AmbientTeams

Staying socially connected in remote knowledge work teams

Dario Bugmann

of Aarau, Switzerland (15-708-852)

supervised by
Prof. Dr. Thomas Fritz
Dr. André Meyer, Alexander Lill

University of Zurich UZH

HASEL

AmbientTeams

Staying socially connected in remote
knowledge work teams

Dario Bugmann

**University of
Zurich** UZH

HASEL

Acknowledgements

Abstract

With the switch to remote work, informal and spontaneous conversations are less likely to occur due to the absence of important cues from colleagues. The lack of such social interactions can lead to feelings of isolation in the workplace. To this end, we developed AmbientTeams, an unobtrusive and informal tool that seeks to reduce the perceived distance between remote colleagues by creating opportunities for more casual interactions. AmbientTeams attempts to do this by taking a micro-blogging approach that allows moods and status updates to be shared with the team. We evaluated our research prototype on a group of five knowledge workers who used the tool for a week. The results show that participants were more aware of each other's moods and availability status and got to know each other better. In addition, the study showed the potential of AmbientTeams to foster more (natural) communication in a remote setting.

Zusammenfassung

Mit der Umstellung auf Telearbeit werden informelle und spontane Gespräche weniger wahrschein-lich, da wichtige Hinweise von Kollegen fehlen. Der Mangel an solchen sozialen Interaktionen kann zu Gefühlen der Isolation am Arbeitsplatz führen. Zu diesem Zweck haben wir Ambi-entTeams entwickelt, ein unaufdringliches und informelles Tool, das die gefühlte Distanz zwis-chen entfernten Kollegen verringern soll, indem es Möglichkeiten für informellere Interaktionen schafft. AmbientTeams versucht dies, indem es einen Micro-Blogging-Ansatz verfolgt, der es er-laubt, Stimmungen und Status-Updates mit dem Team zu teilen. Unseren Forschungsprototyp haben wir an einer Gruppe von fünf Wissensarbeitern evaluiert, die das Tool eine Woche lang verwendet haben. Die Ergebnisse zeigen, dass die Teilnehmer die Stimmungen und den Ver-fügbarkeitsstatus der anderen besser wahrnahmen und sich gegenseitig besser kennenlernten. Darüber hinaus zeigte die Studie das Potenzial von AmbientTeams, mehr (natürliche) Kommu-nikation währed der Fernarbeit zu ermöglichen.

Contents

List of Figures

List of Tables

Chapter 1

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 lead to higher job satisfaction and employee retention [Mul+09; GH07; Mad11].

However, global software development brings challenges, namely coordination and collaboration in a remote environment become much more difficult [Her07]. One reason for this challenge is the lack of workplace or group awareness required for successful coordination and collaboration [Her07; GPS04]. Workplace awareness defines awareness that results from the real-time combination of elements that workers keep in mind when collaborating [GGR96]. Such elements can be people, what they are working on, what are are planning on working on next, which objects they are using, and more [GGR96]. Consequently, a large body of existing research focuses on improving these coordination challenges by increasing awareness amongst team members. Task/coding-related awareness tools ([Bie+07; Jak+09]) are very popular among these. However, there seems to be evidence that software developers can find all the information they need for their work even without task- or work-oriented approaches [GPS04], which is why the focus of our research is more on communication.

Due to the lack of awareness, spontaneous, more informal communication is more difficult in remote work, resulting in reduced spontaneous communication [KEG88; SCS06; Her07; HM05]. This is not desirable, because spontaneous communication, such as "corridor or watercooler talk", can help news spread faster among teams [Her+00] or reduce some of the coordination problems [HG99] mentioned above by gathering important background information that enables more effective teamwork [Lan07; HM01]. Moreover, not only is spontaneous, informal communication impeded, but technical problems in computer-mediated communication generally occur, reducing the productivity of remote teams [SCS06]. There is also research that finds a decrease in communication frequency when the physical distance between employees is increased [HM03], which is not surprising, given that informal communication accounts for about 85% of all communication [Kra+]. Furthermore, the richness of communication is drastically reduced, as written text is the most common communication medium used by remote software developers [GPS04]. However, text-based communication does not have the same ability to convey rich information, resulting in, among other things, a limited ability to convey emotional information [Höö+08].

The lack of such social interactions can lead to other interpersonal problems, such as difficulties in building trust, maintaining working relationships, or lead 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]. This is critical since feeling disconnected from colleagues has been shown to decrease engagement in productive tasks [Eco20], and strong team cohesion has been shown to positively impact team effectiveness and productivity of a team [Car+17]. Existing research has thus also looked into ways of bringing more social interactions within a team into remote work. Virtual offices are an approach that is taken, both in research (e.g., [Sas99; Lou+12]) and commercially (e.g. Branch[1], Reslash[2], Wonder[3], or Gather[4]). Another, less intrusive concept aimed at promoting informal communication is micro-blogging in the workplace (e.g., [ES08; ES10; Zha+10; Dul+13]). WeHomer, a micro-blogging tool introduced by Dullemond et al. [Dul+13], was the first to extend a micro-blogging approach with mood sharing. Their motivation for sharing moods came from García, Favela, and Machorro [GFM99], who argued that being aware of the emotional state of your colleagues and acting accordingly leads to better collaborative work results. By developing and studying WeHomer, Dullemond et al. [Dul+13] found an increase in team-connectedness and easy access to otherwise hard to obtain information. Their findings and the fact that the COVID-19 pandemic has lead to worrying figures relating to workers' well-being and mental health, stating an increase in stress in 65.9% of people, and 44.4% reporting a decrease in mental health [Spa20], has led us to develop AmbientTeams.

AmbientTeams is a desktop application that allows knowledge workers to add their most important team members and visualize them in a glanceable, transparent, and always-on-top window. It differs from existing micro-blogging solutions in that it is more person- and mood-centric, and the novelty of its user interface. This is achieved by making status messages optional and taking a more person-centric approach: the content of textual information is not put in the foreground but is meant to complement the shared moods. These moods are visualized in mood-adapted avatars, which are the center of AmbientTeams. While Dullemond et al. [Dul+13] provides the ability to respond to shared posts with comments, AmbientTeams provides simple response options such as direct messaging and video conferencing to allow for spontaneous interactions. The goal of AmbientTeams is to increase the sense of belonging in the team, and the goal of this thesis is to find out how AmbientTeams is being used, what its users are sharing, and what the broader implications of our approach are. 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 sharing moods and status messages affect the sharing user?

  RQ3.3: 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?

---

[1]https://branch.gg
[2]https://reslash.co
[3]https://wonder.me
[4]https://gather.town

To answer those questions, we conducted a preliminary evaluation with five knowledge workers who used AmbientTeams for 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 what fundamentally motivated our approach. Consequently, the mood-sharing functionality was the most popular feature among participants, primarily used without an attached status message. Regarding the broader effects of AmbientTeams, we found that it helped knowledge workers to 1) be aware of each other's moods and availability status, 2) get to know each other better, 3) enable communication outside of AmbientTeams, and 4) spur self-reflection on one's moods. To summarize, the main contributions of this work include

1. Insights into mood and status sharing behaviors within knowledge work teams and the impact such sharing can have on personal relationships, workplace isolation, or collaboration

2. Successful development of a glanceable, always-on-top status sharing window, and initial insights into the usability of such an approach

3. Provision and initial application of a study design that can be used for a broader study, and resulting suggestions for future features

We start with an overview of related work in chapter 2 before elaborating our approach and its key concepts in more detail in chapter 3. Subsequently, our research prototype and all its features are presented in chapter 4. The study design for the preliminary evaluation conducted can be found in chapter 5 and the results in chapter 6. Last but not least, possible future directions of our approach are outlined in chapter 7.

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 section 2.3. Additionally, remote workers more often lack support from their supervisors and co-workers [MMM07]. Social isolation relates to the fact that remote workers miss informal chats, spontaneous discussions, and meetings around the water cooler [CK02]. We view isolation in the workplace as so critical because when individual team members feel isolated, the resulting less cohesive team is less effective and productive, less satisfied with the team, and less viable [TQT09; Car+17]. Similarly,

feeling disconnected from colleagues has been shown to hinder the execution of productive tasks [Eco20], which in turn negatively impacts productivity.

    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, Egido, 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 and therefore higher 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 (which will be introduced in section 2.3), 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 [FL98; MH01]. 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.

Existing Tools
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 costs 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. Branch[1], Reslash[2], Wonder[3], or Gather[4] also follow the goal of increasing spontaneous, informal communication by creating virtual offices where users can move around with avatars and interact with others. Tandem[5] 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 micro-blogging. Studies have shown that micro-blogging is a form of informal communication [ES10] that is "like a virtual coffee machine as a meeting place" [ES08, p. 158]. Further, many existing micro-blogging approaches have found that micro-blogging results in people feeling more connected [ES10; Zha+10]. Likewise, their study participants found micro-blogging 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 micro-blogging, Dullemond et al. [Dul+13] developed a micro-blogging 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 [Her07; GPS04], so it is of great interest to increase awareness in distributed teams. Moreover, being more aware of and familiar with another person has been shown to increase communication frequency [CE07].

Definition Literature provides various definitions of awareness (e.g., [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*

---

[1] https://branch.gg
[2] https://reslash.co
[3] https://wonder.me
[4] https://gather.town
[5] https://tandem.chat/

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, p. 6]. It includes, for example, the attention state of the other person, their emotions, the level of interest, or whether a person can be disturbed [GG95].

- *Workplace Awareness*
Workplace Awareness defines the awareness that results from the real-time combination of elements workers keep track of when working together [GGR96]. Such elements can what others are working on, what are are planning on working on next, or which objects they are using [GGR96].

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], indicating 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]. Most common "elements" for software developers, as defined by workplace awareness, are colleagues and work artifacts [KDV07].

Existing Tools
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 these awareness-increasing tools require a fair bit of user interaction to be helpful, there have also been attempts for creating ambient approaches to raise awareness in the work environment [MCR20; OMF06; DPH12; AD12; Röc+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

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 [Höö+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).

Existing Tools
The approach by McDuff et al., 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, their solution focuses on the aggregated emotional state towards a project, not 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. While the researchers developed the prototype and saw many potential use cases, such as when or how to contact a person based on shared emotions (and context such as proximity), no study was conducted to verify them.

Emotions, Moods, Sentiments
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].

Measuring Emotions
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 best, most realistic 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].

Visualizing Emotions
There are various approaches to visualizing emotions. A color-based approach is often used, where colored bubbles or clouds are used to represent emotional states (e.g., [CHO10; Kem+14; Guz13]). Other approaches, such as that of McDuff et al. [McD+12], aim to visualize multiple dimensions simultaneously. To this end, they used different colors for the valence dimension and shapes for the arousal dimension. Last but not least, and unsurprisingly given the adoption of emoticons in commercial communication software, emoticons, short for emotion symbols, are another commonly used approach to visualize discrete emotions (e.g., [GFM99; Sán+06]).

Chapter 3

Approach

The group awareness gained by existing tools allows knowledge workers to understand who they are working with and what they are working on, or what the impact of a change can have on others, which is essential for successful collaboration [DB92]. However, they only cover a limited view of awareness by providing few social or emotional cues. 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 Tandem[1], 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; Röc+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.

---

[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 micro-blogging on the feeling of connectedness among colleagues [Dul+13], the users can share their feelings with their colleagues through micro-blogging 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], micro-blogging is one way to foster informal and spontaneous chats in our approach. Existing micro-blogging 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, micro-blogging 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 that the focus on mood awareness in a team is underrepresented in research, especially in a society where many are facing mental challenges caused by the global COVID-19 pandemic. In contrast to Saari et al. [Saa+08], who developed a mobile application with mood-sharing features aimed at knowledge workers, no study was conducted, and no potential use cases were observed. We will, in contrast, study both of our approach's usability and use cases in a preliminary evaluation. Additionally, our approach also features text-based blogging, which can be used to provide additional awareness information. Extending the purely text-based micro-blogging systems, Dullemond et al. [Dul+13] developed a micro-blogging 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. It should be noted that in section 2.4 we briefly distinguished between emotions, moods, and feelings. For simplicity, and to be consistent with previous research from Dullemond et al. [Dul+13], we use the terms "moods", and "emotions" interchangeably, even though some of the available moods are arguably meant to be more short-term than others.

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 micro-blogging concept employed by our approach has the potential to increase spontaneous interactions, our approach also offers additional functionality, namely an ever-running breakroom and quick one-on-one interactions, to further foster and allow such conversations to occur.

Ever-Running Breakroom and Random Video Calls
Allowing to see the team, and not just relying on text-based information, is possible by joining an ever-running breakroom. 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 video call.

Direct 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].

Chapter 4

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 Electron[1]. To facilitate the implementation of the interactive user interface in AmbientTeams, VueJS[2] is used as the JavaScript framework for the front-end. To maintain JavaScript as a common language for the front-end and back-end, NodeJS[3] 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 breakroom 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, and additionally 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 elements are only visible when the user is hovering over this window (see Figure 4.3). 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
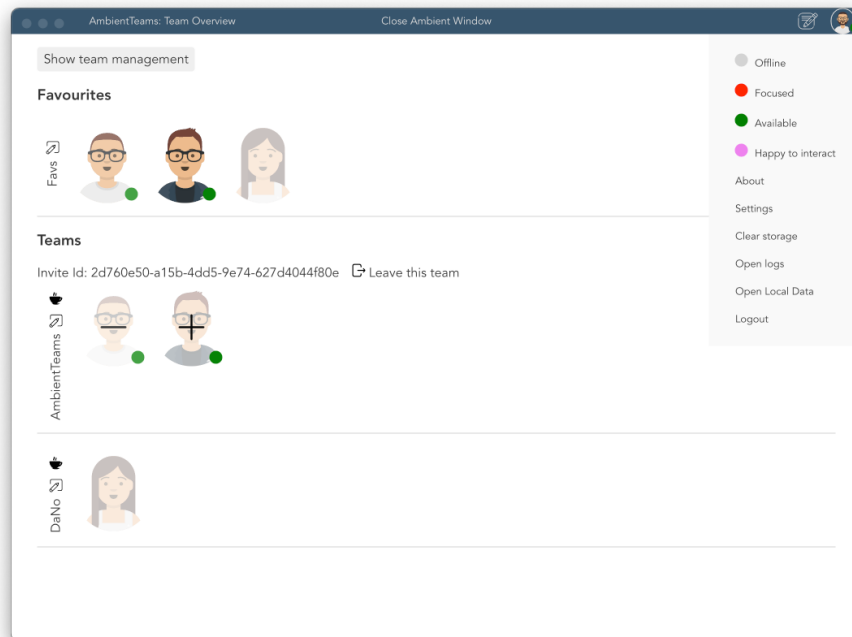
Figure 4.1: Team Overview Window

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 matchmaker 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 OpenMoji[5], 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 by adding a neutral and tired emoticon and two more positive emotions

---

[5]https://openmoji.org

Figure 4.2: Always-on-Top Ambient Window While Working on Another Task

(a) No Hover

(b) Hover
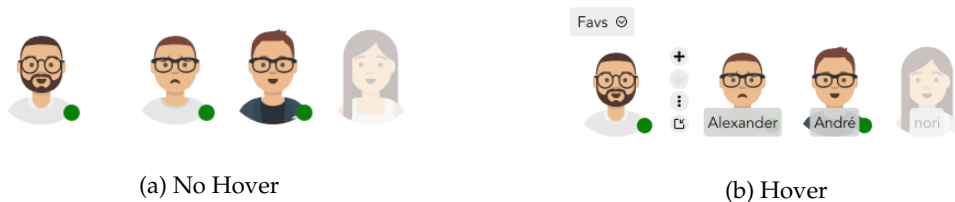
Figure 4.3: Ambient Window

(loving hearts and grinning) to make the selection more balanced. Due to limitations with the avatar API, we could not re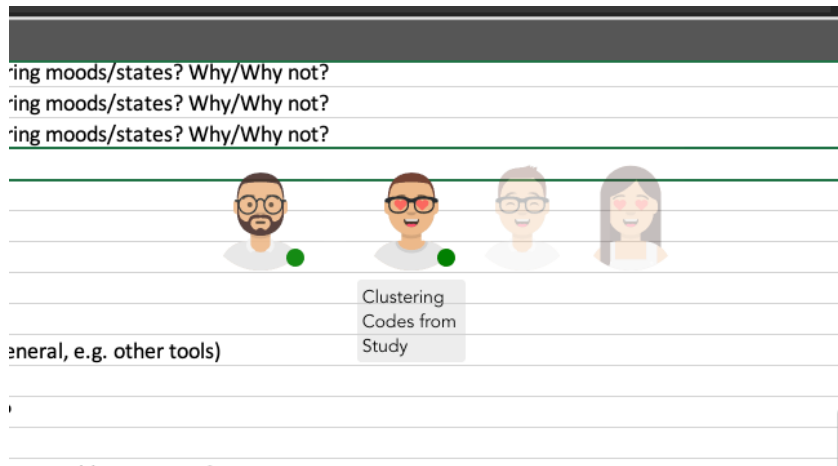nder "fear" well enough, which led us to remove it. On the right, the user can enter additional context in a simple, standard textbox. The contents of this textbox are, if available, pre-populated with the current status message for the currently selected team. Additionally, the text is highlighted when the window is created, facilitating overwriting the current status without using the mouse to select the text manually. The 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 popup 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. We chose those times because that is when most people are already or will still be working.

To ensure that the information shared within AmbientTeams is always 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

(a) Manually Opened

(b) Scheduled
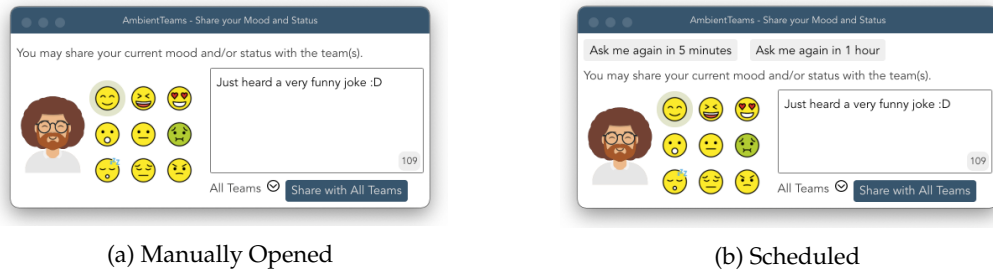
Figure 4.4: Sharing Window

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

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 breakroom and potentially interrupting the initiating user, the breakroom is not created until another user clicks on the coffee icon.

(a) Initiating a Breakroom Creation

(b) Joining a Breakroom
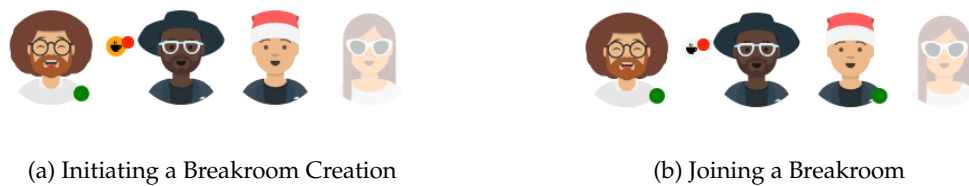
Figure 4.5: Breakroom Creation

Once at least two team members have clicked the breakroom icon, a breakroom is created in the back-end with twilio[6], 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 breakroom. When this timer reaches its end, the user automatically leaves the breakroom.

---

[6]https://www.twilio.com
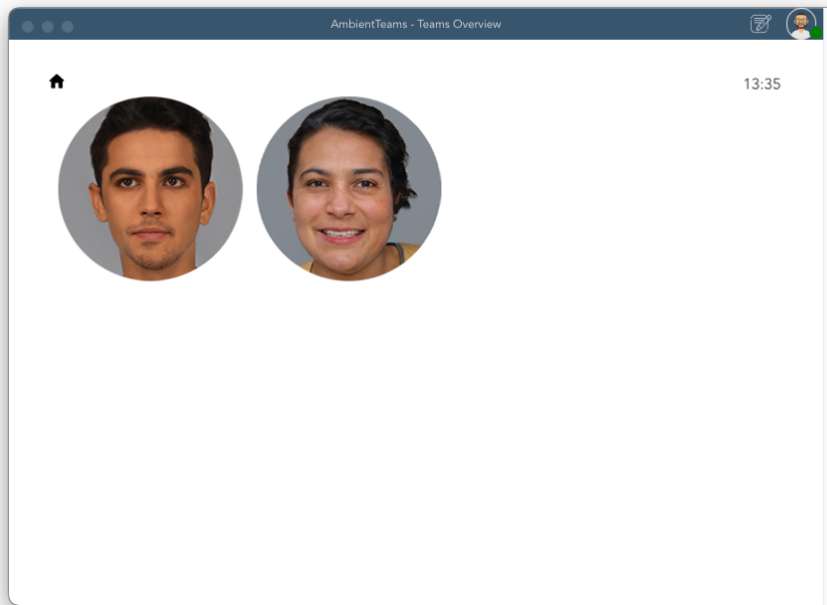
Figure 4.6: Ongoing Breakroom

4.8   Direct Interactions

In addition to broadcasting moods 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).
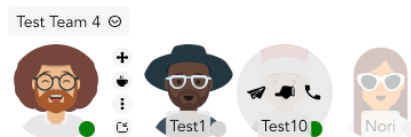
Figure 4.7: Direct Interactions Overlay

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 (Figure 4.9a) are distinguished from status messages by the message icon located to the left of the actual message. Nuding (Figure 4.9b) uses a hand icon pointing to the team member in question. For a video call (Figure 4.9c), the video stream overlays the team member's avatar, and the availability status of
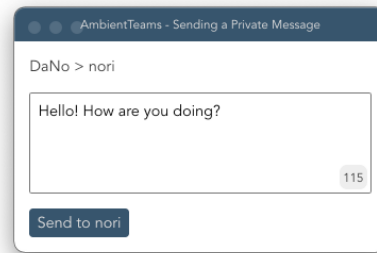
Figure 4.8: Messaging Window

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
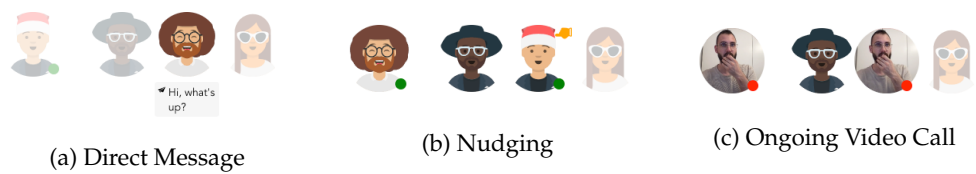
Figure 4.9: Direct Interactions

Preliminary Evaluation

To answer the research questions (see chapter 1 for more information), we conducted a preliminary evaluation. In the small scope of this evaluation, we wanted to learn about the status messages and moods knowledge workers share with their team members, what they learn from their interactions with their teammates and the overall impact on their perceptions of isolation in the workplace. The feedback can then be used to 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 launched with the kick-off meeting with the entire team, each participant was asked to sign and return the consent form (see Appendix A). In addition, each participant was asked to complete a questionnaire that included some demographic questions and a 10-item questionnaire about their perception of isolation in the workplace. During the kick-off meeting, participants were given the opportunity to ask any questions about the consent form. The goal of the kick-off meeting was to install AmbientTeams and show the team each of the features. Following the kick-off meeting, AmbientTeams was deployed for at least three working days (in our case, it was five). After that, but before the final meeting, another questionnaire was sent to the participants to have a before and after comparison of the workplace isolation perceptions. Last but not least, a final interview was conducted with each participant individually to get more qualitative insights.

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

5.1   Participants Recruitment

The first step was to recruit an interested team. The researchers' network was used for this purpose. For this purpose, the study description was forwarded to personal contacts. Once an interested team was identified, it was checked whether it met the participation criteria and whether the potential participants were allowed to install AmbientTeams on their computer (from a technical perspective). If this was not the case, the company's consent and permission to install AmbientTeams were first obtained. To inform the company as much as possible about the study and the confidentiality of the data collected, the consent form and a study description were given to the company for review. After obtaining the company's consent, interested team members were approached individually by introducing the study, discussing the steps and objectives of the study, and emphasizing that participation is completely voluntary. To maintain participant anonymity, each participant was assigned a random pseudonym, e.g., P392, at the beginning of the study, which they could use to identify themselves throughout the study. The requirements for participating teams were:

1. At least three team members
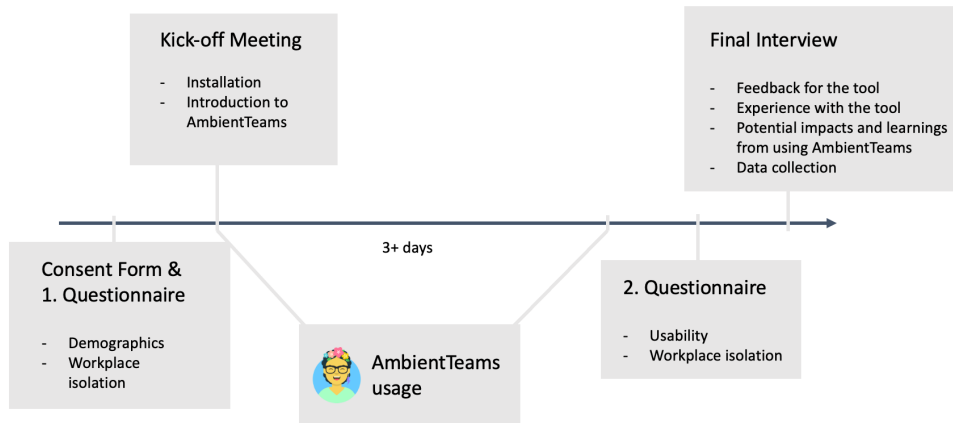
Figure 5.1: Study Timeline

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 includes 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. Questions are also asked about the current culture of communication within the team, whether they are aware of their colleagues' feelings and progress, and preferred work style (remote vs. onsite). The Workplace Isolation Questionnaire was used as a baseline measure. The same questionnaire was also asked at the end of the study, prior to the final interview, to gain possible initial insights into whether our approach could reduce perceptions of workplace isolation among knowledge workers. The workplace isolation questionnaire contains ten questions and uses a 7-point Likert scale, with 1 representing "strongly disagree" and 7 representing "strongly agree". Finally, 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 hold a kick-off meeting with the entire team. During this meeting, the consent form (see Appendix A) and study instructions (see Appendix B) were briefly reviewed, and there was an opportunity to ask questions. We then walked participants through the installation process and explained and demonstrated the functionality of AmbientTeams. Finally, each participant joined the team we had created prior to the meeting. After the kick-off meeting, the study period officially began.

5.4   Evaluation Phase

The team was happy to use AmbientTeams for a workweek (five days) instead of the originally planned three days. During this time, participants were instructed to continue working as usual. Further, participants were instructed to contact us if there was a problem or if they had any other feedback. For very brief feedback, AmbientTeams also has a simple feedback sending feature. During this evaluation phase, usage data of the application was collected from each participant. For this purpose, Table 5.1 shows an overview of all collected data and for which research question it is relevant, along with the storage location (local or server). Local refers to the participants' computers, while 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, whereas only the participants can access the locally stored data unless they explicitly share this data with us at the end of the study.

5.5   Post-Study Questionnaire

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

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

5.6   Semi-Structured Final Interview

To complement the quantitative data, a semi-structured final interview was conducted with each participant individually. The goal of this interview was to gain valuable insight into the use of AmbientTeams, its strengths, weaknesses, and impacts, as well as the participants' sharing behaviors. All interview questions and their relevance to the research questions can be found in Appendix E. Interviews were designed to last approximately 45 minutes per participant, including the time needed to export local data at the beginning of the last interview. Due to the potentially confidential information contained in the data collected, participants were free to obfuscate the contents of the file containing the titles of the active windows before uploading it

to UZH dropfiles[1]. We recorded the interviews if the participant allowed, and then transcribed them. Two researchers (one of whom being the author of this thesis) independently open-coded the transcripts to analyze the interviews.

5.7 Participants

Through our private network of contacts, we were able to find an interested team for the pre-evaluation. The group initially consisted of six knowledge workers working for a Swiss company in the FinTech industry. Unfortunately, one person was eliminated from the study because this person was inactive in using AmbientTeams and could not be reached even after several attempts. The remaining five individuals were three employees who had been with the company for approximately two years. Two had only been with the team for about three months at the time the study began. All participants were between 25 and 34 years old, and their work experience ranged from 3 (working student) to 13 years (senior accountant). Of the five participants, three were female, and two were male.

---

[1]https://dropfiles.uzh.ch/

Entity	Data collected	Storage	RQ Relevance
User	email display name hashed password the teams the user belongs to avatar created on signup	Server	-
Team	name of the team belonging team members	Server	-
Status message	timestamp text content of the status team where status was posted user the status belongs to	Server	RQ2, RQ4
Direct message	timestamp content of the message team where message was sent user the message belongs to	Server	RQ2, RQ4
Availability status	timestamp selected availability status user who posted	Server	RQ4
Direct call	start/end timestamp participants success: true or false	Server	RQ4
Breakroom	team teamMembers start/end timestamp	Server	RQ4
Nudge	sending/receiving user teamId start/end timestamp ending user and type	Server	RQ4
Random call	involved users teamId start/end timestamp succes: true or false	Server	RQ4
Mood	timestamp selected mood user who shared	Server	RQ2, RQ4
Feedback	text content user	Server	-
Window action	opening timestamp minimizing timstamp closing timestamp restoring timstamp	Local	RQ4
Application action	starting timestamp quitting timestamp	Local	RQ4
Active windows	title: e.g. 'Unicorns - Google Search' id: e.g. '5762' bounds: x, y, height, width owner: owning process url: if application is a web browser memoryUsage: e.g. '11015432'	Local	RQ3, RQ4

Table 5.1: Data Collected During the Preliminary Evaluation and Its Relevance for the RQs

Results and Discussion

In this chapter, we present and discuss the results we found by analyzing the collected data (see Table 5.1), the results from the semi-structured interviews, and the findings from the two questionnaires. First, we examined overall usability in section 6.1 and found high usability scores. Furthermore, we analyzed the usage of AmbientTeams in section 6.2. Results show that AmbientTeams ran on average more than 7 hours per day (in the background) on participants' computers, with the time spent using the ambient window falling short of our expectations. Reasons for this were problems with positioning and resizing the ambient window. Lack of mood awareness and lack of social contacts were two challenges cited by our participants, highlighting the need for a mood-based micro-blogging approach (see section 6.3). We discuss the results of each feature of AmbientTeams in section 6.4. Results show that sharing moods was the most frequently used feature. We observed that many participants are hesitant to share negative moods and discuss possible reasons for this in section 6.5. Regarding broader effects of AmbientTeams, we found that AmbientTeams 1) could increase awareness of availability and mood (section 6.6), 2) made getting to know each other better possible, specifically for one participant (section 6.7), and 3) led to more ("natural") communication in other tools (section 6.8). Additionally, self-reflection on moods was perceived as a positive side effect and is discussed in section 6.9. Last but not least, in section 6.10 we present the potential finding that AmbientTeams could potentially improve feelings of isolation in the workplace. However, as with all other findings, a more extensive study would be needed to make more meaningful statements.

6.1   Usability

The results from the usability questionnaire that participants answered at the end of the study are presented in Figure 6.1. For the questions with even numbers, e.g., Q2, Q4, etc., negative (red) answers are desirable, while for questions with odd numbers, e.g., Q1, Q3, etc., positive (blue) answers are ideal. In general, the results look very promising. However, there are some answers that are worth looking at more closely. The "disagree" answer from Q1 came from P3. This participant also did not think that the various functions of the application were well-integrated (Q5). The reason 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. -P3*

The "agree" response in questions Q4 and Q10 came from P2, indicating that the number of features in AmbientTeams is quite challenging to understand on the first encounter. Nevertheless,

this participant did not mention any usability issues either in the interview or through direct feedback, leading us to believe that the application was easy to use after the initial challenge of understanding the application.
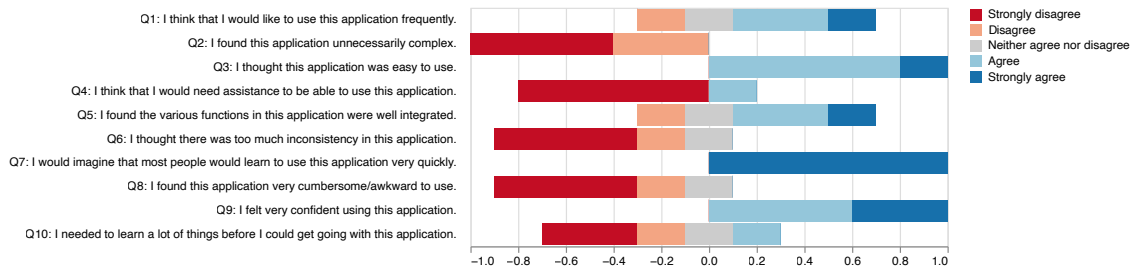
Figure 6.1: Usability Questionnaire Results

Following the instructions from Sauro [Sau11], each participant's responses were then converted to the SUS score to obtain a comparable value. 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], showing that AmbientTeams was easy and intuitive to use.

Participant	SUS score
P1	82.5
P2	80.0
P3	70.0
P4	82.5
P5	90.5
Average	81.1

Table 6.1: Usability Questionnaire Results and Resulting SUS Score

6.2 Tool Usage and Workflows (RQ4)

6.2.1 General Usage

A detailed timeline view of participants and their selected availability state ("Available", "Focused", or "Happy to Interact") during the study is visualized in Figure 6.2. The time a user is in one of these three states is considered the time the application was running. This time also includes the time when the application was not active and was running in the background. This is possible because the user is automatically put into an offline state when the connection to the server is lost. Upon successful reconnection to the server, the user's availability state is also automatically set to "Available". It is, therefore, possible that this metric could be slightly flawed if users manually set their availability status to "Offline". However, this would only underestimate the online time displayed in Figure 6.2. Thus, the times shown there are as conservative as possi-

ble. Overall, the average time spent in an online state, and thus running AmbientTeams, was 7.13 ($\sigma = 3.57$) hours per day (not including the three days with no runtime at all), with a minimum of 0.01 and a maximum of 12.7 hours. Apart from inactivity on weekends, 5 out of a total of 30 working days showed no or minimal runtime. The fact that P1 could not attend the kick-off meeting with the rest of the group explains the lack of use on the first day of the study. In general, the relatively short runtime on the first day was to be expected since the kick-off meeting was held in the early afternoon. The remaining days with very short runtimes most likely indicate non-work days for these participants. This is because, if those were workdays, AmbientTeams would have started automatically as soon as the computer booted up.
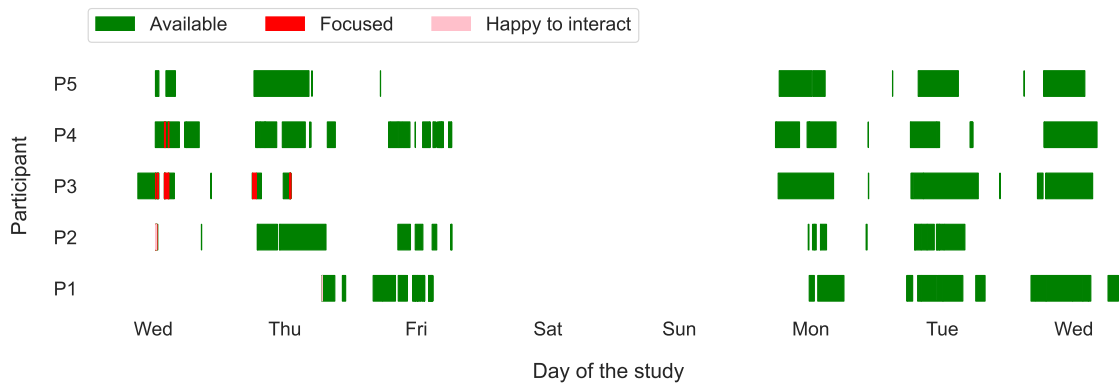
Figure 6.2: Time Spent In the Different Availability States

The results show that participants did not change their availability state often and thus relied mainly on AmbientTeams' automatic setting of the availability state. The "Focused" availability state was selected a few times in the first two days of the study, but this behavior did not continue throughout the study. Similarly, P1 and P2 selected the "Happy to Interact" availability state a total of three times. However, two of those lasted for two seconds, and one during the kick-off meeting for only one minute, making it barely visible in Figure 6.2.

6.2.2 Ambient and Overview Window

Figure 6.3 shows that both the ambient window and the team overview window were open almost exclusively when these windows were in focus. In other words, these two windows were opened, an interaction occurred, and then they were closed or minimized again, disappearing from the user's screen. This is the result we expected in the case of the team overview. However, contrary to our assumptions, the ambient window was used in a very similar way. Conclusively, the ambient window was rarely kept open as a glanceable, always-on-top team view when working on other tasks.

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. -P1*
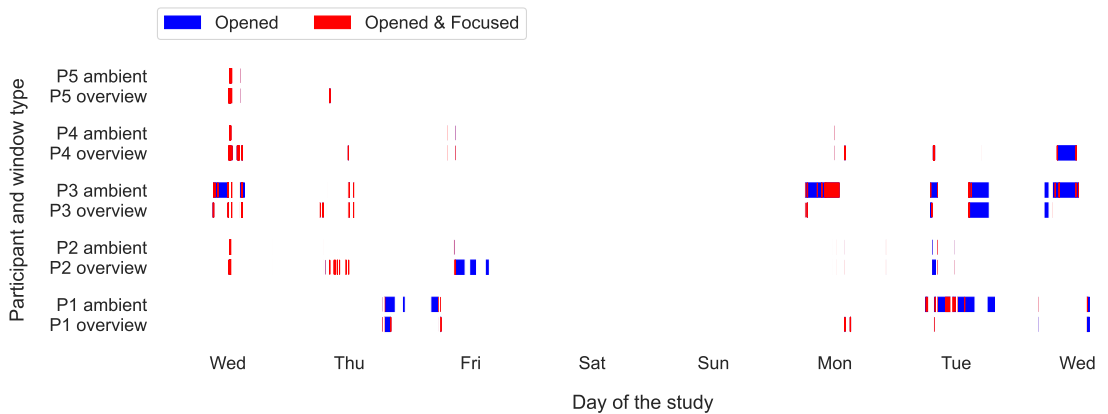
Figure 6.3: Time Using AmbientTeams: Opened vs. Opened and Focused

We suspect that this user was using a single monitor configuration and thus had difficulty finding a suitable position for the ambient window. P3 mentioned that the ambient window was too small and, therefore, difficult to move. This suggests that this participant might have missed the introduction of the resizing feature during the kick-off meeting, or the part was not demonstrated in enough detail. In addition to the inconvenience of the ambient window perceived by P1 and P3, P2 mentioned that manually closing an application that launches automatically is almost automatic for them due to established habits. The inconvenience and difficulty of positioning the ambient window is a fairly crucial issue that may require further development of AmbientTeams; the case described by P2 could be resolved in a future study by not allowing the closing of the ambient window.

To better fit the ambient window into the workflow, P1 suggested that ideally, it should not remain on top of other windows. Instead, it should disappear into the background and only come back to the foreground when a team member has shared something new. P3 also suggested that the ambient window should ideally be hidden when not in use.

Despite the criticism of the ambient window, it was used by all participants except P5 and was seen by P4 as one of the best aspects of AmbientTeams due to its refreshing look and feel:

I liked that the ambient window feels very dynamic and refreshing compared to other tools. -P4

Despite this positive statement, this participant used the team overview window more, which is surprising since all participants were only part of one team during the study, which we believe eliminates the potential advantage of the team overview window. Besides the annoyance of always being in the foreground, we believe that another reason could be that the ambient window is a somewhat novel and unknown approach compared to more traditional applications. In fact, P5 stated exactly that: *"I think it [reason for not using the ambient window] was some insecurity on my part"*. Therefore, a more extended period of usage and getting used to such a window might be required.

However, there were no complaints that the content displayed in the ambient window was distracting in any way, making us feel optimistic about the ambient window and its general appearance. The suggested improvements for better usability are all feasible and could be implemented with reasonable effort.

6.3 Lack of Awareness and Social Contacts (RQ1)

From the interviews, we identified two reasons why there is a need for mood sharing in the workplace: the lack of 1) awareness and 2) social interactions in remote work environments. This finding confirms and reinforces our motivation for developing AmbientTeams.

Lack of Mood Awareness

P2 stated that there is a lack of awareness of the *real* mood when working remotely. Even though one can see their colleagues during video conferences, there is an impression that the feelings expressed by such calls may 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. -P2*

To further emphasize this point, four out of five participants stated in the pre-study questionnaire that they were not or only partially aware of their colleagues' moods. According to P3, this is due to a lack of cues resulting from working from home:

> *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. -P3*

These two statements above both talk about the concept of honesty when it comes to feelings, a topic that, contrary to expectations, was talked about a lot during the interviews and is therefore discussed in more detail in section 6.5.

Confirming what has been mentioned in the related work ([GWS13; Kuw+02]), P4 states that being aware of your co-workers' feelings is important for personal relationships; something P4 says is important:

> *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. -P4*

In addition, by sharing moods and states, certain conclusions can be drawn about the current workload of employees, which facilitates task assignment. Interestingly, the same participant talked about the usefulness of a state "bored", a mood that is not currently part of AmbientTeams. However, such a mood could be a promising addition to the current selection. Before doing that, the potential implications of sharing a negative mood should be considered, something that we discuss in more detail in section 6.5.

> *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. -P2*

Lack of Social Contacts

One participant (P1) talked about how remote working is often very task-oriented, which leads to forgetting the *social aspects of an enterprise*. P3 mentioned that communication is often very business-oriented when working remotely, so conversations are usually started for business reasons only:

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. -P3

In conclusion, there appears to be a need for an approach that provides mood awareness and fosters more social contacts. The following sections examine how our approach, AmbientTeams, performed in addressing the above challenges.

6.4   Moods Were Shared the Most (RQ2)

Moods were the most actively shared statuses, with a total of 31 moods shared. 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, as shown in Figure 6.4. From P2, 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. P5 also mentioned that he/she did not see a reason to provide any more information about the shared moods (which was "tired" ten out of 12 times).
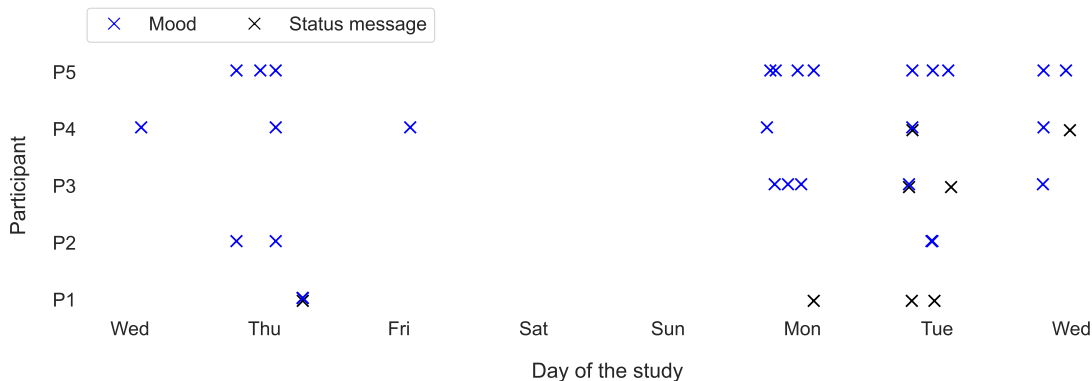
Figure 6.4: Moods and Status Messages Shared

In contrast to the commonly shared moods, only eight status messages were shared. The contents of all status messages can be seen in Table 6.2. In general, none of the status messages contained any work-related information.

Looking at Figure 6.4 or Table 6.2 shows that in only three cases, moods and status messages were shared simultaneously. To our surprise, no negative mood (such as "tired", "angry", or "sad") were further explained with the help of a status message. All three attached moods were either of a happy or neutral nature. However, the neutral mood shared with status message 5 (despite its sad tone) could be due to the absence of an empathy mood in AmbientTeams or a possible mistake by that participant. It becomes apparent that 62.5% of all status messages were sent on one day. The first three messages on that day were all related to a soccer game, which seemed to be of general interest to the group. P3 also described the motivation for sharing such common feelings:

ID	Participant	Day & time	Status message	Attached mood
1	P1	Thu, 20:50	Hiiii	Happy
2	P1	Mon, 16:00	Hiiii	-
3	P3	Tue, 09:00	Hopp Schwiiiiiiz!	Love
4	P1	Tue, 09:30	Switzerland!!!	-
5	P4	Tue, 09:37	Feeling bad for Mbappé :(	Neutral
6	P1	Tue, 13:32	Hey how are you?	-
7	P3	Tue, 16:30	nznznznz, still vibin'	-
8	P4	Wed, 13:42	How is life?	-

Table 6.2: Status Messages Shared and the Moods Linked to Them

[...] 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. -P3

While the scheduled popup window helped remind participants to share something, knowing the importance of social interactions with colleagues (P1) or feeling closer to each other (P5) were other motivators for sharing something with the team.

Given the relatively short time of the study, it is not surprising that many of its features have not been used. Specifically, the features aimed at spontaneous interactions, such as the breakroom and random pairing for a video call, were not used at all. There were two attempts to set up a breakroom, one on the second day of the study and one on the second to last day, but neither was successful because no other team member joined. A reason for no one joining could be that there were only five team members, reducing the likelihood that another person would also take a break. Alternatively, the short time the ambient window was running in the foreground could have resulted in break room requests not being seen at all. During the interview P3 provided a possible explanation for why the spontaneous video chat features were not used:

[...] I have to mention that two or three weeks ago we started with virtual breakrooms 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. -P3

Consequently, it is possible that it was sufficient for the participating teams to meet once a week in their own virtual breakroom. Regardless of the use of the breakroom integrated into AmbientTeams, this suggests that such a breakroom concept is generally perceived as important, as the in-house breakroom is well attended and gives new employees the chance to meet the others according to P3. Like the breakroom, the direct video calls and nudging functionality were only used for testing purposes during the first kick-off meeting. While this shows that the team was aware of how to use these features, they do not seem to have felt the need to do so.

The picture is somewhat different when analyzing the direct messages that were sent via AmbientTeams. A total of six direct messages were sent through AmbientTeams, from three different participants. One of these direct messages was a response to a missed call (during the kick-off meeting), and the other five were either a greeting or of the type "what are you doing?". P1 gives an indication of why the team did not use the functionality described above:

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. -P1

Essentially, P1 explains that AmbientTeams needs to differentiate itself from MS Teams, and it does so with the "Twitter" approach to broadcasting moods and status messages, but not so much with other communications functionality.

6.5 Negative Moods and Honesty (RQ2)

Looking at Figure 6.5, it is clear that except P5, who mostly shared the mood "Tired", the most frequently shared moods were positive (especially "Happy").
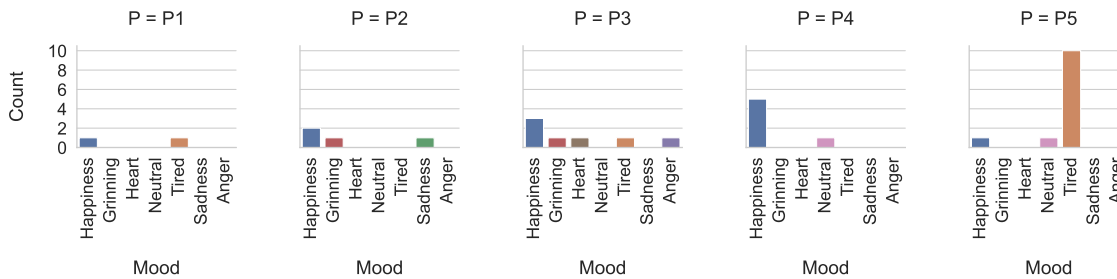
Figure 6.5: Distribution of Shared Moods

Therefore, this finding raised the question of whether this was the true distribution of moods during the study or whether there might be a tendency for more positive moods to be shared, regardless of their true feeling. While P1 sees no problem with sharing negative moods *"we are not in a happy boat where everyone is happy all the time"*, others (P2, P3, P4) would be more hesitant to share such moods. Reasons for not sharing negative moods include 1) *not wanting to explain further*, either for personal reasons or to avoid being distracted (P2), 2) *being fairly new to the company* (P4), 3) *not wanting to share with the whole team* (P3), or 4) because *no one wants to talk about negative feelings at work* (P3).

P4 further differentiated between the severity of moods experienced, indicating that regular, daily negative moods may not benefit colleagues, so stronger negative moods are more likely to be shared:

> *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. -P4*

While most participants seem hesitant about sharing negative moods, P2 mentioned several times during the interview that in cases where a colleague would share a negative mood, P2 would try to help that person.

P4 also brings up that sharing positive moods, even if they are not truthful, could positively affect the person sharing:

> *Sharing something "fake" positive could potentially make them feel better. -P4*

6.6 Availability and Mood (RQ3.1)

The first effect of AmbientTeams was that participants learned who was around (P1, P3) and how they were doing (P1, P4). P5 also noted a significant difference from their previous way of sharing moods and feelings, which was usually via 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. -P5*

AmbientTeams helped P4 raise awareness of colleagues with whom they otherwise have little or no regular communication:

> *I think it was very interesting to see moods and states of team members with whom I might not be currently working together too closely. -P4*

This increased awareness had other implications, namely the opportunity to get to know each other better and to bring back a more natural way of communicating in remote work. We will discuss both in the next sections.

6.7   Getting to Know Each Other Better (RQ3)

AmbientTeams led one person in particular (P4) to find out that a colleague was very funny, which was unknown to this person 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. -P4*

It is no surprise that P4 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 not learning something completely new, P3 mentioned that using AmbientTeams confirmed the previous assumption that *"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 ease getting to know individual team members better, especially for new team members, and to allow learning more about team members with whom 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* (P5). P1 explains that by sharing moods and status messages 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 has 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. -P1*

Another reason for how AmbientTeams can trigger communication includes *seeing when someone comes online* (P1), 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, P2 mentioned that he/she would still offer help in cases of an angry or stressed mood, another possible communication trigger.

Although P2 indicated that AmbientTeams makes it easy to start a conversation by *"simply clicking on the avatar of [a colleague] to start a conversation"* this was not observable in the data collected, as few direct messages were sent and no video calls were made. We, however, observed that AmbientTeams served as a trigger for communication with other tools (e.g., Microsoft Teams, Zoom), which was also brought up in the interviews of P4 and P1. To this end, we also analyzed participants' active window titles during the study to see if there was a higher likelihood of visiting external communication applications after leaving AmbientTeams. More details on active window titles can be found at the end of Table 5.1. As you can see in Figure 6.6 on the left, AmbientTeams was the tenth most frequently used active application. Over the entire duration of the study, the most common communication tools among all participants were Microsoft Teams (4th), Microsoft Outlook (5th), and Skype (9th). The distribution in the chart on the right includes only the active applications that immediately followed AmbientTeams' usage. It can be seen that another application made it into the top ten most active applications: Zoom (rank 3). Two of the three previously mentioned communication tools also improved in rank: Microsoft Teams (rank 1) and Skype (rank 7). The fact that Microsoft Outlook dropped one rank seems reasonable to us, as email is an asynchronous form of communication which we did not expect to be impacted by AmbientTeams. While it is not clear whether the communication promoted by AmbientTeams was work-related or not, P4 mentioned during the interview that he/she had more non-work-related communication during the study. These findings further suggest that AmbientTeams promoted communication in other tools focusing on informal, synchronous communication.
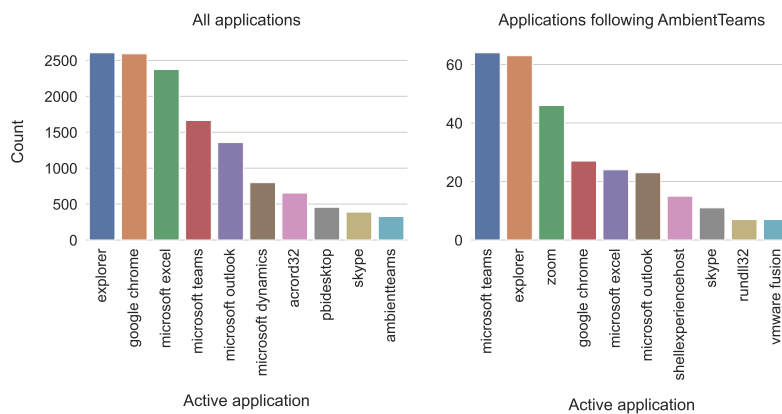
Figure 6.6: Overall Active Window Distribution and Active Windows Following AmbientTeams

6.9 Mood Awareness via Self-Reflection (RQ3.3)

I think it impacted myself because you're always prompted to think about your own mood. -P4

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 (P3, P4, and P5). P5 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. -P3*

6.10 Workplace Isolation (RQ3.4)

The above sections may already suggest the ability of AmbientTeams to reduce feelings of workplace isolation within knowledge work teams. This qualitative data was complemented by our approach to measure workplace isolation quantitatively; a questionnaire was surveyed before and after the study period. Before looking at the results of the questionnaires, it should be noted that we had to adjust the scale due to an error on our side. The original workplace isolation questionnaire uses a 7-point Likert scale. Unfortunately, our post-study questionnaire included a flaw where its answer range was only 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".
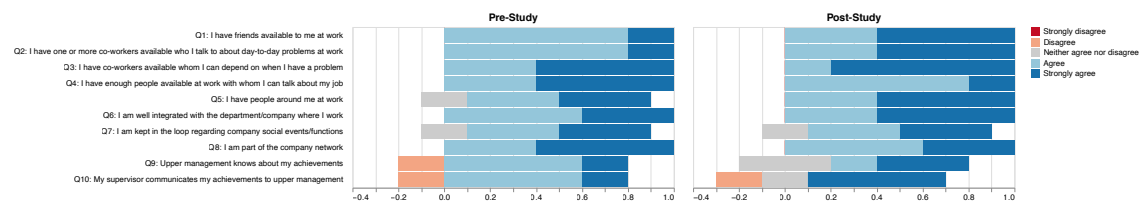
Figure 6.7: Results From the Workplace Isolation Questionnaire: Pre-Study vs. Post-Study

In Figure 6.7, 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 worsened slightly, namely Q4 and Q8. Despite the results showing improvements 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 facilitated by AmbientTeams was not work-related. Second, due to the small size of the study, 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 a suitable supplement for a more extensive study in the future to obtain more accurate information about 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, the 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* (P5) and *company culture* (P2) may be predictors of willingness to share moods in the workplace. Also, the study design worked well in the small setting of this thesis. 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 P2, P3, and P5 indicated that they would prefer to have only one application for their team communications. P2 argued that a single tool would increase the likelihood and time that 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 P3, P4, and P5 told us that there is a genuine interest and potential benefit in reflecting on one's mood. Therefore, one possibility would be for AmbientTeams to move more towards self-reflection in the future. 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]. Furthermore, P3 mentioned that linking tasks to moods would be of high interest. Again, this is similar to AffectAura's functionality of linking emotions to artifacts such as open web pages, documents, or calendar events. 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, P3 liked the idea of linking moods to tasks for self-reflection. Similarly, P5 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.

7.6 Automated Mood Capturing

The most promising future feature prior to this study was the automatic sharing of moods through the use of video input from the webcam. This would lead to real-time sharing of moods and possibly even increase the honesty and accuracy of the shared moods. However, four out of five participants (P1, P2, P3, and P4) mentioned concerns about their privacy and confidentiality if a tool constantly accessed the camera and shared moods automatically. While P5 felt the idea was very progressive, being able to turn off automatic capture would be mandatory. Regardless, if moods are automatically detected, there should always be a confirmation before sharing a mood with the entire team to ensure that nothing undesirable is shared (P4, P5).

Because of privacy concerns with webcam access, we think that using other approaches based more on biometric recognition might be more promising and make it easier to find participants for a study. Regardless of how emotions would be measured, it is probably reasonable to ask users what they want to share before sharing it.

Chapter 8

Conclusion

After having identified the social challenges posed by remote work, we developed an approach to help knowledge workers address these issues. Our approach focused on three main concepts: a design that is unobtrusive, putting the focus on people and their well-being, and fostering informal and spontaneous interactions. Consequently, the key element of our approach was a mood-based micro-blogging solution that allows knowledge workers to share moods and other states with the team and visualizes them in an unobtrusive way. We then developed a research prototype, AmbientTeams, and evaluated it on a team consisting of five knowledge workers.

Complementing our initial research efforts, the interviews confirmed that there seems to be a need for an informal way of sharing moods within knowledge work teams. Our approach aimed to help alleviate feelings of isolation in the workplace and communicate current social states, especially moods, 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 helped knowledge workers to 1) be aware of each other's moods and availability status, 2) get to know each other better, 3) enable communication outside of AmbientTeams, and 4) spur self-reflection on one's moods.

We also found that participants would reject automatic mood detection that requires constant access to the camera due to privacy concerns. Nonetheless, other interesting future directions for AmbientTeams were found and discussed. Possibilities to pursue in the future include conducting a more comprehensive study, focusing solely on the micro-blogging aspect, working on better integration with existing communication platforms, or shifting to a more self-reflection-based approach.

Appendices

Appendix A

Consent Form

**Universität
Zürich**UZH

Software Evolution and Architecture Lab

University of Zürich
Department of Informatics
Binzmühlestrasse 14
CH-8050 Zürich

Contact Person:
Prof. Dr. Thomas Fritz
Tel: +41 44 635 67 32
fritz@ifi.uzh.ch

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

Principal Investigator

Prof. Dr. Thomas Fritz, Associate Professor, Department of Informatics, University of Zurich (fritz@ifi.uzh.ch)

Other Investigators

Dr. André Meyer, Postdoc Department of Informatics, University of Zurich (ameyer@ifi.uzh.ch)

Alexander Lill, PhD Student Department of Informatics, University of Zurich
(lill@ifi.uzh.ch)

Masters Student

Dario Bugmann MS Student Department of Informatics, University of Zurich, (dario.bugmann@uzh.ch)

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

**Universität
Zürich**^{UZH}

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 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.

**Universität
Zürich**^{UZH}

Department of Informatics

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).

Universität Zürich^{UZH}

Department of Informatics

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

Appendix B

Study Instructions

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

Principal Investigator
Prof. Dr. Thomas Fritz, Associate Professor, Department of Informatics, University of Zurich
(fritz@ifi.uzh.ch)
Supervision
Dr. André Meyer, Postdoc Department of Informatics, University of Zurich
(ameyer@ifi.uzh.ch)
Alexander Lill, PhD Student Department of Informatics, University of Zurich
(lill@ifi.uzh.ch)
Masters Student
Dario Bugmann MS Student Department of Informatics, University of Zurich,
(dario.bugmann@uzh.ch)

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
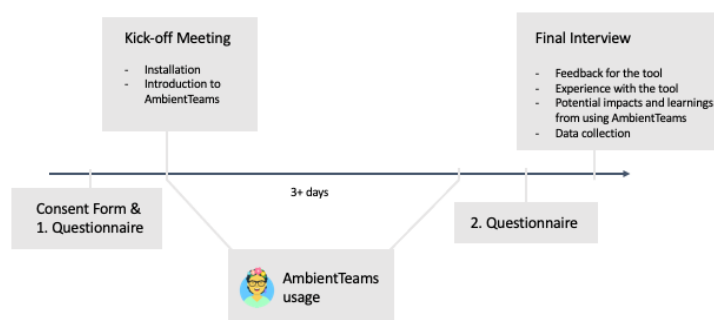
Study Procedure

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 inRemote 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 primarilywork 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 responseswill 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

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 de-
            velopment 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 col-
            laborative systems". In: *6th International Symposium on String Processing and Informa-
            tion 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 con-
            sequences." 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 sup-
            ported 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 Stary, 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.

[Guz13]   Emitza Guzman. "Visualizing emotions in software development projects". In: *2013
            First IEEE Working Conference on Software Visualization (VISSOFT)*. IEEE. 2013, pp. 1–4.

[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 em-
            pathy 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 collabora-
            tion". 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 coor-
            dination". 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 commu-
          nication in globally distributed software development". In: *IEEE Transactions on soft-
          ware engineering* 29.6 (2003), pp. 481–494.

[HM05]   Pamela J Hinds and Mark Mortensen. "Understanding conflict in geographically dis-
          tributed teams: The moderating effects of shared identity, shared context, and spon-
          taneous communication". In: *Organization science* 16.3 (2005), pp. 290–307.

[Höö+08] Kristina Höök et al. "Interactional empowerment". In: *Proceedings of the SIGCHI Con-
          ference 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 commu-
          nication in scientific research collaboration". In: *Proceedings of the 1988 ACM conference
          on Computer-supported cooperative work*. 1988, pp. 1–12.

[Kem+14] Renato Kempter et al. "EmotionWatch: Visualizing fine-grained emotions in event-
          related tweets". In: *Proceedings of the International AAAI Conference on Web and Social
          Media*. Vol. 8. 1. 2014.

[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 confer-
          ence 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. "PresenceScape: 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 Lit-
          erature 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 Aware-
          ness 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*. Citeseer. 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.

[Sán+06] J Alfredo Sánchez et al. "Conveying mood and emotion in instant messaging by using a two-dimensional model for affective states". In: *Proceedings of VII Brazilian symposium on Human factors in computing systems*. 2006, pp. 66–72.

[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.

[TQT09]   Amanuel G Tekleab, Narda R Quigley, and Paul E Tesluk. "A longitudinal study of
            team conflict, conflict management, cohesion, and team effectiveness". In: *Group &
            Organization Management* 34.2 (2009), pp. 170–205.

[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 dis-
            orders". 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.