
2. Quit and restart application (macOS: cmd + Q or in the Menu Bar, windows: exit via system tray)
3. Clear local storage (team overview window → click on your avatar in the top right corner → "Clear storage")

Note however that this step will **delete** your favourite teams, color and device settings, and the team member selection displayed in the ambient window.

4. If none of the above helped, contact me via email (ideally with a screenshot and/or your exported logs (settings→ "Open logs")) at dario.bugmann@uzh.ch.

If you have a question

Don't hesitate to contact us via email (dario.bugmann@uzh.ch) or MS Teams (dario.bugmann@uzh.ch).

In case you find a bug

If you could write an email to dario.bugmann@uzh.ch, ideally with attached screenshots or even logs, that would be highly appreciated.

In case you have feedback (can be anything, really!)

Simply click the "Feedback" button in the "AmbientTeams - Teams Overview" window.

Thanks for your help making AmbientTeams better! Please note that your user ID is stored with your message, so this feedback is not anonymous. This information is needed to contact you in case there is any ambiguity.

Updates

AmbientTeams automatically checks for updates on application startup. Further, there is the option to manually check for updates in the settings.

Note: After the update has been downloaded, a restart of AmbientTeams is required (on windows the user must quit the application via the system tray) for the update to take effect.

Export of locally collected data

At the end of the study (please don't upload before you received the email asking you to do so) you will be asked to export your locally stored data. To do so, please perform the following steps:

1. "AmbientTeams: Teams Overview" window: click on your avatar in the menu bar at the top right and select "Open Local Data"
2. Inside this folder you will find 4 files:

- 1) windowActions: all the window actions (timestamps of when you opened, closed, minimised, or restored windows of AmbientTeams)
- 2) appUsage: timestamps of when you started and quit AmbientTeams
- 3) teamChanges: timestamps when you switched teams inside the ambient window
- 4) activeWindows: information about the active windows when AmbientTeams is running (see <https://github.com/sindresorhus/active-win> for more information)

- Check to see that you don't share any window titles/URL you don't wish. You are free to delete entries from the activeWindows files to protect your privacy.

- Zip the four files and name the archive in following way: {{your pseudonym}}.zip

Example: "P1234.zip"

- Upload zipped file to: <https://dropfiles.uzh.ch/dropzone/6dc8afbf>

Data, Storage & Confidentiality

The following list only serves as a summary! You may find details in the consent form.

1. Your data is stored on a **server hosted at the University of Zurich** and will never leave the research group. This does not include the data under the section "Data collected by AmbientTeams", which is stored locally on your computer until you decide to upload the exported files.
2. Your anonymised data will be stored no longer than 5 years. Any identifiable data will be deleted after the project is published (if it is) and at the latest after 2 years.
3. Messages (both status messages and private messages) are not encrypted. We strongly advise against sharing confidential data within AmbientTeams.
4. Video and audio calls are end-to-end encrypted and are not recorded.
5. Your information will be kept confidential, but keep in mind that all of your colleagues / team members who use AmbientTeams can potentially see your status updates.

Pre-Study Questionnaire

Pre-Study Questionnaire

A study to understand Emotion and Status Sharing in Remote Knowledge Work Teams

Thank you for taking the time to participate in this study! All of your responses will be kept confidential. If you have any questions, please contact me at dario.bugmann@uzh.ch.

1. [text] Please enter your pseudonym, which you received in the email

Demographics

1. [text] What is your job title?
2. [number] How many years of work experience do you have?
3. [dropdown] Which of the following categories best describes the industry you primarily work in (regardless of your actual position)?
4. [number, %] How is your work split between office and working from home / remotely?
5. [number, %] What would be your ideal split of working from home / remotely?
6. [text] Why would that be your ideal split?
7. [dropdown] What gender do you identify with?
8. [dropdown] How old are you?

Communication

1. [text] How and how often do you communicate and meet with your team and what tools do you use?
2. [text] What kind of information do you exchange with each other? Do you exchange purely work-related information, or do you also exchange more personal, informal information?
3. [text] Are you aware of how your team members are feeling and the progress they are making at work?

Workplace Isolation

The scale employs a 7-point Likert-Scale, where 1 strongly disagree, 7 strongly agree, and 4 neither agree nor disagree

1. I have friends available to me at work
2. I have one or more co-workers available who I talk to about day-to-day problems at work
3. I have co-workers available whom I can depend on when I have a problem
4. I have enough people available at work with whom I can talk about my job
5. I have people around me at work
6. I am well integrated with the department/company where I work
7. I am kept in the loop regarding company social events/functions
8. I am part of the company network
9. Upper management knows about my achievements

10. My supervisor communicates my achievements to upper management

Expectations

1. [text] What are your expectations for the tool and study?

Post-Study Questionnaire

Post-Study Questionnaire

A study to understand Emotion and Status Sharing in Remote Knowledge Work Teams

Thank you for having used AmbientTeams in your team! All of your responses will be kept confidential. If you have any questions, please contact me [at dario.bugmann@uzh.ch](mailto:dario.bugmann@uzh.ch).

1. [text] Please enter your pseudonym, which you received in the email

Control questions

1. [number, %] How was your work time during the study split between "at the office" and "remote-work" (e.g. from home)?
2. [text] If > 0%: Please clarify
3. [text] How much of your work time was AmbientTeams approximately running, and you had the ambient (transparent) window in foreground?
4. [text] If < 70%: Please clarify

Usability Questions

The scale employs a 5-point Likert-Scale, where 1 strongly disagree, and 5 strongly agree

1. I think that I would like to use this application frequently.
2. I found this application unnecessarily complex.
3. I thought this application was easy to use.
4. I think that I would need assistance to be able to use this application.
5. I found the various functions in this application were well integrated.
6. I thought there was too much inconsistency in this application.
7. I would imagine that most people would learn to use this application very quickly.
8. I found this application very cumbersome/awkward to use.
9. I felt very confident using this application.
10. I needed to learn a lot of things before I could get going with this application.
11. [text] Do you have any additional comments or explanations to one of your answers above?

Workplace Isolation

The scale employs a 7-point Likert-Scale, where 1 strongly disagree, 7 strongly agree, and 4 neither agree nor disagree

1. I have friends available to me at work
2. I have one or more co-workers available who I talk to about day-to-day problems at work
3. I have co-workers available whom I can depend on when I have a problem
4. I have enough people available at work with whom I can talk about my job

5. I have people around me at work
6. I am well integrated with the department/company where I work
7. I am kept in the loop regarding company social events/functions
8. I am part of the company network
9. Upper management knows about my achievements
10. My supervisor communicates my achievements to upper management

11. [text] We'll address more specific questions in the interview. In case you want to provide any early in the meantime, please use this textbox

Semi-Structured Interview Guide

Semi-Structured Interview Guide

1. Prior to interview: look briefly at participant usage data (moods shared / status messages posted etc.)
2. Write down the pseudonym of the participant.
3. Check if everything of this participant has reached us (the 2 questionnaires and consent form)
4. Export Local Data
5. Ask whether English is fine
6. Ask for recording permissions
7. If yes, start recording

General Ice breakers

1. How long have you been part of the team and how well do you know the other team members?
2. [RQ4] Please talk a little bit about how you used AmbientTeams during the last couple of days.
3. Do you have any concrete examples on how you used AmbientTeams yesterday (or the day before)?
4. Did your usage change over time and if so, how?

Typical Communication Behavior

5. [RQ3] Did your general way of interacting with your team members change with the usage of AmbientTeams? If so, how and why?
 - prompt for potential changes inside AmbientTeams, but also outside
 - Tools, informal communication, meeting style
 - What they share with each other / what they talk about
 - How and if they find out how others feel

Mood and Context Sharing

6. [RQ1] What do you generally think about sharing moods/status messages inside your team? Do you see a need for it? if so, why?
7. [RQ1 & RQ2] What would you say motivated you to share something yourself?
8. Did you notice that your and your team-mates' avatars were fading out? Did this somehow influence you for sharing yourself?
9. [RQ2] What did you generally share with your team? And why? (this question is slightly different for each participant, depending on the individual usage)
10. [RQ2] Did you also share negative moods/states when you didn't feel so good? If so, when and why, or why not?
11. How did you previously share moods and states (e.g. with Slack, Teams, Zoom)? If they did share moods/states: Do you prefer AmbientTeams over your old way sharing moods/states? Why/Why not?

Information Consumption / Awareness

12. [RQ3.1] Was there anything you learned from AmbientTeams about your team members? Was this something you didn't know about them before using AmbientTeams?
- Was it helpful to learn about the moods/states of your team mates? If so, why or why not? Do you have any concrete examples?
13. [RQ3] Did the awareness on your team members' moods and states affect you in any way?

Potential questions if they don't answer:

- Did it make you feel better/worse about your work?
 - Did it alter what you shared with your team members? (e.g. did you share less/more information with them over time?)
 - Did it impact what you know about your team mates' well-being? Is it important to you?
 - Did it impact you knowing about your team mates' progress and/or tasks they're working on? Is that information important to you?
14. [RQ3] Do you know if sharing your states/moods had an impact on your team members? Did it have an impact on yourself?

Broader Impact of AmbientTeams

15. Did/does AmbientTeams have an impact on the frequency of communication and when you share information with your team? (Both inside AmbientTeams and in general, e.g. other tools)

Examples if they don't have ideas:

- More connected to your team? Impact on the number of meetings you had? Less/more time spent in other communication tools? More informal communication? Topics you talk about? AT useful for better small talk topic selection? etc. etc.
16. [RQ3] Was there anything else that you learned or changed from sharing and seeing moods/states with AmbientTeams?
17. [RQ3] With the information that you could gather from AmbientTeams, would you say it could potentially lower the barrier (Widerstand/Hemmschwelle) to communicate?

AmbientTeams Glanceable Display and Features

18. [RQ4] Did you use the ambient window? If yes: How did you like it and why? (Can you think of scenarios where you would use it more?)

The ambient window itself was created as a glanceable display, which is always on top. How did this influence your focus at work? Did it sometimes interrupt and/or distract you? Do you think this should be improved/changed? If so, how?

19. [RQ4] Did you use the teams overview window? If yes: How did you like it and what information did it provide it to you? If no: Why not? Can you think of scenarios where you would use it more?

- Usefulness of the provided information

20. [RQ4] Does AmbientTeams integrate well into your existing work-flows, or could this be improved?
21. [RQ4] Compared to traditional communication tools (such as Slack, Teams, Zoom), is there a difference in the types of content and information that you share with your team using AmbientTeams? Why is that?

Improvements to AmbientTeams

22. Would you consider the past couple of workdays to be typical? (was there something unplanned, extraordinary, etc.?)
23. We are thinking of adding a feature that will detect your current mood and fatigue from a webcam and automatically display it to your co-workers, similarly to what you now did manually. What are your thoughts on such an automated feature?

Follow-up, either:

1. Do you think it would be important to always confirm what is being shared within your closest team?
 2. How would that change if you had to confirm what is being shared before it is actually shared?
24. Could you see yourself using AmbientTeams after the study? Why/Why not? What could be improved?
25. Do you have any other feedback or questions regarding the study?

Closing remarks

Say that they are free to continue using it if they want to

Bibliography

- [AD12] Hamed S Alavi and Pierre Dillenbourg. "An ambient awareness tool for supporting supervised collaborative problem solving". In: *IEEE Transactions on Learning Technologies* 5.3 (2012), pp. 264–274.
- [All+84] Thomas J Allen et al. "Managing the flow of technology: Technology transfer and the dissemination of technological information within the R&D organization". In: *MIT Press Books* 1 (1984).
- [An+17] Sieun An et al. "Two sides of emotion: exploring positivity and negativity in six basic emotions across cultures". In: *Frontiers in psychology* 8 (2017), p. 610.
- [Bie+07] Jacob T Biehl et al. "FASTDash: a visual dashboard for fostering awareness in software teams". In: *Proceedings of the SIGCHI conference on Human factors in computing systems*. 2007, pp. 1313–1322.
- [BK99] NBKDE Bailey and Nancy B Kurland. "The advantages and challenges of working here, there, anywhere, and anytime". In: *Organizational dynamics* 28.2 (1999), pp. 53–68.
- [BN07] Scott Brave and Cliff Nass. "Emotion in human-computer interaction". In: *The human-computer interaction handbook*. CRC Press, 2007, pp. 103–118.
- [Bro+96] John Brooke et al. "SUS-A quick and dirty usability scale". In: *Usability evaluation in industry* 189.194 (1996), pp. 4–7.
- [Car+17] John R Carlson et al. "Virtual team effectiveness: Investigating the moderating role of experience with computer-mediated communication on the impact of team cohesion and openness". In: *Remote Work and Collaboration: Breakthroughs in Research and Practice*. IGI Global, 2017, pp. 687–706.
- [Car99] Erran Carmel. *Global software teams: collaborating across borders and time zones*. Prentice Hall PTR, 1999.
- [CE07] Klarissa T Chang and Kate Ehrlich. "Out of sight but not out of mind? Informal networks, communication and media use in global software teams". In: *Proceedings of the 2007 conference of the center for advanced studies on Collaborative research*. 2007, pp. 86–97.
- [Che+03] Li-Te Cheng et al. "Jazzing up Eclipse with collaborative tools". In: *Proceedings of the 2003 OOPSLA workshop on eclipse technology eXchange*. 2003, pp. 45–49.
- [CHO10] Karen Church, Eve Hoggan, and Nuria Oliver. "A study of mobile mood awareness and communication through MobiMood". In: *Proceedings of the 6th Nordic Conference on Human-Computer Interaction: Extending Boundaries*. 2010, pp. 128–137.

- [CK02] Cecily D Cooper and Nancy B Kurland. "Telecommuting, professional isolation, and employee development in public and private organizations". In: *Journal of Organizational Behavior: The International Journal of Industrial, Occupational and Organizational Psychology and Behavior* 23.4 (2002), pp. 511–532.
- [Com+20] Santiago Comella-Dorda et al. "Revisiting agile teams after an abrupt shift to remote". In: *Retrieved July* (2020).
- [DB92] Paul Dourish and Victoria Bellotti. "Awareness and coordination in shared workspaces". In: *Proceedings of the 1992 ACM conference on Computer-supported cooperative work*. 1992, pp. 107–114.
- [DCR05] Robert DeLine, Mary Czerwinski, and George Robertson. "Easing program comprehension by sharing navigation data". In: *2005 IEEE Symposium on Visual Languages and Human-Centric Computing (VL/HCC'05)*. IEEE. 2005, pp. 241–248.
- [DK04] Laura Dabbish and Robert E Kraut. "Controlling interruptions: awareness displays and social motivation for coordination". In: *Proceedings of the 2004 ACM conference on Computer supported cooperative work*. 2004, pp. 182–191.
- [DPH12] John Downs, Beryl Plimmer, and John G Hosking. "Ambient awareness of build status in collocated software teams". In: *2012 34th International Conference on Software Engineering (ICSE)*. IEEE. 2012, pp. 507–517.
- [Dul+13] Kevin Dullemond et al. "Fixing the 'Out of sight out of mind' problem one year of mood-based microblogging in a distributed software team". In: *2013 10th Working Conference on Mining Software Repositories (MSR)*. IEEE. 2013, pp. 267–276.
- [Eco20] The Economist. *In Search of Lost Focus - The engine of distributed work*. https://lostfocus.eiu.com/downloads/EIU_Dropbox_focus_executive_summary.pdf. [Online; accessed 5-June-2021]. 2020.
- [Eco21] The Economist. *The rise of working from home*. <https://www.economist.com/special-report/2021/04/08/the-rise-of-working-from-home>. [Online; accessed 12-July-2021]. 2021.
- [ES08] Martin Ebner and Mandy Schiefner. "Microblogging-more than fun". In: *Proceedings of IADIS mobile learning conference*. Vol. 2008. 2008, 155Y159.
- [ES10] Kate Ehrlich and N Shami. "Microblogging inside and outside the workplace". In: *Proceedings of the International AAAI Conference on Web and Social Media*. Vol. 4. 1. 2010.
- [ESS+92] Stephen G Eick, Joseph L Steffen, Eric E Sumner, et al. "Seesoft-a tool for visualizing line oriented software statistics". In: *IEEE Transactions on Software Engineering* 18.11 (1992), pp. 957–968.
- [FKC90] Robert S Fish, Robert E Kraut, and Barbara L Chalfonte. "The VideoWindow system in informal communication". In: *Proceedings of the 1990 ACM conference on Computer-supported cooperative work*. 1990, pp. 1–11.
- [FL98] Andy French and Paul Layzell. "A study of communication and cooperation in distributed software project teams". In: *Proceedings. International Conference on Software Maintenance (Cat. No. 98CB36272)*. IEEE. 1998, pp. 146–154.
- [Flo19] Marivic F Flores. "Understanding The Challenges Of Remote Working And It's Impact To Workers". In: *International Journal of Business Marketing and Management (IJBMM)* 4.11 (2019), pp. 40–44.
- [Fri+94] Nico H Frijda et al. "Varieties of affect: Emotions and episodes, moods, and sentiments." In: (1994).

- [GB13] Emitza Guzman and Bernd Bruegge. "Towards emotional awareness in software development teams". In: *Proceedings of the 2013 9th joint meeting on foundations of software engineering*. 2013, pp. 671–674.
- [GFM99] Octavio García, Jesús Favela, and Roberto Machorro. "Emotional awareness in collaborative systems". In: *6th International Symposium on String Processing and Information Retrieval. 5th International Workshop on Groupware (Cat. No. PR00268)*. IEEE. 1999, pp. 296–303.
- [GG95] Carl Gutwin and Saul Greenberg. "Support for group awareness in real-time desktop conferences". In: (1995).
- [GGC96] Saul Greenberg, Carl Gutwin, and Andy Cockburn. "Awareness through fisheye views in relaxed-WYSIWIS groupware". In: *Graphics interface*. Vol. 96. Citeseer. 1996, pp. 28–38.
- [GGR96] Carl Gutwin, Saul Greenberg, and Mark Roseman. "Workspace awareness in real-time distributed groupware: Framework, widgets, and evaluation". In: *People and Computers XI*. Springer, 1996, pp. 281–298.
- [GH07] Ravi S Gajendran and David A Harrison. "The good, the bad, and the unknown about telecommuting: meta-analysis of psychological mediators and individual consequences." In: *Journal of applied psychology* 92.6 (2007), p. 1524.
- [Gor20] Adam Gorlick. "The productivity pitfalls of working from home in the age of COVID-19". In: *Stanford News* (2020).
- [GPS04] Carl Gutwin, Reagan Penner, and Kevin Schneider. "Group awareness in distributed software development". In: *Proceedings of the 2004 ACM conference on Computer supported cooperative work*. 2004, pp. 72–81.
- [Gro13] Tom Gross. "Supporting effortless coordination: 25 years of awareness research". In: *Computer Supported Cooperative Work (CSCW) 22.4-6* (2013), pp. 425–474.
- [GST05] Tom Gross, Chris Stry, and Alex Totter. "User-centered awareness in computer-supported cooperative work-systems: Structured embedding of findings from social sciences". In: *International Journal of Human-Computer Interaction* 18.3 (2005), pp. 323–360.
- [GWS13] Christine A Grant, Louise M Wallace, and Peter C Spurgeon. "An exploration of the psychological factors affecting remote e-worker's job effectiveness, well-being and work-life balance". In: *Employee Relations* (2013).
- [Has+17] Mariam Hassib et al. "Heartchat: Heart rate augmented mobile chat to support empathy and awareness". In: *Proceedings of the 2017 CHI Conference on Human Factors in Computing Systems*. 2017, pp. 2239–2251.
- [Her+00] James D Herbsleb et al. "Distance, dependencies, and delay in a global collaboration". In: *Proceedings of the 2000 ACM conference on Computer supported cooperative work*. 2000, pp. 319–328.
- [Her07] James D Herbsleb. "Global software engineering: The future of socio-technical coordination". In: *Future of Software Engineering (FOSE'07)*. IEEE. 2007, pp. 188–198.
- [HG99] James D Herbsleb and Rebecca E Grinter. "Architectures, coordination, and distance: Conway's law and beyond". In: *IEEE software* 16.5 (1999), pp. 63–70.
- [HM01] James D Herbsleb and Deependra Moitra. "Global software development". In: *IEEE software* 18.2 (2001), pp. 16–20.

- [HM03] James D. Herbsleb and Audris Mockus. "An empirical study of speed and communication in globally distributed software development". In: *IEEE Transactions on software engineering* 29.6 (2003), pp. 481–494.
- [HM05] Pamela J Hinds and Mark Mortensen. "Understanding conflict in geographically distributed teams: The moderating effects of shared identity, shared context, and spontaneous communication". In: *Organization science* 16.3 (2005), pp. 290–307.
- [Höo+08] Kristina Höök et al. "Interactional empowerment". In: *Proceedings of the SIGCHI Conference on Human Factors in Computing Systems*. 2008, pp. 647–656.
- [Jak+09] Mikkel R Jakobsen et al. "WIPDash: Work item and people dashboard for software development teams". In: *IFIP Conference on Human-Computer Interaction*. Springer. 2009, pp. 791–804.
- [KDV07] Andrew J Ko, Robert DeLine, and Gina Venolia. "Information needs in collocated software development teams". In: *29th International Conference on Software Engineering (ICSE'07)*. IEEE. 2007, pp. 344–353.
- [KEG88] Robert Kraut, Carmen Egido, and Jolene Galegher. "Patterns of contact and communication in scientific research collaboration". In: *Proceedings of the 1988 ACM conference on Computer-supported cooperative work*. 1988, pp. 1–12.
- [Kra+] Robert E Kraut et al. "Informal communication in organizations: Form, function, and technology". In.
- [KSO12] Benjamin Koehne, Patrick C Shih, and Judith S Olson. "Remote and alone: coping with being the remote member on the team". In: *Proceedings of the ACM 2012 conference on Computer Supported Cooperative Work*. 2012, pp. 1257–1266.
- [Kuw+02] Kazuhiro Kuwabara et al. "Connectedness oriented communication: Fostering a sense of connectedness to augment social relationships". In: *Proceedings 2002 symposium on applications and the internet (saint 2002)*. IEEE. 2002, pp. 186–193.
- [Lan07] Filippo Lanubile. "Collaboration in distributed software development". In: *Software Engineering*. Springer, 2007, pp. 174–193.
- [Lou+12] Zhe Lou et al. "PresenceScope: Virtual world mediated rich communication". In: *Bell Labs Technical Journal* 16.4 (2012), pp. 219–242.
- [Mad11] Susan R Madsen. "The Benefits, Challenges, and Implications of Teleworking: A Literature Review." In: *Culture & Religion Review Journal* 2011.1 (2011).
- [McD+12] Daniel McDuff et al. "AffectAura: an intelligent system for emotional memory". In: *Proceedings of the SIGCHI Conference on Human Factors in Computing Systems*. 2012, pp. 849–858.
- [MCR20] Sarah Morrison-Smith, Lydia B Chilton, and Jaime Ruiz. "Facilitating Team Awareness Through Ambient Displays". In: (2020).
- [MH01] Audris Mockus and James Herbsleb. "Challenges of global software development". In: *Proceedings seventh international software metrics symposium*. IEEE. 2001, pp. 182–184.
- [Mil+21] Courtney Miller et al. "'How Was Your Weekend?' Software Development Teams Working From Home During COVID-19". In: *arXiv preprint arXiv:2101.05877* (2021).
- [MMM07] Greg W Marshall, Charles E Michaels, and Jay P Mulki. "Workplace isolation: Exploring the construct and its measurement". In: *Psychology & Marketing* 24.3 (2007), pp. 195–223.
- [MR09] Iris B Mauss and Michael D Robinson. "Measures of emotion: A review". In: *Cognition and emotion* 23.2 (2009), pp. 209–237.

- [MRM11] Simone Mora, Verónica Rivera-Pelayo, and Lars Müller. "Supporting mood awareness in collaborative settings". In: *7th International Conference on Collaborative Computing: Networking, Applications and Worksharing (CollaborateCom)*. IEEE. 2011, pp. 268–277.
- [Mul+09] Jay P Mulki et al. "Set up remote workers to thrive". In: *MIT Sloan Management Review* 51.1 (2009), p. 63.
- [OMF06] Benoît Otjacques, Rod McCall, and Fernand Feltz. "An ambient workplace for raising awareness of internet-based cooperation". In: *International Conference on Cooperative Design, Visualization and Engineering*. Springer. 2006, pp. 275–286.
- [OO06] Judith S Olson and Gary M Olson. "Bridging Distance: Empirical studies of distributed teams". In: *Human-computer interaction in management information systems 2* (2006), pp. 27–30.
- [PSV94] Dewayne E Perry, Nancy A. Staudenmayer, and Lawrence G Votta. "People, organizations, and process improvement". In: *IEEE Software* 11.4 (1994), pp. 36–45.
- [Qua20] Qualtrics. *The other COVID-19 crisis: Mental health*. <https://www.qualtrics.com/blog/confronting-mental-health/>. accessed February 23 2020. 2020.
- [RCB96] Krisela Rivera, Nancy J Cooke, and Jeff A Bauhs. "The effects of emotional icons on remote communication". In: *Conference companion on human factors in computing systems*. 1996, pp. 99–100.
- [Röc+04] Carsten Röcker et al. "Using ambient displays and smart artefacts to support community interaction in distributed teams". In: *Proceedings of the OZCHI Conference*. Cite-seer. 2004, pp. 22–24.
- [Rus80] James A Russell. "A circumplex model of affect." In: *Journal of personality and social psychology* 39.6 (1980), p. 1161.
- [Saa+08] Timo Saari et al. "A mobile system and application for facilitating emotional awareness in knowledge work teams". In: *Proceedings of the 41st Annual Hawaii International Conference on System Sciences (HICSS 2008)*. IEEE. 2008, pp. 44–44.
- [Sas99] VAKihiko Obata VKazuo Sasaki. "Video communication system that facilitates informal communication among distributed offices". In: *FUJITSU Sci. Tech. J* 35.2 (1999), pp. 141–148.
- [Sau11] Jeff Sauro. *Measuring Usability with the System Usability Scale (SUS)*. <https://measuringu.com/sus/>. [Online; accessed 8-July-2021]. 2011.
- [SCS06] Bikram Sengupta, Satish Chandra, and Vibha Sinha. "A research agenda for distributed software development". In: *Proceedings of the 28th international conference on Software engineering*. 2006, pp. 731–740.
- [SCS14] Wolfgang H Staehle, Peter Conrad, and Jörg Sydow. *Management: eine verhaltenswissenschaftliche Perspektive*. Vahlen, 2014.
- [Spa20] Jared Spataro. *A pulse on employees' wellbeing, six months into the pandemic*. <https://www.microsoft.com/en-us/microsoft-365/blog/2020/09/22/pulse-employees-wellbeing-six-months-pandemic/>. accessed February 25 2020. 2020.
- [Sto+16] Margaret-Anne Storey et al. "How social and communication channels shape and challenge a participatory culture in software development". In: *IEEE Transactions on Software Engineering* 43.2 (2016), pp. 185–204.

-
- [Tse+14] Angela Tseng et al. "Using the circumplex model of affect to study valence and arousal ratings of emotional faces by children and adults with autism spectrum disorders". In: *Journal of autism and developmental disorders* 44.6 (2014), pp. 1332–1346.
- [Whi+04] Steve Whittaker et al. "ContactMap: Organizing communication in a social desktop". In: *ACM Transactions on Computer-Human Interaction (TOCHI)* 11.4 (2004), pp. 445–471.
- [Zha+10] Jun Zhang et al. "A case study of micro-blogging in the enterprise: use, value, and related issues". In: *Proceedings of the SIGCHI Conference on Human Factors in Computing Systems*. 2010, pp. 123–132.