Smile to Me: Investigating Emotions and their Representation in Text-based Messaging in the Wild

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ABSTRACT

Emotions are part of human communication shaping mimics and revealing feelings. Therefore, conveying emotions has been integrated in text-based messaging applications using emojis. While visualizing emotions in text messages has been investigated in prior work, we studied the effects of emotion sharing by augmenting the WhatsApp Web user interface. For this, we designed and developed four different visualizations to represent emotions detected through facial expression recognition of chat partners using a web cam. Investigating emotion representation and its effects, we conducted a four weeks longitudinal study with 28 participants being inquired via 48 semi-structured interviews and 64 questionnaires. Our findings revealed that users want to maintain control over their emotions, particularly regarding sharing, and their preference to view positive emotions avoiding unpleasant social situations. Based on that, we phrased four design recommendations stimulating novel approaches for augmenting chats.

CCS CONCEPTS

• **Human-centered computing** → **Empirical studies in collaborative and social computing**; *User studies.*

KEYWORDS

Affective computing, emotion recognition, text messaging.

1 INTRODUCTION

With the emergence of digital communication, the way we communicate has changed dramatically. The expressive way of communicating information in combination with emotions and feelings using mimics evolved to a rather puristic way of exchanging information. Digital communication helps simplifying communication by abstracting from parts such as tone, gestures, mimicry, or body language which normally facilitates face-to-face communication. However, conveying emotions in chats has become more difficult since it requires the conscious selection of emojis. Despite the emerge of emojis or GIFs, pervasive sensing technology has put a lot of effort into allowing to implicitly assessing user's emotions. Accordingly, recent work in human-computer interaction (HCI) has often tapped into new ways of sharing and communicating emotions in digital communication platforms through facial expressions [19] or body worn sensors [24, 33]. Through this sensing advancement, emotions can be sensed continuously and ubiquitously. However, there has been little research on the long-term effects of emotion representation in chats in the wild and their deployments for a period of four weeks. While prior work often focus on the evaluation of a specific system or a single emotion representation, our research explores rather the design aspect in connection with the user experience and the consequences for their communication. In this work, we investigate potential effects, risks and preferences on how emotions are favorably displayed in chats by representing emotions in four different visualization modes in an in-the-wild study being deployed for four weeks. As an exemplary chat application, we took the commonly used WhatsApp Web and enriched the text-based communication with current user emotions by building the Chrome browser extension that detected facial expressions via the web cam. Our extension injected
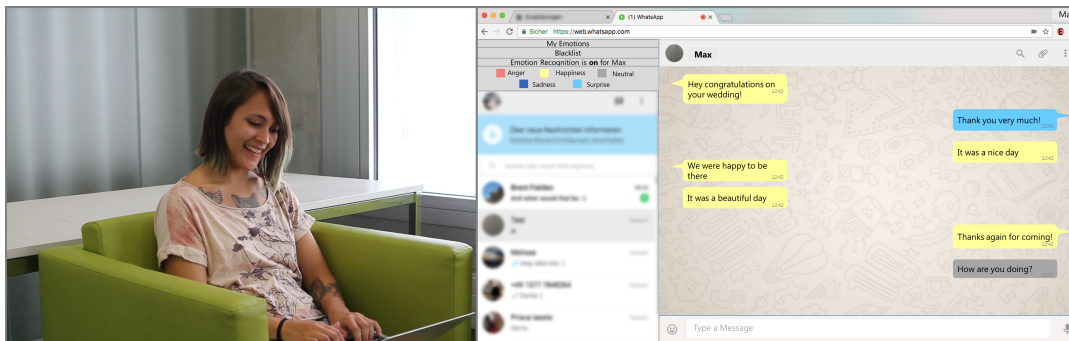
Figure 1: Participant using our system being able to visualize happiness, surprise, sadness, anger, and neutrality during the long-term user study (left). Based on the users' feedback the best visualization mode perceived for presenting and sharing affective states in instant-messaging was the colored chat bubble (right).

HTML code into WhatsApp Web to display the emotions of users by employing four different visualizations. We report on the design process and a long-term user study with 28 participants using all the visualizations for four weeks, particularly one week each. Based on 112 data sets, we discuss how emotion representation in chats is perceived by users when being deployed for four weeks in a natively used text messenger. From this genuine in-the-wild collected feedback, we infer four design recommendations holding insightful implications for designers and developers when augmenting chat applications with emotions.

2 CONTRIBUTION STATEMENT

For this work we designed – informed by a focus group and related literature – and developed a plug-in extension to capture facial expressions and represent the user's affects in the WhatsApp Web application comparing four different visualization modes. We hereby contribute the investigation of emotion representation in text-based messaging in the wild for four weeks. By using the native text messenger participants had been used before and after, we collected genuine user feedback being rested on long-term usage. From our data set comprising 112 interviews and questionnaires in total, we derive four design recommendations from our key findings providing insights on the representation of emotions in chats.

3 RELATED WORK

Emotions

Emotional responses are a part of humans' everyday lives. Due to the diversity of emotions, there exist multiple definitions. Kleiniginna and Kleiniginna [29] categorized 92 definitions and concluded that it is best to give a broad overview referring to the numerous ways in which emotions can be explained. Ekman and Oster [14] were among the first who discussed the notion of a universal set of emotions. According

to Plutchik [46] a set of basic emotions, namely happiness, surprise, acceptance, anticipation, sadness, disgust, anger, and fear is sufficient to express more emotional response also varying in their intensity. Considering intensity, Russell [52] provides another approach; he described emotions in a two dimensional *Circumplex model of affect* containing *arousal* on the y-axis and *valence* on the x-axis. Based on this work, there has been a lot of research focused on emotions and exploring emotionally motivated behavior in HCI. In particular, Rosalind Picard, as one of the pioneers, shaped the term *affective computing* [45]. Emphasizing the importance of emotion recognition to progress in practical applications and wearable computers, prior research focused on the development of an user adaptive system sensing emotions [20, 27, 28, 37, 58]. Simultaneously, Umair et al. [56, 64] presented a wrist display for visualizing affective data. The AFFECTECH training network exceeds the approach to capture emotions based on physiological sensors and rather focuses on understanding and training emotions [50].

Facial Expression Emotion Recognition

The face is one of the richest channels for expressing emotion and non-verbal communication [2, 36, 68]. Facial expression recognition using camera-based technologies has significantly progressed in the past years. Due to the ubiquity of cameras and the collection of large training datasets, the accuracy of classifying emotions from images and videos increased enormously [36]. This advancement led researchers to create toolkits enabling the embedding emotion recognition on various platforms in real-time to build affect-aware systems [2, 36]. Bettadapura [4] and Zeng et al. [68] provide comprehensive overviews on emotion recognition modalities and especially facial expression recognition for emotion detection summarizing the state-of-the-art. Moreover, in education, student's affective state have been monitored and

developed an affect-aware tutoring [3, 67], such as in gaming [42], and in enriching online communication [16, 19]. Hence, Filho et al. [19] created a prototypical mobile phone application recognizing smiles via phone frontal cameras. Further, emotions have been recognized using web cams for mirroring the user's facial expressions on an avatar during chatting [16]. While Angeslav et al. [1] used facial expression recognition while writing emails to communicate contextual cues to the mail receivers, El Ali et al. [15] filtered emojis in chats based on facial expressions recognition.

Emotions in Messaging Applications

Research has been concerned with ways to support emotion expression in instant messaging since it came to existence. While the emotion expression can be explicit, i.e requiring the user to actually input the emoji, GIF, or text adjustment, techniques to implicitly sense emotion in instant messaging are also now prevalent. In practice, researchers have investigated ways to automatically detect emotion cues from text [26, 31, 34, 40], facial expressions [1, 16, 18], or using physiological sensors [24, 32, 66]. Moreover, this input on the user's affects was represented by several text effects, as Lee et al. [31] and Wang et al. [66] explored. Further, Buschek et al. [6] implemented *TapScript*, a mobile chat application which uses custom fonts and phone sensors to add font effects to communicate context. Another way to visualize affect in chats is by representing the chat's atmosphere [62, 65]. Pong et al. [47] presented *GamIM*, where the chat's general atmosphere whether positive or negative, was indicated based on text analysis. Likewise, *iFeelIM* communicates emotional feedback in chats sensed by text analysis, through a wearable garment [63]. Several researchers used avatars, images and emojis to represent emotions in chats based on facial expression detection [1, 16, 18]. With the rise of wearable physiological sensors, researchers started investigating visualizing physiological information in chats to enhance emotional expression. Lee et al. [32] presented *EmpaTalk*, a video chat which utilizes heart rate and skin response sensors and presents their raw values in real time to chatting partners. Hassib et al. [24] used heart rate sensors to visualize heart rate information in text messaging. DiMicco et al. [13] investigated how to communicate arousal in chats by animating text. Additionally, emotional experiences related to social networks [54, 55], as well as associated with communication kinds [9] have been studied by previous work.

Summary

Prior work has used physiological sensing and facial expression detection for sharing information, e.g. arousal in chats. While often dedicated text-messaging applications have been build to investigate the effects, our work provides an WhatsApp Web plug-in that is embedded in the native application

and therefore allowed us to collect genuine user feedback over a usage period of four weeks in the wild.

4 METHOD

Our research approach embraced three different stages: Focus groups, design and implementation of the system, and the evaluation part. First, we performed a consecutive analysis of user requirements by conducting two separate focus groups discussing the concept of emotion-based chat augmentation. Throughout these sessions we gathered fruitful design suggestions and derived several requirements for the design of such a chat application. In conjunction with literature reviews on relevant prior work, we then designed and built our system inspired by the users' desires. By this approach we followed [11, 61] describing the different stages of conducting focus groups and interviews, also referring to their analysis. Lastly, we applied our web browser extension in a long-term user study in the field and collected 112 qualitative data sets via interviews and questionnaires informed prior work [53, 57] when planning the field study.

Design Elicited by Focus Groups

To embed emotions into a chat application, we first used focus groups to explore users' opinions on the integration of emotions in chats. In particular, we focused on gathering ideas on how to visualize emotional responses and to identify important aspects that had to be taken into account in the design process of such an application.

Participants and Procedure. We initially conducted two focus groups, each lasting approximately 90 minutes. A total of twelve participants took part (9 male, 3 females) aged between 20 and 30 years ($M = 22.8, SD = 3.1$). Eleven participants were students and one was a PhD researcher; all but one had studied computer science. We found that all our participants used chat applications frequently and all of them were using WhatsApp. Additionally, 66.7% said they communicated via Skype which was followed by 33.3% using the Facebook Messenger. Some participants also communicated via Telegram, WeChat, Rocket Chat, and Signal depending on the context of usage (e.g., peer groups chats). Once the participants arrived at our lab, we briefly introduced them to the overall topic of the focus group and handed out consent forms. After explaining our idea of automatically augmenting chats with emotions, we asked the participants how they would feel about seeing their own and their chat partner's emotions displayed in a chat. We encouraged them to suggest emotions which they wished to convey in chats noting down all ideas on a whiteboard for subsequent discussions. Then, we asked participants to sketch their ideas of how emotions could be visualized in PC-based chat platforms. Pairs of participants were given a blank sheet of paper, only showing

Figure 2: Two exemplary paper prototypes resulting from our focus groups: (A) Colored faces beside the text bubbles representing happiness with *yellow* and anger with *red* (B) Different profile pictures for contacts showing the detected emotions.

the rough outline of a PC-based chat window that served as a basis for their paper-prototype. Once the paper-prototypes were realized, the participants' ideas were discussed as well as advantages and disadvantages highlighted in group debates. In a second iteration, we presented a sketch of the WhatsApp Web[1] application (cf. Figure 2). We chose this example because WhatsApp Web is widely known which was supported by our participants' statements; it follows clear interface guidelines also used by other chat-applications, such as ICQ2, Skype, or Google Hangouts.

The teams were encouraged to refine their ideas taking the discussed issues into consideration or develop new approaches of how to visualize emotions in chat applications. Lastly, we wanted to know what motives users have for using such an application. For this, we stimulated a discussion on privacy concerns regarding emotion detection via facial expression recognition. In particular, we asked them '*Which emotions would you like to share via chats?*' and '*Would you have any privacy concerns using such a feature?*'. Concluding our focus groups we asked if participants would be willing to use such a feature for WhatsApp Web.

Focus Groups Results. In short, participants liked the idea of sharing emotions with their chat partners stating that: *"Writing in general is a source for misunderstandings".* Participants mentioned that they would prefer both, getting feedback on the chat partners' emotion and their own emotion over time. In addition to the concept of sharing emotions implicitly, they also mentioned that disclosing emotions explicitly as a reaction to particular messages could be desirable. Throughout the discussions, privacy concerns were emphasized as one of the core problems. Besides data security, one of the main concerns raised, was the permanent disclosure of emotions which was expressed in quotes like *"There are emotions that you want to filter in general. I think that most people do not want others to know that they are angry at the very moment."* Additionally, some participants mentioned that it is hard to tell and also depends on their situation with whom they would like to share their emotions. They argued

that maintaining control over the emotions shared is an important aspect for them. Thus, it should be possible to enable/disable the feature for each chat partner individually. Likewise, participants wanted to have the feature of emotion recognition to be disabled as a default configuration for each chat partner. Another important issue mentioned, was the bidirectional communication of emotions. This implies that either both chat users share and see emotions, or no information is being displayed. As one participant pointed out: *"One is only willing to reveal something about oneself, if one gets something in return."* This reflects the attitude of most of our participants, which is similar to the approach current chat applications follow (e.g., WhatsApp read receipts). Different parts of the interface can be modified to display emotions (e.g. the messages, profile pictures, background), as well as various means such as colors or images. Our focus groups participants created a set of different emotion visualizations (cf. Figure 2). Participants in both focus groups preferred visualizing emotions using colors. Besides tinting the profile picture of the chat partner in emotion-associated colors, the participants argued for coloring the background in different gradients and alternatively the chat bubbles as another option. However, the choice of color was also subject to discussions. The second focus group remarked that the mapping between colors and emotions holds some danger of subjectivity for users. While the first focus group did also reflect on this emerging problem, they suggested to let users choose themselves which colors they would like to assign the emotions to. Similarly, the implementation of changes in the chat partners' profile pictures was discussed. Another way of including emotions is visualizing them in the text itself. In addition, participants agreed on the fact that visualizations should be unobtrusive and intuitively understandable.

5 APPARATUS

From the focus groups results we inferred user controls and permissions, developed a concept, and accordingly, built AffEXT: A Chrome browser extension which integrates facial emotion recognition in WhatsApp Web using four different visualizations. Taking an existing chat application which is known to its users ensures that the variety of features and number of contacts is appropriate and it is regularly used.

Set of Emotions

The utilized set of emotions has been introduced by Ekman and Oster [14]. Since happiness, surprise, anger, and sadness are universal emotions that are understood among different age groups and cultures, we decided to focus on these four. We excluded contempt, disgust and fear [16] on purpose due to our focus groups participants' statements saying that they did not want to see whether their chat partner experiences adverse emotions preventing unpleasant and embarrassing
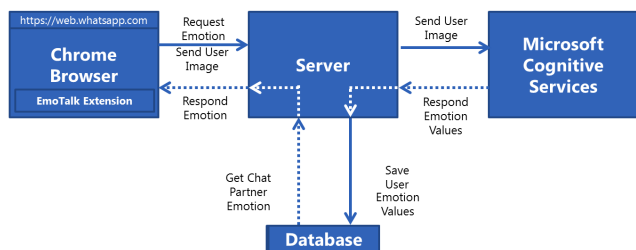
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[1]https://web.whatsapp.com/

Figure 3: Overview of the AffEXT system. An image from the user's web cam is send via our server to the Microsoft API and the returning emotion values are stored in our database.

situations for both chat parties. Neutrality has been included in our set because we wanted to clearly communicate the fact that currently no emotion was detected [10].

Implementation of AffEXT

To be able to customize WhatsApp Web without the aid of an API we built a Google Chrome browser extension that injects code in the WhatsApp Web website. It is built using Javascript, HTML, and CSS. It is connected to an external PHP server and a database (cf., Figure 3). Once the Chrome extension is installed and Whatsapp Web is loaded for the first time, the user is asked to allow the web cam stream for this website. Facial expressions are extracted through the web cam image using the Microsoft Emotion API [48] like related work did before [30, 41, 69]. The web cam captures user pictures every 10 seconds and sends it to our PHP server. Our server then uses the Microsoft API which responds with a JSON string containing the accuracy values according to the basic emotions in percentage between 0 and 100, namely anger, happiness, neutral, sadness, and surprise. The emotion scoring the highest values is then chosen to be stored in our database and communicated back to the Chrome extension to be displayed depending on the currently chosen visualization. If no emotion exceeded the 50% classification accuracy,the event is displayed as *"neutral"*. As soon as two chat partners enable the Chrome extension, the data is sent from the server to the extension and, thus, the emotion is visualized.

AffEXT Visualization Modes

To represent emotions in chats, we picked four visualization modes (cf. Figure 4) preferred by the focus groups' participants and based on prior work, to be displayed by AffEXT.

Colored Background. Based on the detected emotion of the chat partner, the chat window's background color changed [22, 39, 46, 60]. Only the current chat partner's emotion could be seen but not their own emotions (cf., Figure 4, A). We took red for indicating anger, yellow for happiness, dark blue signaling sadness, and light blue for surprise, being inspired by Plutchik et al. [46] and natural associations [43]. We chose

gray to indicate neutrality, in this case no emotion detected. To prevent people from misinterpreting colors, we provided a key indicating which color signifies which emotion, that has been visible in both color-based modes.

Colored Chat Bubbles. Using the same color mappings as for the colored background mode, the chat bubble for each message sent was colored depending on the detected emotion. Both chat partners saw their own and the partner's emotions; each message was linked to an emotion (cf. Figure 4, B).

Font Change. The message's font changed according to the captured emotion when receiving a message [6]. For surprise, the font showed spaces between each character [7]. A capitalized text signified anger [12], for happiness an italic text was displayed [7], and for sadness the text had a line over it. Users saw their own and their partner's emotion through the font change per message (cf. Figure 4, C).

Profile Pictures. Users could take dedicated pictures of themselves for each emotion. These pictures were displayed as a profile picture when the corresponding facial expression was recognized which has been implemented similarly through 3D avatars [17] and animated agents [35]. Each user only saw the chat partner's emotion signified through his or her profile picture (cf. Figure 4, D).

User Controls and Permissions

Users were asked to give their initial permission to use the webcam before starting the extension. AffEXT's interface consisted of the following elements (cf., Figure 4): First, there was a button displayed as a capital **E** which had an underlying checkbox; this button enabled or disabled the extension. Additionally, users could blacklist people from their contact list to ensure that they would not exchange emotions with them [38]. Further, the feature could be enabled/disabled for each chat partner by clicking on a button when opening the particular chat window. To ensure that users did not entirely forget to use AffEXT, we prompted users with a pop-up notification whenever it had been disabled for too long or when the face could not be detected. Based on participants feedback saying they also wanted to see their own emotions, we added the "My Emotions"-button listing all detected emotions sorted by the time stamp when they had been tracked. Accordingly, we developed two visualization modes in which the sender's emotions were also displayed in the chat window: *colored chat bubbles* and *font change.*

6 EVALUATION

To explore the effects of emotion representation in chats and to evaluate we conducted a field study for the duration of four weeks. In particular, we investigated user preferences and the potentials of using beyond the study. For this, we asked
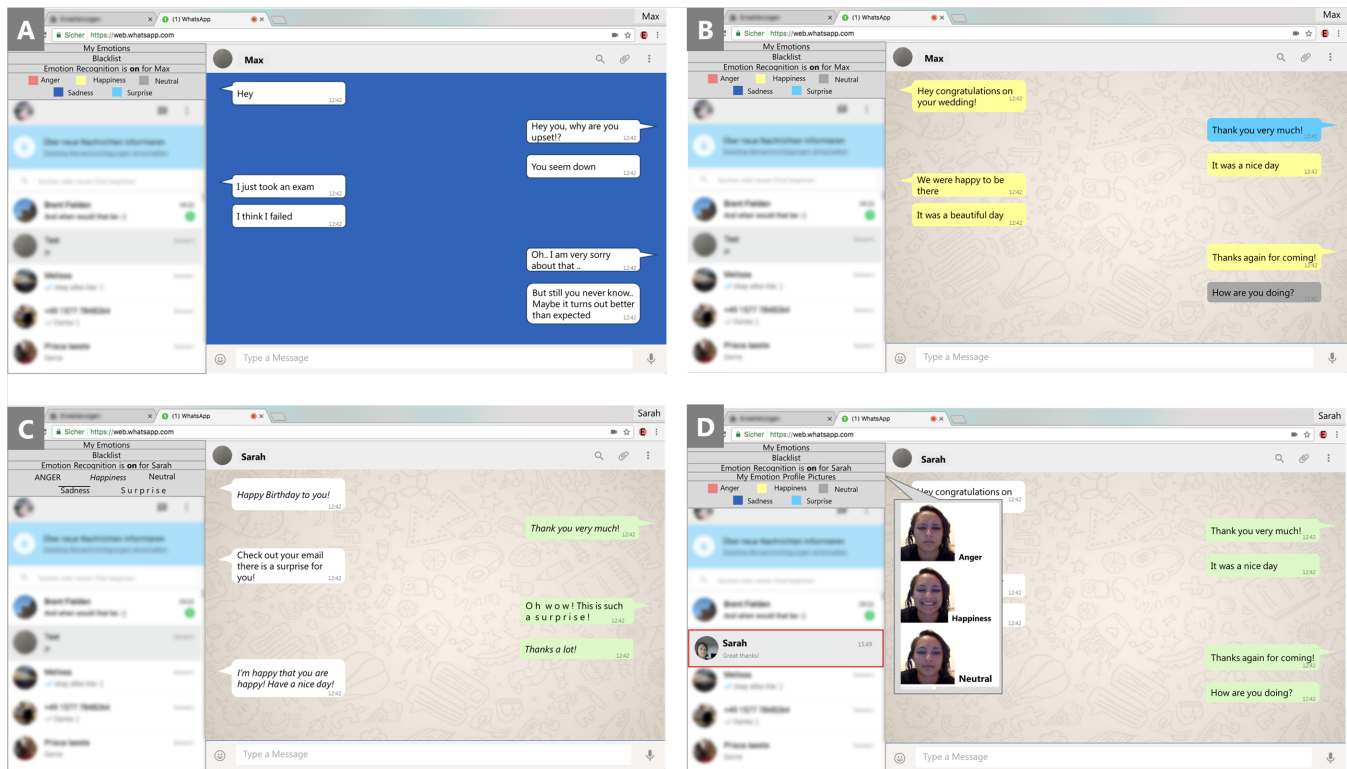
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Figure 4: AffEXT's UI showing the WhatsApp Web interface with the emotion visualization key on the left bar for the four implemented visualization modes: (A) Colored Background: The chat partner's emotion is inks the background color of the chat window. (B) Colored Chat Bubbles: Both chat partners' emotions are indicated by the color of the chat bubble. (C) Font Change: Both chat partners' emotions represented through font changes depicted in the chat bubbles. (D) Profile Pictures: The chat partner's emotion is shows in his/her profile picture.

the participants to use our system in all contexts whenever they communicated via WhatsApp Web including working environments. Affective states were only visible for those chat partners who had installed our plug-in.

Study Design

Participants used each of AffEXT's four different visualization modes for one week randomized among all participants according to Latin square resulting in a within-subject study design. We collected qualitative information through 48 semi-structured single interviews and 64 questionnaires which were conducted after every week of using the visualizations.

Participants and Procedure

We recruited 34 participants of which 28 participants fully completed the study (23 male, 5 female) having a mean age of 24.4 years (SD = 7.4). All participants were acquired via university mailing lists and personal contacts. We deliberately looked for pairs of participants that were regularly engaged in conversations with each other. Hence, we ensured that the chat teams knew each other beforehand and already chatted with one another on a regular basis sharing

interests, etc. We instructed them to chat at least once a day with their chat partner for a duration of 10-20 minutes at minimum. We interviewed six randomly chosen groups (8 males, 4 females; 2 groups identified as fellows, 3 as friends, and one as colleagues) consisting of two chat partners four times each during the study participation which resulted in 48 single semi-structured interviews. We sent qualitative questionnaires to another eight groups comprising 16 participants, also four times during the study which made a total of 64 questionnaires to be included in our analysis. 20 participants were students with Engineering or Computer Science background, five were PhD students, one employee and another two participants who did not disclose their occupation. Each participant received 30 Euros as compensation for their participation. The study was ethically approved by the Ethical Committee of our institution. Before the study began, each participant received an email including the details of the study procedure and an explanation of data being collected, a consent form, and a guide on how to install the extension. After receiving the signed consent form, each participant was sent a short questionnaire collecting demographic information (i.e., age, gender). With the installation

of the extension, the first visualization started automatically and switched to the next after seven days. After one week of usage of one visualization, each participant was either invited to a personal semi-structured in-depth interview or was administered a questionnaire, both inquiring the same. The entire study included four of these inquiring sessions per participant and one for each visualization. Participants stuck to their role as either interviewees or were inquired via questionnaires. All interviews were audio recorded with the interviewees' consents. The interviews were carried out separately lasting between 20 and 30 minutes each.

Qualitative Data Analysis

Analyzing the 48 semi-structured interviews, we first transcribed all the data from the recorded interviews. Afterwards two experimenters separately coded the transcribed data deducing important aspects. Subsequently, the emerging framework was compared among the two analytics and those which did not match were extensively discussed until a consent was reached. In our analysis, we also included the 64 qualitative questionnaires addressing the same questions as in the interviews. Using this analysis approach, we received feedback on the users' genuine impressions sharing emotions in chats and caught reflections upon design improvements.

Interview Questions Set

Our interview question set consisted of 15 questions derived from the main aspects mentioned in the focus groups shaping our AffEXT concept. Two questions polled which emotions were shared or not shared during AffEXT's usage. Three questions assessed in what kind of situations and with whom the participants wanted to share or not to share their emotions also tackling the personal disclosure. Accordingly, we wanted to know if the interviewees had any privacy concerns regarding the usage and whether they would use AffEXT privately. From the perspective of a *"receiver"* we inquired which emotions the participants would like to see and if this stimulated talking to a chat partner. Further, we collected opinions on the different visualizations including comparative observations and inquired how helpful and beneficial the emotion representation was perceived. Lastly, we asked which additional emotional responses they would like to express in chat applications and if they had any ideas to improve emotion representation in chats.

7 RESULTS

Next, we present our qualitative results gathered in the four weeks of our user study providing the participants' feedback on AffEXT. Every group is encoded with 'Gr*n*' for a group number and each participant of a group is encoded with 'P*n*'. Consequently, we refer to our 28 participants by addressing their group number and participant number as 'Gr*n*P*n*' in

the following. Statements assessed using questionnaires are not marked as quotes but are represented through non-literal paraphrases. None of the participants participated in our previously conducted focus groups and all quotes are provided in English translated from native language.

Feedback on Representing Emotions in Chats

At length, users found the concept of presenting and visualizing emotions in chats interesting. In total, 22 participants explicitly stated that *"it is cool"*, *"a nice gimmick"*, or regarded it to be *"helpful"*. For example, Gr3P2 mentioned that she often *"noticed the emotion as a means to emphasize a statement"* and, hence, interpreted the text in combination with the emotion. Some participants mentioned that *"it brings you closer together"* because it was perceived as if *"you faced each other"* [Gr2P1]. Further Gr5P2 said that *"in the current form of communication [chats] there is something getting lost and this feature brings it back"*, which reflects the users' opinion referring to AffEXT as providing an added value. Many users also clarified that it helps to reduce misunderstandings. Whereas Gr2P1 even considered this feature to be a *"signpost for emotions"*, another two participants said that they did not use facial expressions much in chat conversations which contributes to the statement of participant Gr5P1 reporting that he did not *"see an advantage that cannot be achieved by using emojis"*. With respect to using AffEXT prospectively in their everyday lives, ten participants phrased that they would use emotion representation in instant-messaging exclusively for related persons, e.g. family. Several interviewees explicitly said that they would *"not use it for colleagues"* [Gr1P2] or *"in business contexts"* [Gr6P1]. Another participant referred to the distinction as whether he knows his chat partners in the real-life, and encounters them frequently, or just communicates via chats., while two participants confirmed a non-exclusive usage.

Monitoring Emotions is Preferred

The visualization using coloured chat bubbles was perceived best in general. An advantage was the *"unobtrusiveness"*, *"intuitiveness"*, and that it *"provides all the necessary information simultaneously"*. A participant said that it facilitated *"displaying the emotions mutually"*, which enabled tracing back conversations [Gr2P1]. Asking the users how intuitively they evaluated each visualization, there was a strong tendency suggesting that the coloured modes were perceived more intuitive compared to the text and profile pictures modes. Five participants clarified that this is because colours were signifying the associated emotions intuitively. Some participants would have liked to choose the colours representing their emotions explaining that some people *"associated different feelings with colours"* [Gr1P2]. Concurrently, the font visualization mode dissatisfied participants who already used

italic or bold fonts in their chat conversations. From the perspective of personalization, the profile picture condition was perceived paramount. Gr2P1 said *"it was more personal since you could see the chat partner's face"*. Regarding the obtrusiveness of visualizations, ten interviewees remarked that the profile picture visualization mode was too unobtrusive. Saying that they did not realize that the profile picture changed owing to its small size. Other chat teams indicated that they appreciated this particular mode more because they took funny pictures exaggerating mimics which made them laugh. Also some participants criticized the fonts as *"less intuitive"* or *"boring"*, others liked the fact that it was less obtrusive than the coloured modes for example.

The Kind of Emotion is Important

Considering unveiling emotions in general, most of the participants said that it was either dependent on the context, the chat partner, or the particular emotion itself whether they were willing to share emotions. Twelve interviewees directly mentioned that they would prefer visualizing emotions rather in easy conversations e.g. talking about superficial or funny things than in serious conversations about work or encountering private problems. Gr1P2 explained that this was because happy topics are beneficial for a comfortable atmosphere. Another explanation for not sharing negative emotions, such as sadness or anger was that *"sadness is something very private"* [Gr4P2]. Multiple participants stated that *"it is nicer to see positive emotions"* [Gr5P1], especially from colleagues and people who were not very close. They also stated they would feel pressured to ask why the person is in a negative mood (i.e. angry/sad). Several participants explained that they would have liked to see adverse emotions only depending on their relationship with the sender. The closer the relationship was, the more emotions they wanted to see [G2P1, Gr3P2, Gr5P1]. Eight interviewees said they would have preferred to see all of the chat partners' emotions, but that it depended on the emotions which they themselves would want to share. One participant argued for seeing all of the others' emotions following the principle of *"all or nothing"* [Gr1P1]. Further, the interviews revealed that privacy and associated concerns (e.g. data misuse) played a considerable role for them when considering sharing emotions. All participants agreed that since they participated in a scientific study, they did not feel their privacy was being violated. We inferred that users perceived the threat on two different levels. First, they feared a misuse of their data and second, they felt more vulnerable since *"one becomes more open"* because of the web camera being turned on [Gr5P1]. Asking them how privacy threatening they perceived facial expression recognition via web cam use in general, 26 participants admitted that they felt a bit uncomfortable having the feeling that others (i.e. the chat partner, third parties) would

watched him/her. Multiple participants said that they were usually *suspicious* if an application required the camera rights [Gr2P2, Gr3P2, Gr4P2]. Others argued that it depends on who receives the data and respectively where it was stored. Four participants stated that they were already masking their web cams always because they had heart of incidents when the web cam data was misused. On the other hand six participants reported that they had no concerns since (a) the web cam and respectively the feature could have been turned off easily, (b) the feature had been used in the study context only, and (c) their data had already been acquired by *"the internet"* and, thus, huge companies such as Facebook, Microsoft, or Google would have had their private data *"anyway"*.

Potential Improvements of AffEXT

Although our participants found the concept of enriching chats through emotion visualization interesting and *"more personal"* [Gr6P1], they wished to improve or add some features. For example, Gr3P2 argued that displaying a neutral state was critical because this could have been perceived as negative feedback, for example, if the chat partner was telling a joke. A desirable feature would have been having emojis suggested based on the detected emotions [Gr5P2]. Furthermore, some interviewees wished to blacklist emotions additional to switching the feature on/off for particular chat partners, for example negative emotions for particular contacts. Two participants requested a confirmation button to remain control over the sent emotion. As for additional emotional responses, seven subjects said that they would have liked to display different levels of one particular emotion or visualize a fine-grained range. For example Gr5P1 explained that she would have appreciated to see different stages of *"feeling happy and thinking something is funny"*.

8 DISCUSSION

Regarding the overall usage of instant-messaging applications our findings are in line with prior work confirming that chats are mostly used for communicating with friends [5]. The distinction between private and business environments was regarded to be extremely important by our participants. A possible explanation could be that there are different topics, such as work tasks or negotiating ability [23] that are usually discussed in workplace chat applications. In sum, our results suggest that emotions in chats shall be exclusively presented and shared in private, rather than in business contexts.

Preferred Visualizations

Based on the participants' statements the colored chat bubbles visualization was perceived paramount. One of the reasons mentioned, was that this mode provided feedback directly in the chat window on the sender's emotions too. This criteria also seems crucial for how deliberately users

wanted to share their emotions. Some argued that it felt more transparent for them if their emotions were displayed simultaneously. Likewise, retracing emotions in conversations allowed users to take a look in the past which stimulated self-reflection. Another important factor was the unobtrusiveness of the visualization which had been discussed in the focus groups. Oviatt and Cohen [44] emphasized the "trade-off" regarding obtrusive interfaces, which we also found in our users' opinions. While some participants argued for an unobtrusive visualization, others appreciated clear visibility. Further, users named the advantage of being able to trace back the conversation's emotional theme in the colored chat bubble mode- even if it happened a day ago. Regarding the visualization modes using colors, a disadvantage was that colors could be associated with different emotions and therefore being misinterpreted. Some users said this issue could be solved by choosing colors reflecting the emotions individually. After all, we could observe that visualizations modes were perceived ambiguously. Whereas some participants found the colors representing emotions intuitively comprehensible, others wished to be able to choose colors individually. Accordingly, we conclude that users appreciate certain degrees of freedom in designing visualizations for sharing emotions in chats.

Maintaining Control over Emotions

As has been observed in the results, most of the users enjoyed presenting and sharing emotions in chats. They perceived it beneficial since chatting was experienced as *"more personal"*. Nevertheless, the increased individual notion of the chat added through the emotion representation, was seen ambiguous by our participants, since they had controversial opinions on their willingness to share emotions with chat partners. While some interviewees did not have any concerns and were willing to share their emotions with all of their contacts openly, other participants argued that they would like to share positive emotions exclusively because sharing negative emotions could be uncomfortable and was rather a private matter. This is in line with findings from related work [25]. Two main factors can be derived determining whether an individual wants to share his/her emotions: first, the particular situation a person is facing; second, the particular chat partner the person is communicating with. According to our findings, these two factors are essential for the decision whether one would like to openly share emotions or not. Besides the privacy playing an important role, the participants also assumed a feeling of "control" which they wanted to maintain while sharing emotions. This desire of control goes beyond regular interface design guidelines that suggest to make the user the initiator of an action [59], which is why we address it in our design recommendations.

Privacy is an important issue for most of the participants. When being asked about embedding emotion representing chats in real life, our participants mentioned privacy related issue, for instance how the data was stored. Despite the fact that being seen is a well known privacy concern of camera based systems also mentioned by the majority of our users, almost a quarter of our participants stated that popular internet services such as Facebook, Microsoft, and Google *"know everything anyway"*. Thus, we found a broad spectrum in our sample ranging from sensitive users who masked their web cams to those who accepted the loss of privacy as a drawback of the internet. This controversial perception among user groups was also observed in a study by Church and De Oliveira [8]. Participants were asked whether they had any privacy concerns regarding their chat partners being able to see when they had been online last in WhatsApp. Only one user argued that this felt like *"an invasions of privacy"*. These findings reflect the ambiguity designers, developers, and also companies elaborating messenger services, have to deal with when it comes to user concerns relating to privacy. Accordingly, Godefroid et al. [21] proposed a framework that helps to comply with data policies aiming to increase the degree of user's confidence when dealing with collaborative platforms. Consequently, we felt that how is being dealt with personal data needs to be communicated transparently.

Being Picky with Emotions Represented

The majority of our users preferred seeing positive over negative emotions also partly to avoid social pressure. Riva et al. [51] classified positive technologies based on their function to promote well-being. Scaling down AffEXT to representing positive feelings only, would be considered as an hedonic and social technology meaning that it provokes pleasant feelings while increasing the connectedness between chat partners. Accordingly, participants raised the issue of social pressure in chat conversations in terms of feeling implicitly obliged to ask the chat partner why he/she is having the negative emotion. This is supported by the results from Church and De Oliveira [8], who identified in their research that expectations are raised by visual indicators of a message's delivery. One of their participants explicitly phrased her frustration saying that "*[...] If you're offline then I don't expect but if you're online, it sort of means that it's in front of you and you are doing other stuff and you are ignoring me*". This phenomenon can be related to a *response pressure* described by Renaud et al. [49], who found that recipients felt pressure to respond when they had to deal with e-mails. Transferring this observation to chat behavior, our participants did not want to feel the urge to respond to adverse emotions displayed, which explains why they preferred seeing positive emotions only. Thus, positive emotions in chats are more desirable because they do not pressure the chat partner to react on them.

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9   DESIGN RECOMMENDATIONS

Based on our findings, we derived the following four design recommendations intending to support the development of chat platforms visualizing affective states.

Allow Fine-Grained Control of Emotion Sharing. One of the core aspects mentioned in the focus groups and user study, is that they wanted to stay in control of which emotions are shared, when and with whom. Statements like *"Sadness is something very private"* and *"There are emotions you want to filter in general"* underline that the system should offer capabilities to deliberately chose which user receives which emotions. This feature should be adjustable on a user basis, so that each potential chat partner can be granted access to certain shared emotions. Providing for example a checkbox that could be turned on and off according to specific situations could be an envisaged solution. Further, we argue for an additional control mechanism in the chat partner's interface referring to the associated social pressure. Since users did not want to feel pressured by seeing undesired information such as adverse emotions of their chat partner, the fine-grained control of all emotions on both sides is important. Particularly, users would like to be more in control of turning on and off the view of the chat partner's emotions.

Allow Customization of Visualization. Exploring various visualizations within this study, we found that users interpret certain design properties differently. As participants correctly emphasized *"For some people green is a happy color, for others red is a happy color"*, which is why users should be allowed to customize visualizations. Due to the individual nature of emotional responses and the high demand of intuitiveness, as mentioned in both, focus groups and interviews, choosing colors or profile images for emotions supports the user in understanding the communicated emotion. It further allows the feature to meld with the chat application and to deliver the emotions without distracting the user too much from the actual purpose of the application, namely chatting.

Provide Feedback on own Emotions. While receiving the emotions of a chat partner is the main use case, we also found that seeing their own emotions is demanded by users. On the one hand, this serves as a control mechanism and, on the other hand, this helps the users to be aware of their emotions and supports self-reflection. *"Displaying the emotions mutually"* helps the sender to reflect on what his or her current emotional state is and how this message can be perceived by the receiver, what may prevent misunderstandings.

Respect the Privacy of Emotions. Emotions are among the most private information one could share with others. Thus, users are particularly keen on having these information securely stored and not accessible by others. The fact that many participants reported that they were *"suspicious"* or felt *"watched"*, emphasizes the underlying fear that *"some companies create profiles"* as highlighted in the focus groups. Accordingly, clearly communicating how and where information on emotions are stored, as well as who has access to them is important to create trust among the users.

10   LIMITATIONS AND FUTURE WORK

Although, 16 participants said happiness and surprise were recognized well, AffEXT's reliability was perceived only moderately. Using facial expressions for emotion detection in general yields some inherent drawbacks. Tantamount to that users do not always express their emotions through facial expressions or conversely could fake an emotion, one facial expression might involve more than one affect. For this, the classification being processed via the Microsoft Emotion API [48] cannot be regarded as ultimately accurate, although it is well suited to detect emotions that are well expressed by the user (e.g., a broad grin) and considered to be one of the latest and most powerful APIs. This can be observed from the underlying recognition process, being that each emotion is assigned a value between 1 and 100. Only those emotions that exceed 50 are classified, while the others are neglected.

11   CONCLUSION

In this work we investigated potential effects, risks and preferences on how emotions are displayed in chats by comparing four different designs. For this, we designed and built the plug-in browser extension and collected qualitative feedback from 28 users using it for four weeks in the wild. The results revealed that the openness to share emotions was affected by associated privacy concerns, predominantly on data storage. Further, we observed that the person with whom affects were exchanged mattered and even more importantly, the kind of emotion. In this context, the aspect of responsiveness was perceived to partly impose social pressure. Through the user feedback, we found that participants preferred to retrace emotions of oneself and over entire conversations, preferably using colored chat bubbles. Moreover, they preferred having fine grained control with whom emotions are shared by using contact filters for sharing and receiving emotions. Regarding the type of emotions, participants stated they would preferably see positive affects. We derived four design recommendations stimulating novel approaches to improve the augmentation of emotion representation in chats from user, designer, and developer perspectives.

REFERENCES

[1] Jussi Ängeslevä, Carson Reynolds, and Sile O'Modhrain. 2004. EmoteMail. In *ACM SIGGRAPH 2004 Posters (SIGGRAPH '04)*. ACM, New York, NY, USA, 9–. https://doi.org/10.1145/1186415.1186426

[2] Tadas Baltrušaitis, Peter Robinson, and Louis-Philippe Morency. 2016. Openface: an open source facial behavior analysis toolkit. In *Applications of Computer Vision (WACV), 2016 IEEE Winter Conference on*. IEEE, 1–10.

[3] M. S. Bartlett, G. Littlewort, I. Fasel, and J. R. Movellan. 2003. Real Time Face Detection and Facial Expression Recognition: Development and Applications to Human Computer Interaction.. In *2003 Conference on Computer Vision and Pattern Recognition Workshop*, Vol. 5. 53–53. https://doi.org/10.1109/CVPRW.2003.10057

[4] Vinay Bettadapura. 2012. Face expression recognition and analysis: the state of the art. *arXiv preprint arXiv:1203.6722* (2012).

[5] Tatiana Buhler, Carman Neustaedter, and Serena Hillman. 2013. How and Why Teenagers Use Video Chat. In *Proceedings of the 2013 Conference on Computer Supported Cooperative Work (CSCW '13)*. ACM, New York, NY, USA, 759–768. https://doi.org/10.1145/2441776.2441861

[6] Daniel Buschek, Alexander De Luca, and Florian Alt. 2015. There is more to typing than speed: Expressive mobile touch keyboards via dynamic font personalisation. In *Proceedings of the 17th International Conference on Human-Computer Interaction with Mobile Devices and Services*. ACM, 125–130.

[7] Saemi Choi, Toshihiko Yamasaki, and Kiyoharu Aizawa. 2016. Typeface Emotion Analysis for Communication on Mobile Messengers. In *Proceedings of the 1st International Workshop on Multimedia Alternate Realities*. ACM, 37–40.

[8] Karen Church and Rodrigo de Oliveira. 2013. What's up with whatsapp?: comparing mobile instant messaging behaviors with traditional SMS. In *Proceedings of the 15th international conference on Human-computer interaction with mobile devices and services*. ACM, 352–361.

[9] Pietro Cipresso, Daniela Villani, Claudia Repetto, Lucia Bosone, Anna Balgera, Maurizio Mauri, Marco Villamira, Alessandro Antonietti, and Giuseppe Riva. 2015. Computational psychometrics in communication and implications in decision making. *Computational and mathematical methods in medicine* 2015 (2015).

[10] Roddy Cowie and Ellen Douglas-Cowie. 1996. Automatic statistical analysis of the signal and prosodic signs of emotion in speech. In *Spoken Language, 1996. ICSLP 96. Proceedings., Fourth International Conference on*, Vol. 3. IEEE, 1989–1992.

[11] M. Denscombe. 2014. *The Good Research Guide: For Small-scale Social Research Projects*. McGraw-Hill Education.

[12] Michael H Dickey, Molly McLure Wasko, Katherine M Chudoba, and Jason Bennett Thatcher. 2006. Do You Know What I Know? A Shared Understandings Perspective on Text-Based Communication. *Journal of Computer-Mediated Communication* 12, 1 (2006), 66–87.

[13] Joan Morris DiMicco, Vidya Lakshmipathy, and Andrew Tresolini Fiore. 2002. Conductive Chat: Instant messaging with a skin conductivity channel. In *Proceedings of Conference on Computer Supported Cooperative Work*. Citeseer.

[14] Paul Ekman and Harriet Oster. 1979. Facial expressions of emotion. *Annual review of psychology* 30, 1 (1979), 527–554.

[15] Abdallah El Ali, Torben Wallbaum, Merlin Wasmann, Wilko Heuten, and Susanne CJ Boll. 2017. Face2Emoji: Using Facial Emotional Expressions to Filter Emojis. In *Proceedings of the 2017 CHI Conference Extended Abstracts on Human Factors in Computing Systems*. ACM, 1577–1584.

[16] Rana El Kaliouby and Peter Robinson. 2004. FAIM: Integrating Automated Facial Affect Analysis in Instant Messaging. In *Proceedings of the 9th International Conference on Intelligent User Interfaces (IUI '04)*. ACM,

New York, NY, USA, 244–246. https://doi.org/10.1145/964442.964493

[17] Marc Fabri and DJ Moore. 2005. Is empathy the key? Effective communication via instant messaging. In *Proceedings of the 11th EATA International Conference on Networking Entities*.

[18] Marc Fabri, DJ Moore, and DJ Hobbs. 2005. Empathy and enjoyment in instant messaging. In *Proceedings of 19th British HCI group annual conference (HCI2005), Edinburgh, UK*. 4–9.

[19] Jackson Feijó Filho, Thiago Valle, and Wilson Prata. 2014. Non-verbal communications in mobile text chat: emotion-enhanced mobile chat. In *Proceedings of the 16th international conference on Human-computer interaction with mobile devices & services*. ACM, 443–446.

[20] Octavio Garcia, Jesús Favela, Guillermo Licea, and Roberto Machorro. 1999. Extending a collaborative architecture to support emotional awareness. *CICESE, Mexico* (1999).

[21] Patrice Godefroid, James D. Herbsleb, Lalita Jategaonkar Jagadeesany, and Du Li. 2000. Ensuring Privacy in Presence Awareness: An Automated Verification Approach. In *Proceedings of the 2000 ACM Conference on Computer Supported Cooperative Work (CSCW '00)*. ACM, New York, NY, USA, 59–68. https://doi.org/10.1145/358916.358963

[22] Gerald J Gorn, Amitava Chattopadhyay, Tracey Yi, and Darren W Dahl. 1997. Effects of color as an executional cue in advertising: They're in the shade. *Management science* 43, 10 (1997), 1387–1400.

[23] Mark Handel and James D. Herbsleb. 2002. What is Chat Doing in the Workplace?. In *Proceedings of the 2002 ACM Conference on Computer Supported Cooperative Work (CSCW '02)*. ACM, New York, NY, USA, 1–10. https://doi.org/10.1145/587078.587080

[24] Mariam Hassib, Daniel Buschek, Paweł W. Wozniak, and Florian Alt. 2017. HeartChat: Heart Rate Augmented Mobile Chat to Support Empathy and Awareness. In *Proceedings of the 2017 CHI Conference on Human Factors in Computing Systems (CHI '17)*. ACM, New York, NY, USA, 2239–2251. https://doi.org/10.1145/3025453.3025758

[25] Mariam Hassib, Mohamed Khamis, Stefan Schneegass, Ali Sahami Shirazi, and Florian Alt. 2016. Investigating User Needs for Bio-sensing and Affective Wearables. In *Proceedings of the 2016 CHI Conference Extended Abstracts on Human Factors in Computing Systems (CHI EA '16)*. ACM, New York, NY, USA, 1415–1422. https://doi.org/10.1145/2851581.2892480

[26] Kiraz Candan Herdem. 2012. Reactions: Twitter based mobile application for awareness of friends' emotions. In *Proceedings of the 2012 ACM Conference on Ubiquitous Computing*. ACM, 796–797.

[27] Javier Hernandez and Rosalind W Picard. 2014. SenseGlass: using google glass to sense daily emotions. In *Proceedings of the adjunct publication of the 27th annual ACM symposium on User interface software and technology*. ACM, 77–78.

[28] Jonathan Klein, Youngme Moon, and Rosalind W. Picard. 2002. This computer responds to user frustration: Theory, design, and results. *Interacting with computers* 14, 2 (2002), 119–140.

[29] Paul R Kleininna and Anne M Kleininna. 1981. A categorized list of emotion definitions, with suggestions for a consensual definition. *Motivation and emotion* 5, 4 (1981), 345–379.

[30] Evdokimos I Konstantinidis, Antonis Billis, Theodore Savvidis, Stefanos Xefteris, and Panagiotis D Bamidis. 2017. Emotion Recognition in the Wild: Results and Limitations from Active and Healthy Ageing cases in a Living Lab. In *eHealth 360°*. Springer, 425–428.

[31] Joonhwan Lee, Soojin Jun, Jodi Forlizzi, and Scott E. Hudson. 2006. Using Kinetic Typography to Convey Emotion in Text-based Interpersonal Communication. In *Proceedings of the 6th Conference on Designing Interactive Systems (DIS '06)*. ACM, New York, NY, USA, 41–49. https://doi.org/10.1145/1142405.1142414

[32] Myungho Lee, Kangsoo Kim, Hyunghwan Rho, and Si Jung Kim. 2014. Empa Talk: A Physiological Data Incorporated Human-computer Interactions. In *Proceedings of the Extended Abstracts of the 32Nd Annual*

ACM Conference on Human Factors in Computing Systems (CHI EA '14). ACM, New York, NY, USA, 1897–1902. https://doi.org/10.1145/2559206.2581370

[33] Fannie Liu, Laura Dabbish, and Geoff Kaufman. 2017. Supporting Social Interactions with an Expressive Heart Rate Sharing Application. *Proceedings of the ACM on Interactive, Mobile, Wearable and Ubiquitous Technologies* 1, 3 (2017), 77.

[34] Hugo Liu, Henry Lieberman, and Ted Selker. 2003. A Model of Textual Affect Sensing Using Real-world Knowledge. In *Proceedings of the 8th International Conference on Intelligent User Interfaces (IUI '03)*. ACM, New York, NY, USA, 125–132. https://doi.org/10.1145/604045.604067

[35] C. Ma, A. Osherenko, H. Prendinger, and M. Ishizuka. 2005. A chat system based on emotion estimation from text and embodied conversational messengers. In *Proceedings of the 2005 International Conference on Active Media Technology, 2005. (AMT 2005)*. 546–548. https://doi.org/10.1109/AMT.2005.1505418

[36] Daniel McDuff, Abdelrahman Mahmoud, Mohammad Mavadati, May Amr, Jay Turcot, and Rana el Kaliouby. 2016. AFFDEX SDK: A Cross-Platform Real-Time Multi-Face Expression Recognition Toolkit. In *Proceedings of the 2016 CHI Conference Extended Abstracts on Human Factors in Computing Systems (CHI EA '16)*. ACM, New York, NY, USA, 3723–3726. https://doi.org/10.1145/2851581.2890247

[37] Daniel J McDuff, Javier Hernandez, Sarah Gontarek, and Rosalind W Picard. 2016. Cogcam: Contact-free measurement of cognitive stress during computer tasks with a digital camera. In *Proceedings of the 2016 CHI Conference on Human Factors in Computing Systems*. ACM, 4000–4004.

[38] Nicola Millard and Linda Hole. 2008. In the Moodie: Using 'affective widgets' to help contact centre advisors fight stress. *Affect and Emotion in Human-Computer Interaction* (2008), 186–193.

[39] Saif Mohammad. 2011. Colourful language: Measuring word-colour associations. In *Proceedings of the 2nd Workshop on Cognitive Modeling and Computational Linguistics*. Association for Computational Linguistics, 97–106.

[40] Alena Neviarouskaya, Helmut Prendinger, and Mitsuru Ishizuka. 2007. Textual Affect Sensing for Sociable and Expressive Online Communication. In *Affective Computing and Intelligent Interaction*, Ana C. R. Paiva, Rui Prada, and Rosalind W. Picard (Eds.). Springer Berlin Heidelberg, Berlin, Heidelberg, 218–229.

[41] Jan Novotny, Jan Dvorak, and Ondrej Krejcar. 2016. User based intelligent adaptation of five in a row game for android based on the data from the front camera. In *International Conference on Augmented Reality, Virtual Reality and Computer Graphics*. Springer, 133–149.

[42] Mohammad Obaid, Charles Han, and Mark Billinghurst. 2008. "Feed the Fish": An Affect-aware Game. In *Proceedings of the 5th Australasian Conference on Interactive Entertainment (IE '08)*. ACM, New York, NY, USA, Article 6, 6 pages. https://doi.org/10.1145/1514402.1514408

[43] James Ohene-Djan, Andrew Sammon, and Rachel Shipsey. 2006. Colour spectrumâĂŹs of opinion: An information visualisation interface for representing degrees of emotion in real time. In *Information Visualization, 2006. IV 2006. Tenth International Conference on*. IEEE, 80–88.

[44] Sharon Oviatt and Philip Cohen. 2000. Perceptual user interfaces: multimodal interfaces that process what comes naturally. *Commun. ACM* 43, 3 (2000), 45–53.

[45] R. W. Picard. 1995. *Affective Computing*. Citeseer, Pennsylvania State University, PA, USA.

[46] Robert Plutchik and Henry Kellerman. 1980. *Emotion, Theory, Research, and Experience: Theory, Research and Experience*. Academic press.

[47] Ke-Chen Pong, Chi-An Wang, and Shuo Hsiu Hsu. 2014. GamIM: Affecting Chatting Behavior by Visualizing Atmosphere of Conversation. In *CHI '14 Extended Abstracts on Human Factors in Computing Systems (CHI EA '14)*. ACM, New York, NY, USA, 2497–2502.

https://doi.org/10.1145/2559206.2581168

[48] Microsoft Cognitive Services (previously Project Oxford). [n.d.]. Developer Guide. Retrieved July 28, 2017 from https://docs.microsoft.com/en-us/azure/cognitive-services/.

[49] Karen Renaud, Judith Ramsay, and Mario Hair. 2006. 'You've got e-mail!'... shall I deal with it now? Electronic mail from the recipient's perspective. *International Journal of Human-Computer Interaction* 21, 3 (2006), 313–332.

[50] Claudia Repetto, Corina Sas, Cristina Botella, and Giuseppe Riva. 2017. AFFECTECH: Personal Technologies for Affective Health. In *The 15th European Congress of Psychology, 2017*.

[51] Giuseppe Riva, Andrea Gaggioli, Daniela Villani, Pietro Cipresso, Claudia Repetto, Silvia Serino, Stefano Triberti, Eleonora Brivio, Carlo Galimberti, and Guendalina Graffigna. 2014. Positive technology for healthy living and active ageing. *Active Ageing and Healthy Living: A Human Centered Approach in Research and Innovation as Source of Quality of Life* 203 (2014), 44–56.

[52] James A. Russell. 1980. A Circumplex Model of Affect. *Journal of Personality and Social Psychology* 39, 6 (1980), 1161–1178.

[53] Corina Sas and Alan Dix. 2009. Designing for Reflection on Experience. In *CHI '09 Extended Abstracts on Human Factors in Computing Systems (CHI EA '09)*. ACM, New York, NY, USA, 4741–4744. https://doi.org/10.1145/1520340.1520730

[54] Corina Sas, Alan Dix, Jennefer Hart, and Ronghui Su. 2009. Dramaturgical Capitalization of Positive Emotions: The Answer for Facebook Success?. In *Proceedings of the 23rd British HCI Group Annual Conference on People and Computers: Celebrating People and Technology (BCS-HCI '09)*. British Computer Society, Swinton, UK, UK, 120–129. http://dl.acm.org/citation.cfm?id=1671011.1671025

[55] Corina Sas, Alan Dix, Jennefer Hart, and Ronghui Su. 2009. Emotional Experience on Facebook Site. In *CHI '09 Extended Abstracts on Human Factors in Computing Systems (CHI EA '09)*. ACM, New York, NY, USA, 4345–4350. https://doi.org/10.1145/1520340.1520664

[56] Corina Sas, Muhammad Umair, and Muhammad Hamza Latif. 2018. *Designing for Self-Regulation from both Pragmatic and Critical Design Lenses*. http://dx.doi.org/10.1145/

[57] Corina Sas, Steve Whittaker, Steven Dow, Jodi Forlizzi, and John Zimmerman. 2014. Generating Implications for Design Through Design Research. In *Proceedings of the SIGCHI Conference on Human Factors in Computing Systems (CHI '14)*. ACM, New York, NY, USA, 1971–1980. https://doi.org/10.1145/2556288.2557357

[58] Jocelyn Scheirer, Raul Fernandez, Jonathan Klein, and Rosalind W Picard. 2002. Frustrating the user on purpose: a step toward building an affective computer. *Interacting with computers* 14, 2 (2002), 93–118.

[59] Ben Shneiderman. 1997. *Designing the User Interface: Strategies for Effective Human-Computer Interaction* (3rd ed.). Addison-Wesley Longman Publishing Co., Inc., Boston, MA, USA.

[60] Satyendra Singh. 2006. Impact of color on marketing. *Management decision* 44, 6 (2006), 783–789.

[61] J. A. Smith. 2015. *Qualitative Psychology: A Practical Guide to Research Methods*. Sage.

[62] A. Tat and M. S. T. Carpendale. 2002. Visualising human dialog. In *Information Visualisation, 2002. Proceedings. Sixth International Conference on*. 16–21. https://doi.org/10.1109/IV.2002.1028751

[63] Dzmitry Tsetserukou, Alena Neviarouskaya, Helmut Prendinger, Naoki Kawakami, Mitsuru Ishizuka, and Susumu Tachi. 2009. iFeel_IM! Emotion enhancing garment for communication in affect sensitive instant messenger. In *Human Interface and the Management of Information. Designing Information Environments*. Springer, 628–637.

[64] Muhammad Umair, Muhammad Hamza Latif, and Corina Sas. 2018. Dynamic Displays at Wrist for Real Time Visualization of Affective Data. In *Proceedings of the 2018 ACM Conference Companion Publication*

on Designing Interactive Systems (DIS '18 Companion). ACM, New York, NY, USA, 201–205. https://doi.org/10.1145/3197391.3205436

[65] Fernanda B. Viégas and Judith S. Donath. 1999. Chat Circles. In *Proceedings of the SIGCHI Conference on Human Factors in Computing Systems (CHI '99)*. ACM, New York, NY, USA, 9–16. https://doi.org/10.1145/302979.302981

[66] Hua Wang, Helmut Prendinger, and Takeo Igarashi. 2004. Communicating Emotions in Online Chat Using Physiological Sensors and Animated Text. In *CHI '04 Extended Abstracts on Human Factors in Computing Systems (CHI EA '04)*. ACM, New York, NY, USA, 1171–1174. https://doi.org/10.1145/985921.986016

[67] Beverly Woolf, Winslow Burleson, Ivon Arroyo, Toby Dragon, David Cooper, and Rosalind Picard. 2009. Affect-aware tutors: recognising and responding to student affect. *International Journal of Learning Technology* 4, 3-4 (2009), 129–164.

[68] Z. Zeng, M. Pantic, G. I. Roisman, and T. S. Huang. 2009. A Survey of Affect Recognition Methods: Audio, Visual, and Spontaneous Expressions. *IEEE Transactions on Pattern Analysis and Machine Intelligence* 31, 1 (Jan 2009), 39–58. https://doi.org/10.1109/TPAMI.2008.52

[69] Yu Zhu, Yan Li, Guowang Mu, and Guodong Guo. 2015. A study on apparent age estimation. In *Proceedings of the IEEE International Conference on Computer Vision Workshops*. 25–31.