Master Thesis

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AmbientTeams

Staying socially connected in remote knowledge work teams

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Abstract

As remote work is becoming more prevalent, the informal, spontaneous conversations regularly encountered in co-located work become less frequent because knowledge workers lack essential cues about their colleagues, such as their state of attention or current location. The lack of such social interactions can lead to feelings of isolation at work. While existing approaches focus mainly on improving team awareness to ameliorate coordination and collaboration problems caused by remote work, fewer tools focus on fostering informal, spontaneous communication to reduce the feeling of isolation. To address this gap, our approach focuses on people, their moods and current status, and opportunities for spontaneous interactions to create more social awareness. To this end, we developed AmbientTeams, an unobtrusive and informal tool that aims to reduce the perceived distance between distant colleagues. AmbientTeams seeks to achieve this goal through a mood-based micro-blogging approach that allows knowledge workers to share moods and status updates with their team and provides various ways to respond to what has been shared. In a preliminary evaluation, we tested our research prototype on a group of five knowledge workers who used the tool for one week. The results show that AmbientTeams facilitated getting to know each other by sharing moods and bringing more natural communication, which is otherwise often lost in a remote setting. In general, the encouraging results show that our novel approach of allowing knowledge workers to quickly and easily share moods with their team can benefit them by enabling and encouraging a more informal, lighthearted way of communicating.

Zusammenfassung

Mit der zunehmenden Verbreitung von Fernarbeit werden informelle und spontane Gespräche, die bei der Arbeit am gleichen Standort regelmäßig stattfinden, seltener, da Wissensarbeiter keine wesentlichen Hinweise über ihre Kollegen erhalten, wie beispielsweise deren Aufmerksamkeitszustand oder aktuellen Standort. Der Mangel an solchen sozialen Interaktionen kann zu Gefühlen der Isolation bei der Arbeit führen. Während sich bestehende Ansätze hauptsächlich auf die Verbesserung des Team-Bewusstseins konzentrieren, um Koordinations- und Kooperationsprobleme, die durch Fernarbeit verursacht werden, zu verbessern, konzentrieren sich weniger Tools auf die Förderung informeller, spontaner Kommunikation zur Reduzierung der Isolation am Arbeitsplatz. Um diese Lücke zu schließen, konzentriert sich unser Ansatz auf Menschen, ihre Stimmungen und ihren Status sowie auf Gelegenheiten für spontane Interaktionen, um mehr soziales Bewusstsein zu schaffen. Zu diesem Zweck haben wir AmbientTeams entwickelt, ein unaufdringliches und informelles Tool, das darauf abzielt, die wahrgenommene Distanz zwischen entfernten Kollegen zu verringern. AmbientTeams strebt dieses Ziel an, indem es einen stimmungsbasierten Micro-Blogging-Ansatz verfolgt, der es Wissensarbeitern ermöglicht, Stimmungen und Status-Updates mit ihrem Team zu teilen und somit Raum für Reaktionen schafft. In einer vorläufigen Evaluation haben wir unseren Forschungsprototyp an einer Gruppe von fünf Wissensarbeitern während einer Woche getestet. Die Ergebnisse zeigen, dass AmbientTeams das gegenseitige Kennenlernen durch den Austausch von Stimmungen erleichterte und eine natürlichere Kommunikation ermöglichte, die sonst durch die Distanz oft verloren geht. Im Allgemeinen zeigen die ermutigenden Ergebnisse, dass unser neuartiger Ansatz, der es Wissensarbeitern ermöglicht, schnell und einfach Stimmungen mit ihrem Team zu teilen, ihnen zugutekommen kann, da er eine informellere, unbeschwertere Art der Kommunikation ermöglicht und fördert.

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Chapter 1

Introduction

Knowledge work has become increasingly distributed in recent years [HM01]. This trend is caused by globalization, access to talent, cheaper labor, and the increasing popularity of working from home [Her07; Eco21]. Reasons for this growing popularity 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 manage their family responsibilities better, leading to higher job satisfaction and employee retention [Mul+09; GH07; Mad11].

However, working remotely also brings challenges, namely that coordination and collaboration become much more difficult [Her07]. One reason for this challenge is reduced team awareness, which is the understanding who is working on what, what they will do next, and how their actions might affect others [DB92; Her07; GPS04]. This is because much of the implicit information (who is around, who can be disturbed, or who is currently working on what file) is no longer available when working remotely [GG04]. Consequently, a large body of research has focused on improving these coordination and collaboration challenges by creating tools to increase awareness amongst team members (e.g., [Bie+07; Jak+09; Che+03; DCR05]). These tools aim to improve collaboration efficiency by visualizing file navigation history, improving the understanding of other users' thought processes, visualizing co-workers' progress, or offering chat functionality where work-related conversations can be had, organized, and saved for later reference [Bie+07; Jak+09; Che+03; DCR05].

However, previous work by Gutwin, Penner, and Schneider suggested that software developers can find all the information they need for their work even without such advanced awareness approaches [GPS04]. Further, advances in commercial collaboration tools seem to develop rapidly (e.g., Google Workspace, JetBrains Space, GitHub, Microsoft Teams). For those reasons, our research focuses on more social challenges resulting from remote work, such as the scarcity of informal communication.

Due to the reduced awareness in remotely working teams, spontaneous, and often informal, communication is more difficult to initiate, and thus less prevalent in remote work [KEG88; SCS06; Her07; HM05]. However, this is not desirable, because spontaneous or serendipitous communication, such as "corridor or watercooler talk", accounts for about 85% of all communication [Kra+], and can help to spread news faster among teams [Her+00] or reduce coordination problems [HG99] by gathering important background information that enables more effective teamwork [Lan07; HM01].

The lack of such social interactions can lead to other interpersonal problems, such as difficulties in building trust, maintaining working relationships, or leading to feeling disconnected from the team [Com+20; OO06]. In extreme cases, 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], while strong team cohesion has been shown to positively impact team effectiveness and productivity of a team [Car+17]. Research has thus also looked into ways of encouraging more social, spontaneous interactions within remotely working teams. One approach is virtual offices, which use virtual representations of an office where users can navigate around and interact with others and which have been developed both in research (e.g., [Lou+12]) and commercially (e.g., Branch[1], Reslash[2], Wonder[3], or Gather[4]). While Lou et al. [Lou+12] noted an increase in informal communication through the use of their virtual worlds approach, we believe their 3D office visualization can be intrusive and therefore less suitable for everyday use in the workplace.

Another, less intrusive concept aimed at promoting informal communication is micro-blogging in the workplace (e.g., [ES08; ES10; Zha+10; Dul+13]). Micro-blogging is an informal form of communication where users can describe their current status, progress, or thoughts in short text messages and share them with other users [Jav+07; 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 more effective collaboration. However, this information is often lost in a remote setting because written text, which is often used among knowledge workers, has limited ability to convey emotional data [Höö+08]. By studying WeHomer, Dullemond et al. [Dul+13] found an increase in team-connectedness and their participants had easy access to otherwise hard to obtain information. Despite their promising results, we note some limitations of their approach, namely that sharing moods was impossible without a status message, making it impossible to measure an isolated effect of sharing moods. In addition, the representation used for the moods was relatively inconspicuous by using text (e.g., ":-)"), leading us to believe that the effect of sharing moods was not very pronounced. Last but not least, responding to shared posts is only possible via commenting, which is visible to everyone else and therefore may not be ideal for more personal comments. Their findings and the fact that the COVID-19 pandemic has led to alarming numbers in employee well-being and mental health - 65.9% of people report an increase in stress, and 44.4% report a decrease in mental health [Spa20] - prompted us to develop a mood-based micro-blogging approach built on the foundation of WeHomer.

In our work, we extend WeHomer by addressing the identified limitations and studying the following key concepts:

1. *Focus on People and Micro-Blogging*
   Our approach focuses on people both visually and content-wise, and enables informal communication through mood-based micro-blogging.

2. *Spontaneous Interactions*
   Complementing micro-blogging, we believe that various opportunities for spontaneous interactions should be offered.

3. *Unobtrusive Design*
   Our approach focuses on moods by emphasizing them in a novel, unobtrusive user interface.

Following these concepts, our goal is to increase social awareness and strengthen the sense of belonging to the team. This work aims to implement those concepts in a research prototype and evaluate their potential in a small preliminary evaluation. We investigate whether there is a

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

general need for mood sharing in the workplace (RQ1), what users share with their team (RQ2), how users use our tool (RQ3), and what the broader implications of our approach are (RQ4). 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?

Tool Usage and Workflows

RQ3: How do knowledge workers use and interact with a mood-based micro-blogging tool? How do they integrate it into existing workflows?

Impacts of AmbientTeams

RQ4: What are the effects of a mood-based micro-blogging tool?

- *RQ4.1*: Do mood and status sharing increase the awareness between team members, and how? What do they learn from each other?
- *RQ4.2*: Does sharing moods and statuses affect the sharing user?
- *RQ4.3*: Does a mood-based micro-blogging tool reduce the feeling of isolation in remote knowledge work teams?

Following the concepts introduced above, we developed AmbientTeams, 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 (see Figure 1.1). It differs from existing micro-blogging solutions in that it is more person- and mood-centric, and uses a novel approach to the user interface. Further, the content of textual information is de-emphasized as it 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 response options such as direct messaging and video conferencing to allow for spontaneous interactions.

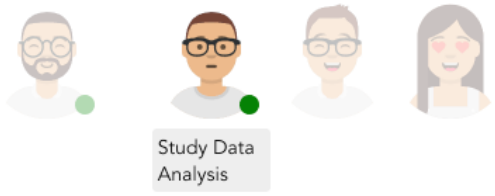


Figure 1.1: AmbientTeams: Screenshot of the Glanceable, Always-on-Top Window

To answer the research questions, we conducted a preliminary evaluation with five knowledge workers who used AmbientTeams for one week *in-situ*. The participants confirmed the importance of staying aware of their co-workers' moods. 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 more aware of each other's moods and availability status, 2) get to know each other better, 3) foster communication outside of AmbientTeams, and 4) spur self-reflection on one's moods. To summarize, the main contributions of this work include:

1. the development of a mood-based micro-blogging approach with spontaneous interaction capabilities, and
2. the conduct of a preliminary evaluation that led to findings on increasing awareness and micro-blogging behavior in remote teams, as well as design considerations for such tools.

The thesis starts with an overview of related work in chapter 2 and continues with a discussion of the approach and its key concepts 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, our findings are discussed and possible future directions of our approach are outlined in chapter 7.

Chapter 2

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 remotely, namely the feeling of workplace isolation, reduced informal communication, lack of awareness, and reduced well-being. Together with existing solutions to solve 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 [MMM07]. Organizational isolation stems from the perception that remote workers might "fear that when they're out of sight, they're out of mind" [BK99, p. 61]. This is related to a lack of awareness, which is discussed in section 2.3 in more detail. Additionally, remote workers more often lack support from their supervisors and co-workers [MMM07]. Social isolation relates to the fact that remote workers miss the informal, spontaneous conversations 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, productive, and viable [TQT09; Car+17].

Similarly, feeling disconnected from colleagues has been shown to hinder the execution of productive tasks [Eco20].

For these reasons, the following section takes a closer look at communication and, more specifically, informal communication.

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 [CE07; GG95]. 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 [GPS04]) 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 essential for many developers [Sto+16] and a lack thereof 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 particular 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]. Therefore, 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] further pronounces the importance of informal communication.

Existing Tools
Because of the above-mentioned benefits, it is no surprise that numerous approaches have been developed to foster 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 a colleague 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 game-like approach by being more similar to the user interfaces of traditional communications applications.

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 the sharing of short messages 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, 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:

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

- *Informal Awareness*
  Informal awareness is the "general sense of who's around and what they are up to" [GGR96, p. 6]. 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 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 [GGR96]. 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 it can help with difficulties in finding experts in a distributed team [HM03]. Social awareness is a necessity to initiate and carry on a conversation [GGR96], 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, disappearing separation between work and private 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 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–negative), whereas the arousal dimension contrasts states of low arousal with states of high arousal (calm–excited)" [TB14, p. 117]. 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
Color-based approaches are commonly used when visualizing emotions, which make use of colored bubbles or clouds 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 [McD+12]. 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

Existing approaches are were shown to be successful at increasing knowledge workers' team awareness on topics such as who their co-workers and teammates are, which tasks everyone is working on, and the progress they have made [Bie+07; Jak+09; Che+03; DCR05]. However, they only cover a limited view of awareness by providing few social or emotional cues. Therefore, our work focuses on social, casual information exchanges to help remote teams facing challenges with workplace isolation, team awareness, informal communication, 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 this chapter.

3.1 Focus on People

Remote workers "fear that when they're out of sight, they're out of mind" [BK99, p. 61] and potentially suffer from the perception of workplace isolation [Mul+09; MMM07]. In addition, virtual employees may fear that their efforts will not be recognized or appreciated as much as those of their co-located colleagues [CK02]. Despite those facts, only a few approaches developed for use at the workplace seem to include social awareness, an essential type of awareness at the workplace [GGC96]. Some, such as JazzBand and ContactMap [Che+03; Whi+04] take a similar visual approach to ours by visualizing individual team members and enabling communication between them. However, by being an Integrated Development Environment (IDE) plugin, we argue that JazzBand's resulting communication likely is work-related and only used during coding activities. Similarly, ContactMap facilitates email communication [Whi+04], 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 those types of team 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 emphasizes the people rather than work artifacts. Other social awareness information displayed by our approach is elaborated in the following section.

3.2 Mood and Context Sharing

To leverage the positive impact of micro-blogging on the feeling of connectedness among colleagues [Dul+13], we use a micro-blogging approach with optional mood sharing. Existing micro-

blogging tools explicitly designed for use at work lay the foundation of our approach and the information we want to visualize in our glanceable, always-on-top view (more details are given in section 3.4). However, micro-blogging is a purely text-based form of communication. Similarly 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 [Spa20]. In contrast to WeHomer, a micro-blogging tool developed by Dullemond et al. [Dul+13], we make mood sharing optional and visually de-emphasize the shared status message compared to the moods. Last but not least, combining an ambient approach introduced in section 3.4 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.

3.3 Spontaneous Interactions

Remote workers tend to desire the social interaction of informal chats and spontaneous discussions [CK02]. Further, spontaneous communication is crucial for achieving high productivity and social goals [Kra+] such as developing work relationships [Com+20; OO06], which makes the fostering of informal, spontaneous of communication a goal of our approach. While the micro-blogging concept employed by our approach has the potential to increase spontaneous interactions, we also want to enable serendipitous moments (e.g., random "watercooler talks") and quick one-on-one interactions.

Serendipitous Interactions
The goal is to mimic the watercooler in the office. Thus, simple signaling, similarly to just walking to the watercooler in an office and indicating to the other team members that you are now on a break, is required. This effortless signaling is motivated by Chang and Ehrlich [CE07], who emphasize that initiating a conversation must be as simple as possible.

Direct Interactions
Similar to Chang and Ehrlich [CE07], we believe that initiating a conversation should be made as easy as possible. To this end, our approach allows users to respond directly to shared moods or status updates, something that was heavily used in WeHomer developed by Dullemond et al. [Dul+13]. We extend their functionality by exploring different ways to initiate direct contact with another person.

3.4 Unobtrusive Design

By mimicking real offices, virtual office approaches, many of which have been released due to the COVID-19 pandemic, all have a significant downside: requiring a fair bit of user interaction due to the visually complex user interface. We argue that this adds much 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. Thus, we want to keep interactions lightweight and casual; hence the functionality is kept simple, maybe even limited,

[1] https://tandem.chat/

by design. The information shared and displayed is transient, meaning no chat history is available, making the tool essentially useless 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 hide potential distractions are required.

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 previously 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"

Teams are stored on the server and require a unique identifier to join, similar to a simple invitation-based approach commonly used in practice. For scenarios where a user is part of multiple teams, team members from different teams can be associated with a "favorites" team, such that these colleagues from different teams appear side-by-side in the ambient window (see subsection 4.4.2). These "favorites" teams exist only on users' local machines. In general, there is no visual difference between the two types within AmbientTeams, except that there is no breakroom available for "favorites" as they exist only locally.

4.3 Avatars

At the core of our approach are the users' avatar representations. 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 because it is much easier to perform simple mood

[1] `https://www.electronjs.org/`
[2] `https://vuejs.org/`
[3] `https://nodejs.org/`

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 avatar during the sign-up process and can 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 mood.

4.4 Two Main Windows

AmbientTeams consists of two main windows: the team overview and the ambient window. The functionality and use cases for both are introduced in the next sections.

4.4.1 Team Overview Window

The team overview window is responsible for maintaining a connection to the server, authentication, login functionality, and includes a settings page. 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 members from each team that will then be displayed on the other main window of AmbientTeams, namely 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 are part of.

4.4.2 Ambient, Glanceable Window

The ambient window always remains 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 use 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. By clicking on the three dots in the menu (see Figure 4.3b), which will reveal a small drop-down menu, the team overview window can be opened or closed. Also, in this menu, the ambient window can be zoomed in or out 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.

4.5 Availability Status

We wanted to keep the number of interruptions in AmbientTeams to a minimum, which is why there is the "Focused" availability state (see Figure 4.9c) that exists in addition to the three other availability states ("Available", "Offline", and "Happy to Interact"). Users in this focused state cannot be called. Further, they do not see any direct messages or incoming nudges until they leave the focused state. In addition, focused users cannot directly interact with other team members,

[4] https://getavataaars.com

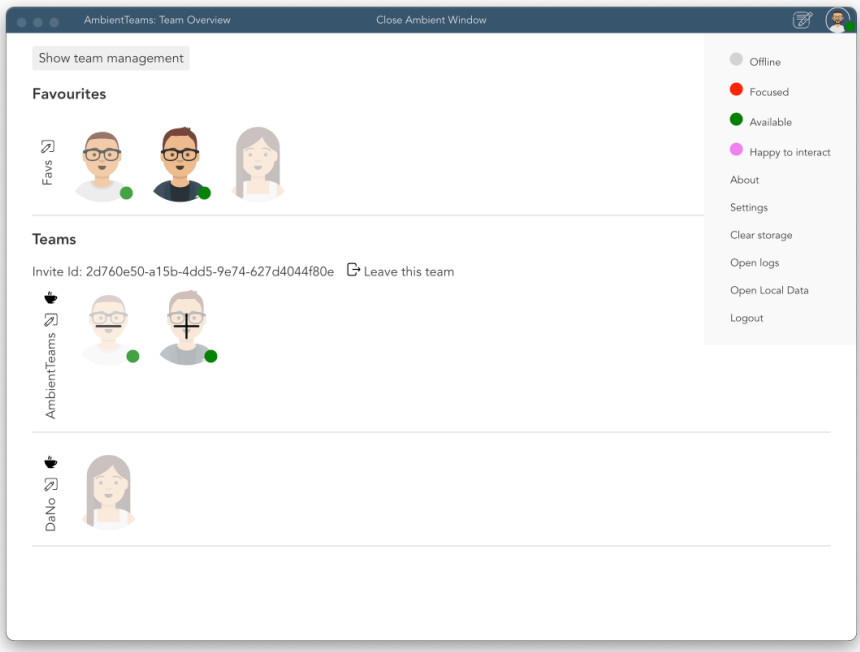


Figure 4.1: Team Overview Window

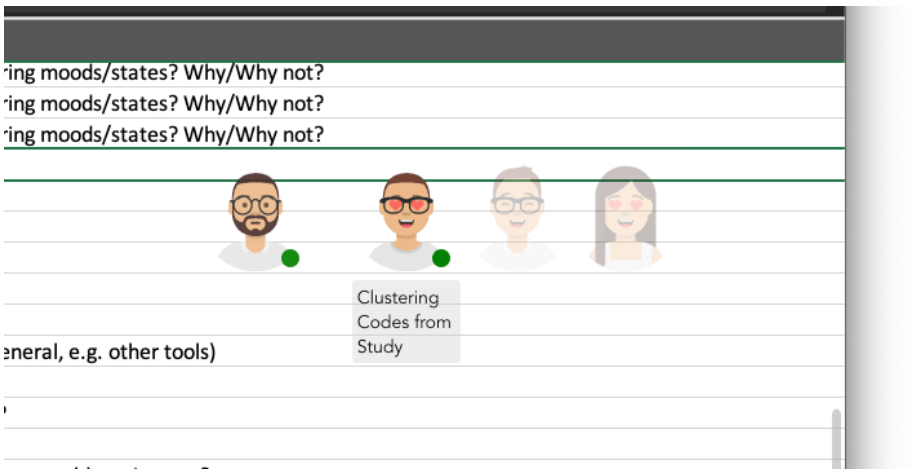


Figure 4.2: Always-on-Top Ambient Window While Working on Another Task

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.

(a) No Hover

(b) Hover

Figure 4.3: Ambient Window

4.6 Sharing Moods and Status Messages

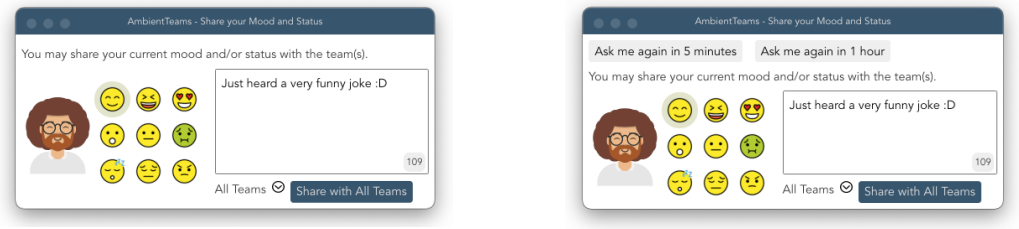
The user can open the sharing window from both the team overview and the ambient window, and the system tray menu. All of those actions will open the sharing window as shown in Figure 4.4a, where on the left, a preview of the current avatar and the selection of available moods are displayed. There are 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 (loving hearts and grinning) to make the selection more balanced. Due to limitations with the avatar API, we could not render "fear" well enough, which led us to remove it. On the right, the user can enter additional context in a simple, standard textbox. The contents of this textbox are, if available, pre-populated with the current status message for the currently selected team. Additionally, the text is highlighted when the window is opened, facilitating the overwriting of the current status without using the mouse to select the text manually. The length of the status message is limited to 140 characters, motivated by Twitter's initial limit [Dul+13]. Below the text field, the user finds 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 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: the longer there has been no recent activity, the more the avatars fade. Those activities include status and mood sharing, direct messaging, and nudging. This automatic hiding should motivate users to interact with such hidden team members and allow them to easily spot updates from colleagues. Another measure we have taken to avoid presenting outdated content is automatically resetting status updates at midnight.

Since the goal of AmbientTeams is to encourage informal, spontaneous communication, there is no chat history or other history built into the application. We want to promote more casual and less formal communication with this feature and hope to avoid that AmbientTeams becomes just another tool to keep track of.

[5] https://openmoji.org



(a) Manually Opened (b) Scheduled

Figure 4.4: Sharing Window

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.

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).

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 dis-

[6] https://www.twilio.com

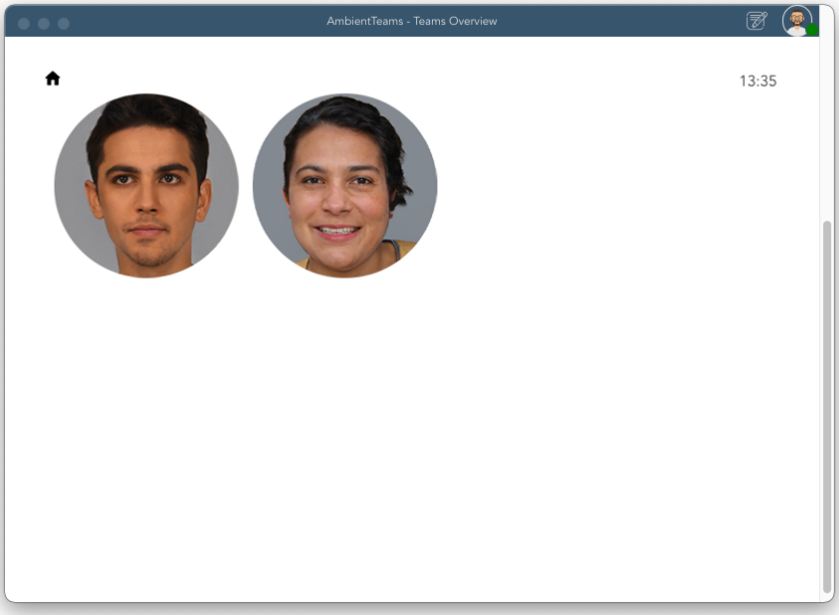


Figure 4.6: Ongoing Breakroom

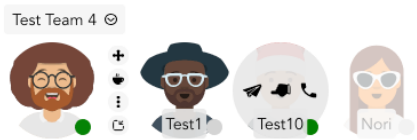


Figure 4.7: Direct Interactions Overlay

played 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.

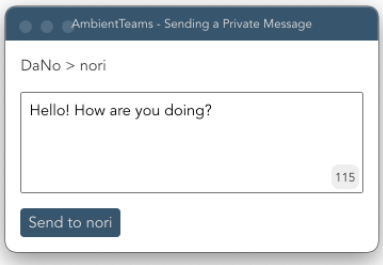


Figure 4.8: Messaging Window

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 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, one has 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

Chapter 5

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. Their 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, 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 all the features and functionality of AmbientTeams. 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.

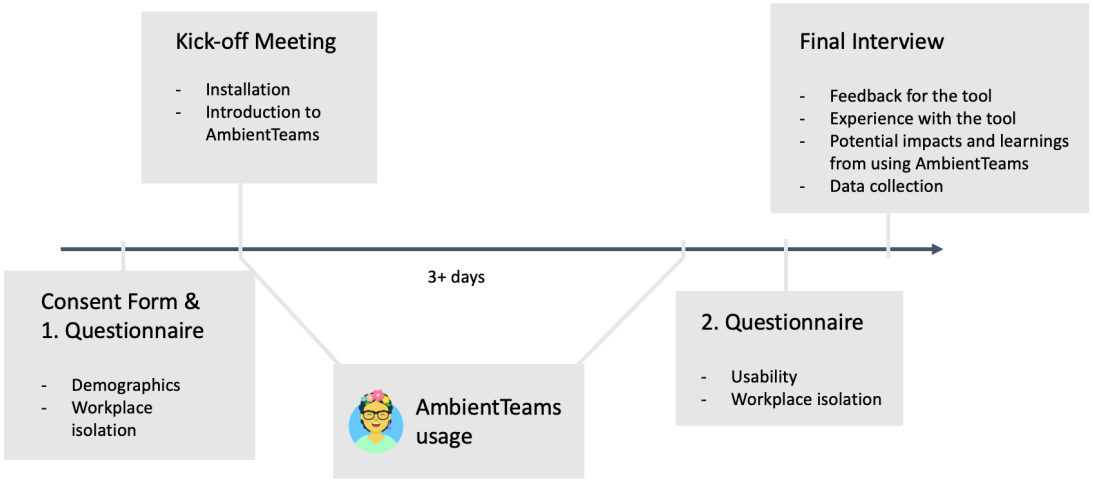


Figure 5.1: Study Timeline

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. To that end, the study description was forwarded to personal contacts. Once an interested team had been identified, we 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 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 entirely 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
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 one 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 the data was 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. Due to the small number of participants, this comparison was not evaluated with statistical measures, but results were compared exclusively with visualizations. In addition, the SUS helped 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 when the participant allowed and then transcribed them. Two researchers (one of whom is the author of this paper) independently open-coded the transcripts to analyze the interviews. First, each statement was assigned a code, with new codes added on an ongoing basis. Then, similar codes were clustered into multiple categories. These codes and categories were then compared and discussed by both researchers to reach a consensus.

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, RQ3
Direct message	timestamp content of the message team where message was sent user the message belongs to	Server	RQ2, RQ3
Availability status	timestamp selected availability status user who posted	Server	RQ3
Direct call	start/end timestamp participants success: true or false	Server	RQ3
Breakroom	team teamMembers start/end timestamp	Server	RQ3
Nudge	sending/receiving user teamId start/end timestamp ending user and type	Server	RQ3
Random call	involved users teamId start/end timestamp succes: true or false	Server	RQ3
Mood	timestamp selected mood user who shared	Server	RQ2, RQ3
Feedback	text content user	Server	-
Window action	opening timestamp minimizing timstamp closing timestamp restoring timstamp	Local	RQ3
Application action	starting timestamp quitting timestamp	Local	RQ3
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

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

Chapter 6

Results

In this chapter, we present the results from the preliminary evaluation, based on the collected data (see Table 5.1), the semi-structured interviews, and the findings from the two questionnaires.

First, we identified two challenges when working remotely, namely a lack of mood awareness and social contacts, highlighting the need for a mood-based micro-blogging approach (see section 6.1). We then examined the overall usability of AmbientTeams in subsection 6.4.2 and show high usability scores. What is more, we analyzed the usage of AmbientTeams in section 6.4. Results show that AmbientTeams ran on average more than 7 hours per day (in the background) on participants' computers. Reasons for this included problems with positioning and resizing the ambient window. We discuss the impact of each feature of AmbientTeams in section 6.2. 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 6.3. Regarding broader effects of AmbientTeams, we found that AmbientTeams 1) could increase awareness of availability and mood (section 6.5), 2) made it easier to get to know each other (section 6.6), and 3) encouraged more ("natural") communication in other tools (section 6.7). Additionally, self-reflection on moods was perceived as a positive side effect and is discussed in section 6.8. Last but not least, we present the potential finding that AmbientTeams could improve feelings of workplace isolation in section 6.9.

6.1 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.

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*

The two statements above both talk about the concept of honesty when it comes to feelings, a topic that was talked about a lot during the interviews and is therefore discussed in more detail in section 6.3.

Emphasizing the importance of mood awareness, P4 stated that being aware of co-workers' feelings is essential for personal relationships:

> *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 "bored" state, 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 6.3.

> *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*. Similarly, 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 those challenges.

6.2 Moods Were Shared the Most (RQ2)

Moods were the most actively shared statuses, with a total of 31 moods shared (out of 45 total interactions). 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 confirms 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 status message, as shown in Figure 6.1. 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).

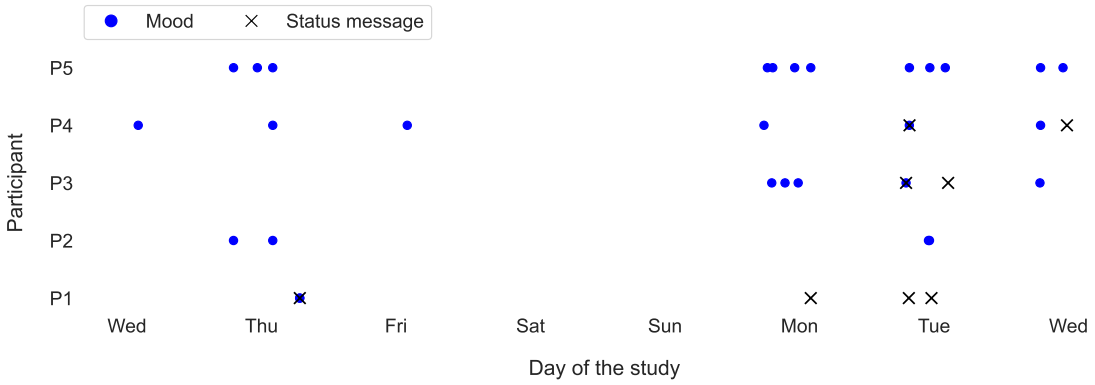


Figure 6.1: Moods and Status Messages Shared

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 6.1: Status Messages Shared and the Moods Linked to Them

In contrast to the commonly shared moods, only eight status messages were shared in total. The contents of all status messages can be seen in Table 6.1. In general, none of the status messages contained any work-related information.

Looking at Figure 6.1 or Table 6.1 shows that in three cases, moods and status messages were shared simultaneously. To our surprise, no negative moods (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:

> *[...] 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.

Many of the features of AmbientTeams were not used during the preliminary evaluation. 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. 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*

Like the breakroom, the direct video calls and nudging functionality were only used for testing purposes during the kick-off meeting.

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.

6.3 Negative Moods and Honesty (RQ2)

Looking at Figure 6.2, it is clear that except P5, who mostly shared the mood "Tired", the most frequently shared moods were positive (especially "Happiness").

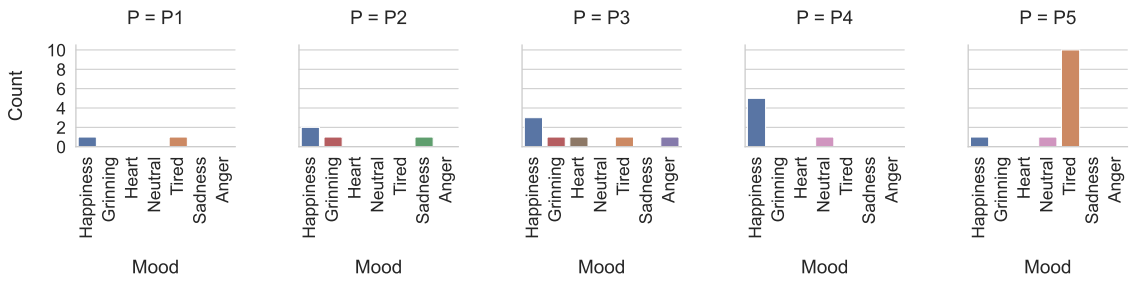


Figure 6.2: Distribution of Shared Moods

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 true feeling. While P1 sees no problem with sharing negative moods because *"we are not in a happy boat where everyone is happy all the time"*, others (P2, P3, and 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, 3) not wanting to share with the whole team (P3), or 4) because it is not desirable to talk about emotions at work.

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*

6.4 Tool Usage and Workflows (RQ3)

6.4.1 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.

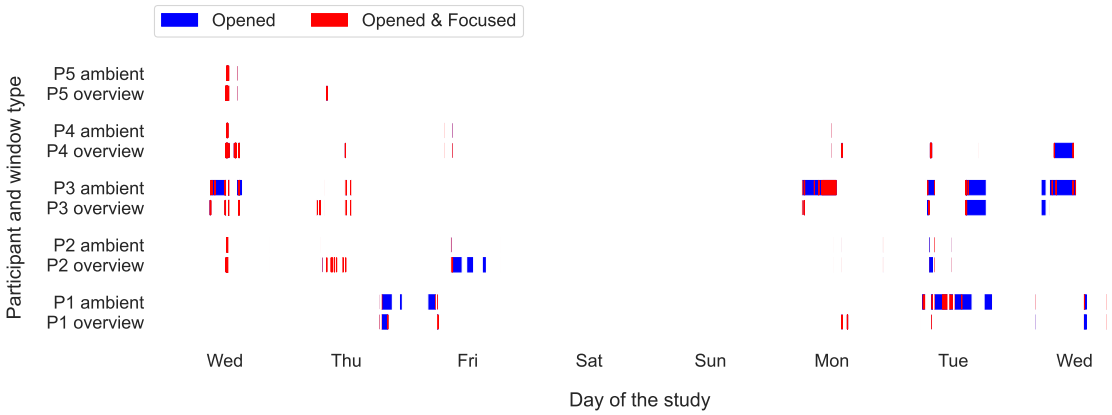


Figure 6.3: Time Using AmbientTeams: Opened vs. Opened and Focused

The interviews gave us some more insights into possible reasons 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

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.

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 optimistic statement, this participant used the team overview window more without clearly explaining why this was the case.

6.4.2 Usability

While there were no usability issues reported during the study, we still asked the participants to fill out a usability questionnaire before the final interview. The results from the standardized usability questionnaire that participants answered at the end of the study are presented in Figure 6.4. 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, showing high usability ratings overall. However, there are some answers that are worth discussing. First, the "disagree" answer from Q1 came from P3, who also thought that the various features of the application were not 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

Second, 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.

Following the instructions from Sauro [Sau11], each participant's responses were then converted into the SUS score to obtain a comparable value. The resulting average SUS score was 81.1 ($\sigma = 6.58$, $min = 70.0$, $max = 90.5$) across all five participants. 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. Scoring 80.3 or higher also increases the likelihood of recommending the product to a friend [Sau11].

6.4.3 Availability

A detailed timeline view of participants and their selected availability state ("Available", "Focused", or "Happy to Interact") during the study is visualized in Figure 6.5. The time a user is

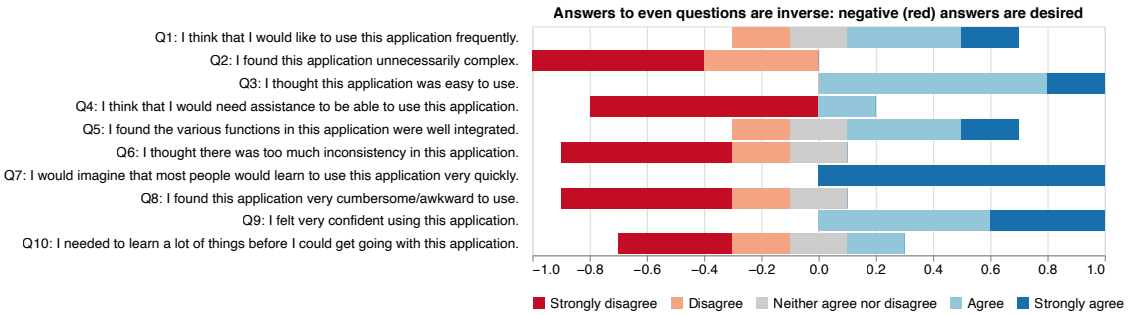


Figure 6.4: Usability Questionnaire Results

in one of these three states is considered the time the application was running. This time also includes the period 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, 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 6.5. Thus, the times shown there are conservative. Apart from inactivity on weekends, five out of a total of 30 working days showed no or minimal runtime (less than one hour), leading us to remove those five data points. The average time spent in an online state, and thus running AmbientTeams, was 7.68 ($\sigma = 3.09$) hours per day, with a minimum of 2.04 and a maximum of 12.7 hours. 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.

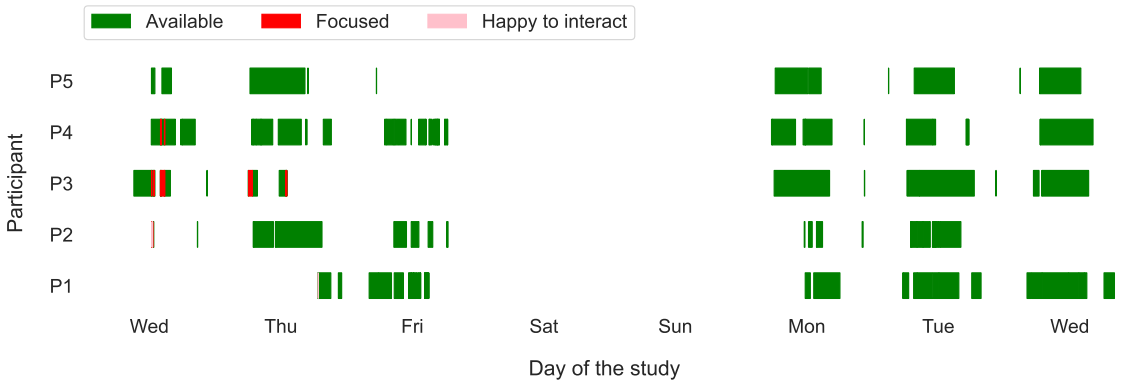


Figure 6.5: Time Spent In the Different Availability States

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 6.5.

6.5 Availability and Mood (RQ4.1)

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 elaborate on both in the following sections.

6.6 Getting to Know Each Other Better (RQ4)

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 not surprising that P4 was relatively new to the company and therefore had not yet had the opportunity 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 that 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 can ease getting to know individual team members better, especially for new team members, and allow learning more about team members with whom they might not be in constant exchange.

6.7 Bringing Back “Natural” Communication (RQ4)

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 way 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 confirm this, we also analyzed participants' active window titles during the study to see if there was a higher likelihood of visiting other 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. Two of the three previously mentioned communication tools improved in rank: Microsoft Teams (rank 2) and Skype (rank 6). While it is not clear whether the communication promoted by AmbientTeams was work-related or not, P4 mentioned during the interview that they had more non-work-related communication during the study. Microsoft Outlook was not affected and remained on rank 5, further suggesting that AmbientTeams promoted communication in other tools focusing on informal communication.

6.8 Mood Awareness via Self-Reflection (RQ4.2)

> *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 mentioned 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:

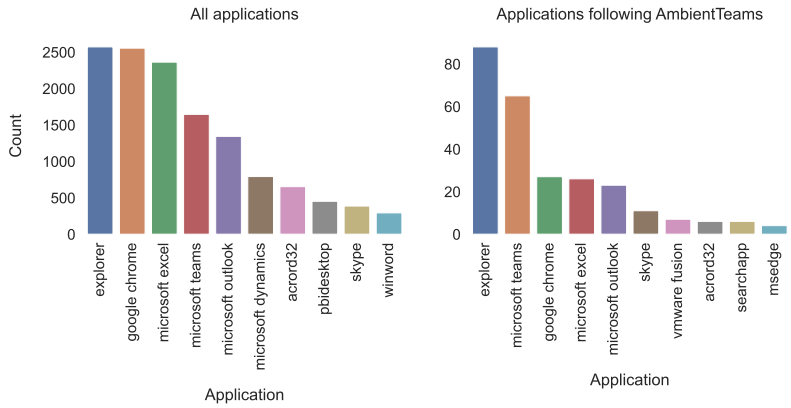


Figure 6.6: Overall Active Application Distribution and Active Applications Following AmbientTeams

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

6.9 Workplace Isolation (RQ4.3)

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 more 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”.

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.

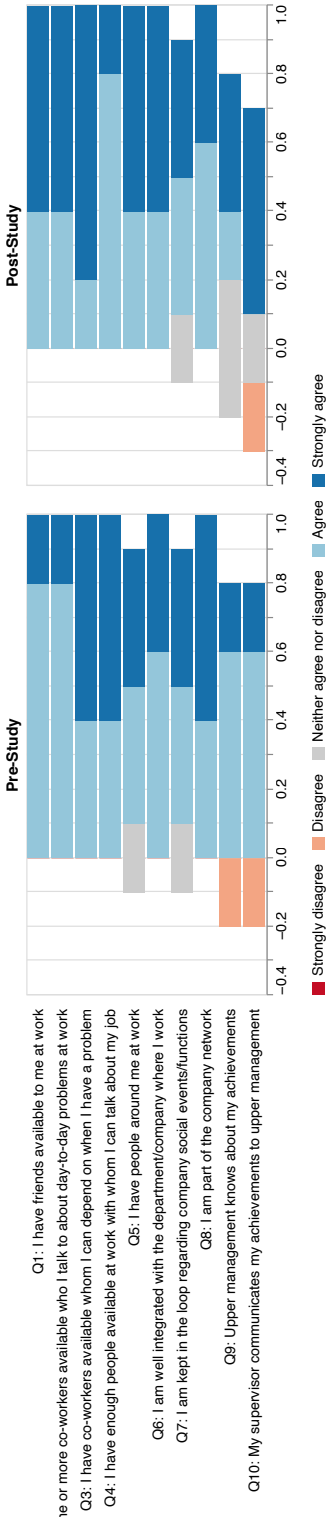


Figure 6.7: Results From the Workplace Isolation Questionnaire: Pre-Study vs. Post-Study

Chapter 7

Discussion

This chapter discusses the key findings from our preliminary evaluation and elaborates on possible future directions that our approach, AmbientTeams, could take.

7.1 Ambient Window

In contrast to our expectations, the ambient window was not necessarily the primarily used window when interacting with AmbientTeams. While the high usability scores that resulted from the system usability questionnaire show that AmbientTeams was perceived as intuitive and easy to use, P1 mentioned that they were annoyed by the ambient window, as it always was in the foreground. This inconvenience and the difficulty of positioning the ambient window is a fairly crucial issue that may require further development of AmbientTeams. Allowing the ambient window to disappear behind other applications is a potential solution given by one of the participants. The case described by P2 (closing AmbientTeams due to established habits) could be resolved in a future study by not allowing the closing of the ambient window. Further, we believe that another reason for the little usage of the ambient window could be that its 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"*. Possibly related to that is the behavior of P4, who liked the ambient window, yet still used the team overview window more often. Therefore, a more extended period of usage and getting used to such a window might be required.

All things considered, and since there were no complaints that the content displayed in the ambient window was distracting in any way, we are 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.

7.2 (Mood) Awareness and Informal Interactions

Our participants confirmed that they experience a lack of mood awareness and social interactions when working remotely, reinforcing our motivation for developing AmbientTeams. As their in-house breakroom is well attended and gives new employees the chance to meet each other, it suggests that such a breakroom concept is generally perceived as essential and partially explains why the breakroom integrated into AmbientTeams might not have been used.

Since the mood sharing functionality was used more extensively, AmbientTeams managed to increase awareness, primarily mood awareness. Like Church, Hoggan, and Oliver [CHO10], who

stated that being aware of one's moods could act as a springboard for communication, we could gather similar insights. While we have not been able to identify lots of communication within AmbientTeams, we see an increase in other communication applications such as Microsoft Teams or Skype directly after AmbientTeams was used. While this does not necessarily guarantee that a conversation took place at all or that it was spontaneous, it suggests that interactions immediately following AmbientTeams seem to take place on more informal platforms such as Skype, which still leaves us feeling optimistic.

In contrast to the beliefs of García, Favela, and Machorro [GFM99] that mood awareness would improve the effectiveness of collaboration, we cannot make such statements about our participants. However, our participants mentioned that they would be likely open to help should they notice that their colleagues shared a negative mood. We also learned that a rather unexpected benefit of AmbientTeams was that it managed to increase mood awareness throughout the day, not just in the morning, which is beneficial because this information was not readily available before the study. In addition, we believe this could also be an advantage for most teams, even if daily standup meetings are established.

7.3 Sharing Behavior

Our mood-based micro-blogging approach seems not to have impacted work-related awareness since exclusively non-work-related content was shared. This is in contrast to the study performed on WeHomer, which found that the content of the shared status messages was often personal or non-work-related but also included work-related information [Dul+13]. Reasons for this discrepancy could be that our finding is 1) highly company-specific or 2) not comparable due to a lack of collected data points. Despite these concerns, however, we believe that one possible explanation is that our mood-centered visualization approach, coupled with the transient nature of the displayed content, primarily supported the sharing of non-work-related status messages. If there is no chat history, the contents inevitably are less likely to be formal because the chat no longer serves as a "knowledge archive".

We believe that this is also the reason why moods were shared far more frequently than status messages. Further, and confirming what has been mentioned in the related work (e.g., [GWS13; Kuw+02]), P4 mentioned the importance of staying aware of others' moods for personal relationships. On top of that, we hypothesize that the visual representation of AmbientTeams stirred the participants unconsciously towards sharing more moods and non-work-related information. Regardless of the reasons for such behavior, we see this as an advantage as it positions AmbientTeams in a somewhat niche sector of communication tools.

To our surprise, the reasons behind deciding which moods should be shared or which not, particularly negative moods, were often brought up in the final interviews. While Dullemond et al. [Dul+13] found similar results in the sense that positive moods were shared more frequently, we were able to gather first insights into the reasons why people might be hesitant to share negative moods.

A possible future update to the sharing mechanism currently in use could include allowing content to be shared with only a subset of the team. This could be beneficial as not all moods, and status updates are intended for the entire team (P3).

7.4 Workplace Isolation

Although the results of the conducted workplace isolation questionnaire suggest slight improvements in most questions, 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 study's small scale, there was no control group, so comparing the two questionnaire answers 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.

7.5 More Extensive Study

In order to make more meaningful statements about AmbientTeams, a more extensive study is required, especially considering that certain functionality was not used during our preliminary evaluation. 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. Nevertheless, 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, and potentially the ambient window as explained in section 7.1 - in a larger setting.

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 possible updates in the following sections.

7.6 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 message 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. However, these are findings that we obtained from a small group of participants, all part of one company, and therefore cannot be generalized. Regardless, simplifying AmbientTeams would also have the benefit of making it easier for study participants to learn to use, as there are fewer features to learn and discover.

7.7 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 this 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 the simplicity of initiating a call with a few clicks, it could also leverage the more mature video conferencing capabilities of the existing solution for more seamless interaction between AmbientTeams, making it feel less like "just another tool" and more like a potential facilitator for using existing tools. The second possibility 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 subscribers' desire for a universal communication tool, we would also lose much flexibility. The ambient window would have to go, and it is 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 more appropriate approach.

7.8 Self-Reflection

Feedback from P3, P4, and P5 showed 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 some new "local mood" that is only visible to them. 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 [McD+12]. 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.

7.9 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 their colleagues' current workload. Following the idea of integration with existing tools (see section 7.7), 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.

7.10 Automated Mood Capturing

We asked the participants during the final interview what they generally think about an automatic sharing of moods through video input from the webcam. In our opinion, this would lead to real-time sharing of moods and possibly even increase the honesty and accuracy of the shared moods. Furthermore, such a feature could positively affect the long-term usage of AmbientTeams, as it requires little to no effort to share 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, having the option 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 using other approaches based more on biometric sensing that can be used without exposing too much private information (such as skin conductivity or respiration [PVH01]) might 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.

7.11 Threats to Validity

External validity: In our preliminary evaluation, one threat to external validity is the generalization of a single, relatively small team to the entire remotely working population. Therefore, to achieve better generalization beyond the setting in which we conducted the preliminary evaluation, the study should be repeated in other teams. Regarding the generalizability of the sample data, there are risks due to the small number of data points and the very short study period. The short evaluation period may have also biased results because of the novelty effect of our tool. Finally, the ongoing COVID-19 pandemic may limit the ability to generalize our results to a situation outside of a pandemic.

Internal validity: There may have been a bias in the open coding of the interviews. This is because the author of this thesis was heavily involved in the open coding of the interviews. However, we attempted to minimize this risk by bringing in another researcher who was also familiar with the project. Last, because one participant dropped out during the evaluation period, there is a chance that the feedback obtained during this preliminary evaluation was positively biased in favor of the tool.

Chapter 8

Conclusion

After identifying 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: 1) an unobtrusive design, 2) focusing on people and their well-being, and 3) encouraging informal, spontaneous interactions. Consequently, we developed a research prototype, AmbientTeams, a casual and informal tool based on mood-based micro-blogging that allows knowledge workers to share moods and status updates with the team. We then tested and evaluated AmbientTeams on a team consisting of five knowledge workers.

Complementing our initial research efforts, the interviews confirmed that it seems beneficial to share 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 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) trigger 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.

The main contributions of this work include 1) the development of a mood-based micro-blogging approach with spontaneous interaction capabilities and 2) the conduct of a preliminary evaluation that led to findings on increasing awareness and micro-blogging behavior in remote teams, as well as design considerations for such tools.

Appendices

Appendix A

Consent Form

Universität Zürich[UZH]

Software Evolution and Architecture Lab

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

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Purpose

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

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

Study Procedure

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

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

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

Benefits and Risks

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

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

Personal Information

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

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

Data, Storage & Confidentiality

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

Data collected by AmbientTeams

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

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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

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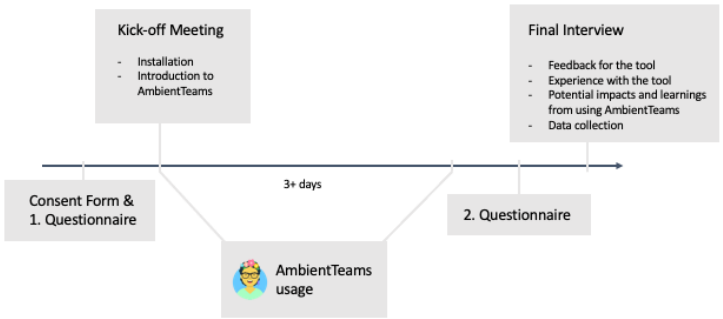
Masters Student
Dario Bugmann MS Student Department of Informatics, University of Zurich, (dario.bugmann@uzh.ch)

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.

Appendix C

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?

Appendix D

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

Appendix E

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

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